LEAN STRATEGIES FOR FURNITURE MANUFACTURING

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ABSTRACT

The aim of this paper is to explore the various requirements needed for the implementation of lean strategies in a job shop environment, which is a significant sector in the manufacturing industry. In particular we test the methodology in the furniture industry.

Application of Lean in the job shop environment stumbles on a variety of obstacles, primarily due to the high product mix, which explains why extensive utilization of lean is not reported in the journals for this industrial sector.

Most of the reported applications and documentations are discussing lean in cases where there are a few families of high volume products and processes involved. The reports mainly fail to detail the ways waste is removed. The recommendations are far from applicable when thousands of parts in low quantity and several nonlinear processes are involved. Most papers, which refer to the issues, do not attempt to suggest improved approaches. This paper aims to extend the scope of lean strategies in the job shop environment by improving existing methodologies through employing some Industrial Engineering techniques with more technical detailed issues encountered in implementation stage. A new methodology is introduced and exemplified by the result of a case study conducted at a furniture manufacturing company.

Key Words: Lean Manufacturing, Furniture Manufacturing.

1. INTRODUCTION

The objective of a lean manufacturing system is to minimize the consumption of resources that added no value to a product. Lean Manufacturing can be defined as: "A systematic approach to identifying and eliminating waste (non-value-added activities) through continuous improvement by making the product flow at the pull of the customer in pursuit of perfection" (Tennant, 2000). Taichi Ohno(1988) linked it to shopping in a supermarket where the customer purchases exactly what is needed, when needed. As purchases occur and are recorded, the shelves are immediately restocked and all applicable departments are notified (Vasilash, 1999). Other pioneers who have contributed to Lean Manufacturing include Henry Ford, Shingeo Shingo, W. Edwards Deming, Taiichi Ohno, Heijunka (Johan Bicheno, 2000).

(Dossenbach, 1999) has discussed the urgency behind lean manufacturing implementation that he described as the Titanic Syndrome. The warning implies that every furniture manufacturer, wood products supplier, and millwork factory should perform a critical review of their company every two to three years to identify and eliminate weakness and waste, or face the competition unprepared. All his recent articles (Dossenbach, 2000), (Dossenbach, 2001), (Dossenbach, 2002) discuss lean strategies only in the terms of value added and non-value added activities. However such a distinction by itself is not sufficient to become lean or to help dramatically reduce the production lead-time in this industry.

(Adams, 1999) points out that in the furniture industry there are millions of components that make the task of implementing lean manufacturing system more difficult due to the complexity of the product mix. (Koski, 2000) advocates investing in newer more modern machinery for quicker setup and processing time. However quicker processing time saves in value added activity while the lean focus is more on non-value added activities where waste occurs.

(Christianson, 2000) discusses the introduction of manufacturing cells in the furniture industry. Further more (Allegri, 1984) pointed out that facility layout design and cellular manufacturing significantly affects the total manufacturing cost and performance of manufacturing systems. The problem faced in applying cellular manufacturing in the furniture industry is how to deal with this high variety / low volume (HV/LV) environment. (Stockton et al., 1995) points out many reasons why the traditional approach of identifying and adopting group technology cells is inadequate for HV/LV producers such as the furniture industry.

(Bozzone, 2002) points out that theory of constraints and load scheduling can't be used in the job shop environment due to high product mix and variation in load on each machine.

The first introducer of value stream mapping (VSM) in (Rother and Shock, 1998) point out that it is important to understand clearly that we need to focus on one product family. They state that, "Drawing all your product flows on one map is too complicated" (Rother and Shock, 1998 P6). To apply VSM to any organisation we need to select the product or product families, which sell most to draw the current and future state map for.

(Tennant et al., 2000) lists many techniques associated with lean manufacturing. The applicability of those techniques in high product mix environments such as the furniture industry stumble on a variety of obstacles, primarily due to their diverse product mix with many dissimilar routings. Even though some of the standard elements of "Lean ", such as work place organisation (5S), set-up time reduction could be applied to this manufacturing environments, there is a need for new approaches and specifically suited tools.

