

Lean Implementation Through Value Stream Mapping: A Case Study of A Footwear Manufacturer

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Abstract: Lean production is one of the initiatives that are applied by many manufacturers to obtain the competitive advantages in the increasingly competitive global market. Value Stream Mapping (VSM) is one of the key lean tools to identify the opportunities for other lean approaches and for waste elimination in the production system. Since the performance of the supply chain would significantly influence that of individual partners, the implementation of lean thinking should also extend beyond the boundary of the manufacturing plant to the whole value chain. This paper introduces the VSM and the extended VSM used for description, analysis and identification of improvement initiatives internally and externally in the context of a footwear manufacturing enterprise. It can be seen from the analysis of the “initial state”, “current state” and “future state” VSM that the inventory and other non-value added activities within the manufacturing plant can be reduced by the launch of lean initiatives internally. However, the market responsiveness and competitiveness would not be enhanced substantially unless the extended VSM is taken into the implementation of lean.

Key Words: Lean Production, Value Stream Mapping, Footwear Manufacturer

1 INTRODUCTION

Manufacturers in the footwear and apparel industry are facing increasing challenges of firm's efficiency and competitiveness in today's global market [1]. One of the effective strategies for manufacturing organizations is to follow the principles of “lean”. The concept of lean production was firstly proposed by Toyota during 1950s, known as Toyota Production System (TPS). Till now, the philosophy of lean has been broadly accepted by various industries and has been applied successfully across many disciplines [2]. The focus of lean is to improve efficiency by eliminating wastes, referred to those non value added activities [3]. As an integrated system composed of a wide variety of management practices, Lean production system involves a set of tools and techniques such as Just-in-time (JIT), Value Stream Map (VSM), cellular manufacturing and production smoothing [4,5]. VSM is always treated as the first step to apply lean thinking, including five basic steps: 1) creating a current VSM; 2) evaluating the current map; 3) identifying problems areas; 4) creating a future state VSM; 5) implementing the final plan [6]. During this process of analysis, the non-value added activities would be discovered, and other suitable lean tools would be identified to eliminate the wastes accordingly.

Lean production requires that not only should technical issues be fully understood, but the relationship and connection between the manufacturer and the other factors external to the firm should also be examined in depth [7]. The concept of supply chain management (SCM) first

appeared in the mid-1980s [8, 9], and gradually showed its significant influence on business performance during 1990s [10]. Such significance is becoming increasingly obvious with the intensifying market competition [11]. As a result, the implementation of lean thinking should not be limited to a lean manufacturing plant or a lean organization, but rather the establishment of lean supply chain. Therefore, the aim of this study is to examine how VSM, on an internal and extended base both, improves the performance of the manufacturing plant. The improvement is achieved historically from the “initial state” VSM to the “current state” one and finally a “future state”, and vertically from the internal VSM to the extended VSM. The remainder of the paper is organized as follows: section 2 gives the overview of the case study concerned in the paper; section 3 shows the “initial state” VSM and identifies the main problems of the traditional “push” supply chain; section 4 presents the “current state” VSM which addresses some of the key issues in the initial stage but leaves the extended value chain not lean enough; section 5 accordingly makes the recommendation of a “future state” VSM; finally the paper ends with conclusion.

2 OVERVIEW OF THE CASE STUDY

In this paper, a footwear manufacturer named EA is examined to illustrate the application of VSM, together with other lean tools, to improve the production line and the value chain. The factory investigated in this research is a final assembly plant, and the production line for “cut-through-assembly” product in the plant is presented. For these “cut-through-assembly” shoes, EA outsources the production of soles and imports the raw materials for the upper in the global market. The uppers were than fully manufactured and attached to the shoes in EA's factory.

Production begins in the cutting room. Here raw materials for the upper are cut into prescribed shapes, using instruments that look like cookie cutters. After cutting, some of the cut parts are skived for better fit and some are embossed or embroidered with details or logos. This is referred to as “Pre-fit”. Next, parts are brought to the department which is called Computer Stitching: a machine guided by computer vision joins up to 20 parts into each upper. Here the uppers are transformed from a flat form to a 3D (three-dimension) form. Parts that cannot be automated stitched are then taken to manual stitching workshop. Finally, the nearly-finished uppers circulate to the assembly where the uppers are placed and stretched on foot-shaped molds called “last”, and attached with soles.

3 “INITIAL STATE” VSM

Historically, EA tended to place orders for components (i.e., soles, uppers, or kits) on a monthly basis in batches as large as 20000 pairs. It took approximately one week for EA to place a purchasing order and have it accepted by the suppliers worldwide. It then took roughly six weeks for the suppliers to manufacture the required components and an additional five weeks to deliver them cross-country to the raw material warehouse which held the storage of 4.5-week consumption. Then the materials circulated to EA’s manufacturing plant directed by the production control system. The ERP system gave the daily schedule to the shipping department and weekly schedule to each separate

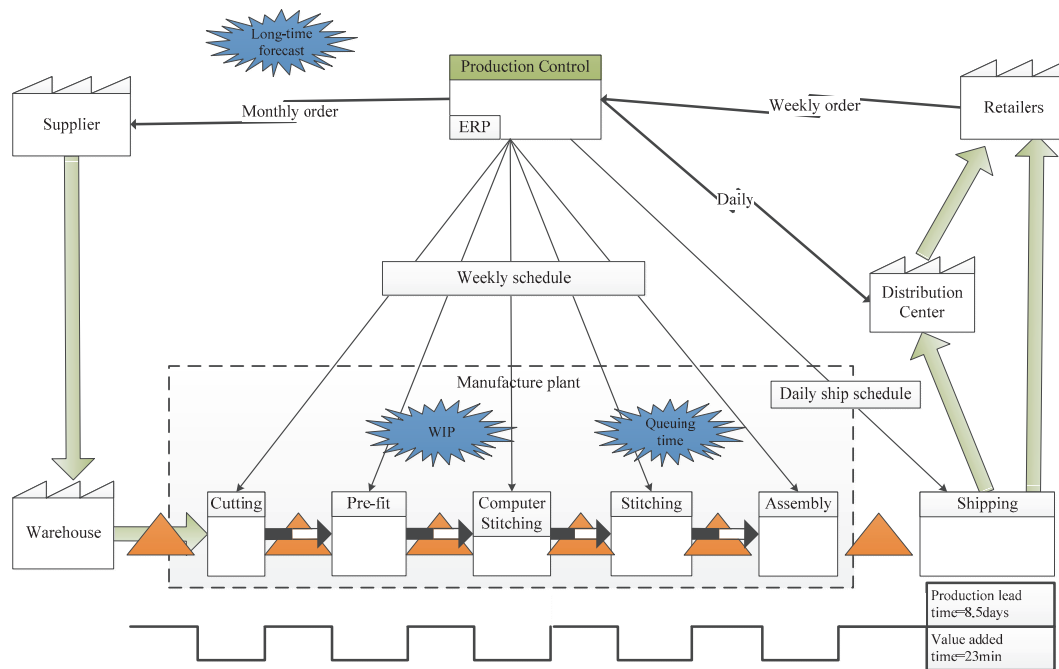


Fig 1. “Initial state” VSM