2. EXPERIMENTATION OF LEAN TECHNIQUES

<u>VSM Method at the Studied Company</u>

A VSM was developed for the current state of producing a product that sold most at the host company. The study showed that using VSM helped to improve the ratio of non-value added to value added activities with less throughput time and shorter customer lead-time. VSM helped visualisation when there were more than a single process level; it provides a clear vision of the business operations. However, there were some difficulties in using VSM in this typical job shop environment, including:

- To plan based on 80% of sales units need to improve the flow of several thousands of different components leading to several thousands different or one messy VSM. Is VSM an appropriate technique to develop the lean implementation strategies under high product mix environment?
- VSM does not have any facility to consider shared resources in presence of many different parts.
- Scheduling the high product mix to produce any part when the next process needs the parts is complicated, particularly when long setup time is required.

This problem has been addressed in Mixed Model Value Stream Mapping (MMVSM) based on the concept of shared resources, machines that produce components more than one product family, introduced by Duggan (2002). The author points out that it is best to consider product family by looking at the group of parts, which have similar work content after the shared resource, thus defining a product family as a group of products that passes through similar downstream processes to the customer as a pull system. The product families are formed by rank order clustering (ROC) and the capacity requirements needed to schedule them through the value stream.

The application of MMVSM at the company proved that the concept of shared resources was helpful to allocate supermarket models in our future state maps. Examining the operation process charts at the company identified that the first two manufacturing operations for most of parts produced are the same, which are docking and moulding. Therefore, the flow, starts after those two operations and controlled by the use of a supermarket model with a maximum production limit to control the consumption of this material.

As a result of the study at the company we find that applying Mixed Model Value Stream Mapping in the furniture industry stumble on the following obstacles:

- ROC algorithm is an inefficient method to develop group families in a high product mix environment. As (Efstathiou and Golby, 2001) points out human interaction is needed to modify the groups.
- Most of the machines are shared among other product families.

The new approach attempts to overcome these obstacles.

3. THE PROPOSED METHODOLOGY FOR LEAN IMPLEMENTATION

The following is a brief description of the proposed methodology, as tested at the host furniture company, where most products share the same resources or have very similar routings.

- Develop a product quantity sales analysis to determine the product that contributes to 85% of sales to identify where we need to focus our recourses.
- Conducting ABC analysis or pareto chart, Figure 1, showed 10 different product ranges, which involve 143 units or 1800 components worth 87% of sales. This reflects the high complexity of the process due to the high number of units involved in planning and scheduling production.
- Use Production Flow Analysis for the top product groups such as (PFAST) (Irani at el., 2000) and from-to-chart analysis, four alternative layouts were developed, those layout were achieved, as in Table 1.

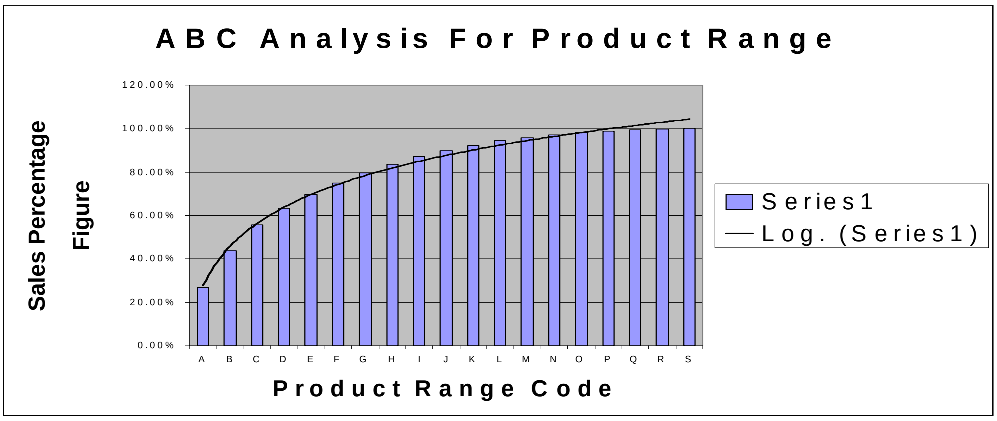
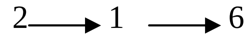
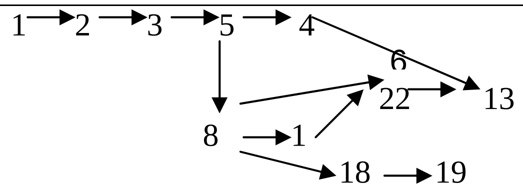
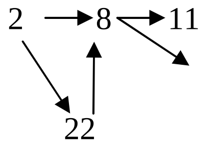
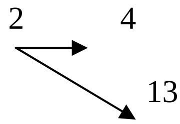
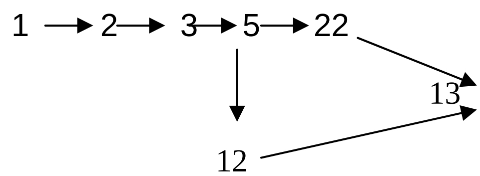
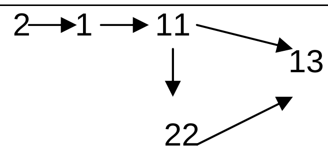
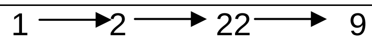
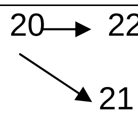


Figure 1. ABC Analysis for Product Ranges

Table 1. Layout Modules, the numbers in column 3 represents different workstation codes.

<table>
<tr><th>Module #</th><th>Cluster group obtained form PFAST</th><th>Layout module created for each cluster. Shows material flow lines</th></tr>
<tr><td>M1</td><td>Centre Bar K/Q</td><td>
</td></tr>
<tr><td>M2</td><td>Side Rail, Bed head Leg, Bed Foot Leg, Draw Front Small, Draw Front Large, and Top Draw Front.</td><td>
</td></tr>
<tr><td>M3</td><td>Filler, Divider, Back Rail, Cross Rail</td><td>
</td></tr>
<tr><td>M4</td><td>Base, Plinth</td><td>
</td></tr>
<tr><td>M5</td><td>Tops, Turning, Floor</td><td>
</td></tr>
<tr><td>M6</td><td>Bed Cross Rail</td><td>
</td></tr>
<tr><td>M7</td><td>Fascia</td><td>
</td></tr>
<tr><td>M8</td><td>Back, Shelves, door Panel, Ply bottom, Unit side.</td><td>
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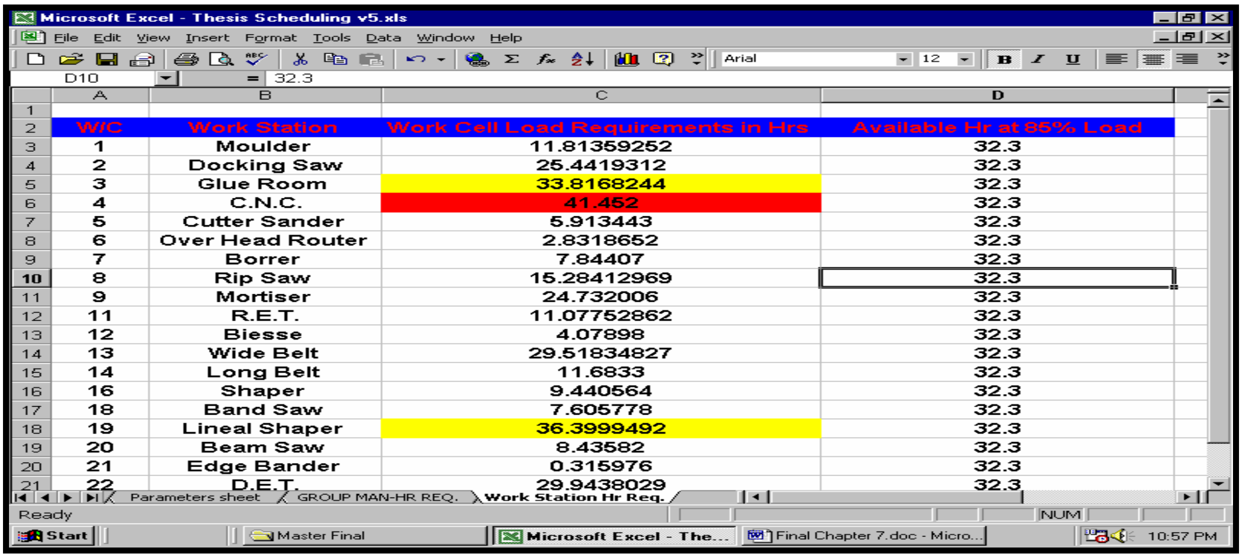
- Resolve bottlenecks in by grouping parts based on for example similar setups at the critical machines as long as they involve 80% similar work content in one group family.
- Establish a Kanban system, supermarket model, to control the consumption of generically shared materials at the shared resources, before the pull system starts. This supermarket model is usually controlled through Mixed Logic Chart (Duggan, 2002).
- Develop a product scheduling system to determine the capacity and man-hour requirements for each group to produce selected customer orders in this high product mix environment, Figures 3 and 4.



W/C	Work Station	Work Cell Load Requirements in Hrs	Available Hr at 85% Load
1	Moulder	11.81359252	32.3
2	Docking Saw	25.4419312	32.3
3	Glue Room	33.8168244	32.3
4	C.N.C.	41.452	32.3
5	Cutter Sander	5.913443	32.3
6	Over Head Router	2.8318652	32.3
7	Borrer	7.84407	32.3
8	Rip Saw	15.28412969	32.3
9	Mortiser	24.732006	32.3
11	R.E.T.	11.07752862	32.3
12	Biesse	4.07898	32.3
13	Wide Belt	29.51834827	32.3
14	Long Belt	11.6833	32.3
16	Shaper	9.440564	32.3
18	Band Saw	7.605778	32.3
19	Lineal Shaper	36.3999492	32.3
20	Beam Saw	8.43582	32.3
21	Edge Bander	0.315976	32.3
22	D.E.T.	29.9438029	32.3

Figure 3. Man Hr Requirements at Each Workstation

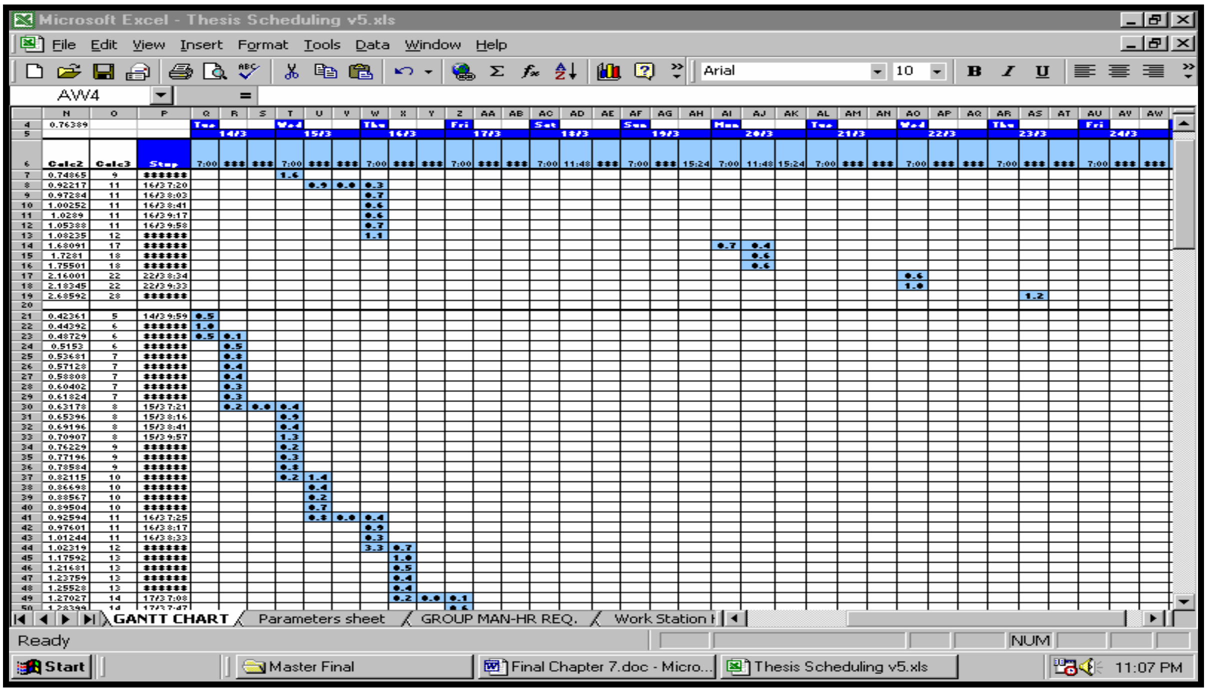


Figure 4. Gantt chart for Group Production

- Apply 5S, Visual control, and SMED Techniques at the machine with high production capacity requirements.
- If customer constant capacity constraints exist, overall equipment efficiency (OEE) needs to be conducted at the most occurring bottleneck machines or workstations. The OEE will point the most efficient lean tool to be used first at the bottleneck workstation.
- Balance the production load by using mixed logic chart (Duggan, 2002) which involves the following lean techniques: every part every interval (EPEI), First In First out (FIFO) Lane, floating pitch and regular runs, Supermarket Models and Kanban System.
- Debug the plan and the lean techniques to be used with the teams.

4. DISCUSSIONS

As noticed in Table 3 groups 13 and 12 represent bottlenecks, thus the mix logic chart was used. As in Figure 3, the software identified two bottleneck workstations, C.N.C., Lineal Shaper and the Glue Room. Accordingly these workstations in a normal shift will fail to meet production targets. To further ensure that these workstations are the actual bottlenecks more customer orders for different time periods were studied and the heavily loaded machines and workstations were closely observed in discussions with machine shop operators and production supervisors. It was noted that the C.N.C. workstation generally tended to slow production more than any other workstation. Either the Lineal shaper or the Glue Room comes next depending on customer orders. Accordingly it was agreed to start the OEE at the C.N.C. area first and to cover the shortage in capacity for the other two workstations through over time and shift overlap for the time being.

Analysis of the data led to the fact that 85% of the groups could be machined within 7 working days now, which could be further dropped through the implementation of lean techniques, Table 3 shows the comparison between existing way of product production and new suggested way of production after implementing the new methodology to reduce waste.

Table 3 Comparison Table Between the Two systems

Comparison Criterion	Existing Production System	New Suggested Production System
Order average waiting time in the system for the trigger points to start production	20 Days	5 Days
Machining Lead Time	7 Days	11 Days

5. CONCLUSIONS

This paper introduced a new methodology for lean implementing strategies in the furniture industry. The effectiveness of the new method was managed by taking the facility layout improvement as a major issue since material-handling cost could reach up to 85% of production. The scheduling software was used as a guide in this methodology. The software help assessing the capacity requirements in the selected high product mix environment. Lean techniques in the new methodology were introduced on the basis of improving capacity limitations. The new lean methodology guarantees effectiveness by using OEE measurements at the bottleneck workstations.

Additionally, scheduling software was used as a tool to show the production supervisor what the potential weaknesses are in meeting production targets for selected customer orders. Based on the mixed logic chart, the production supervisor can assess all the different alternatives in production planning.

Finally the new method guides the selected company to adopt an effective lean implementation strategy. This lean implantation strategy evolves adopting a new production system which is based on a group family production rather than product ranges. Even though the new production method might take longer lead-time due to the higher number of machine setups per groups, this lead-time can be dropped to meet targets by having some supermarket models for certain groups and conducting the appropriate lean technique at the bottleneck workstations using OEE measurements. In addition to that, the new production system has helped in reducing the average time of order sets waiting for a predetermined batch sizes to trigger production.

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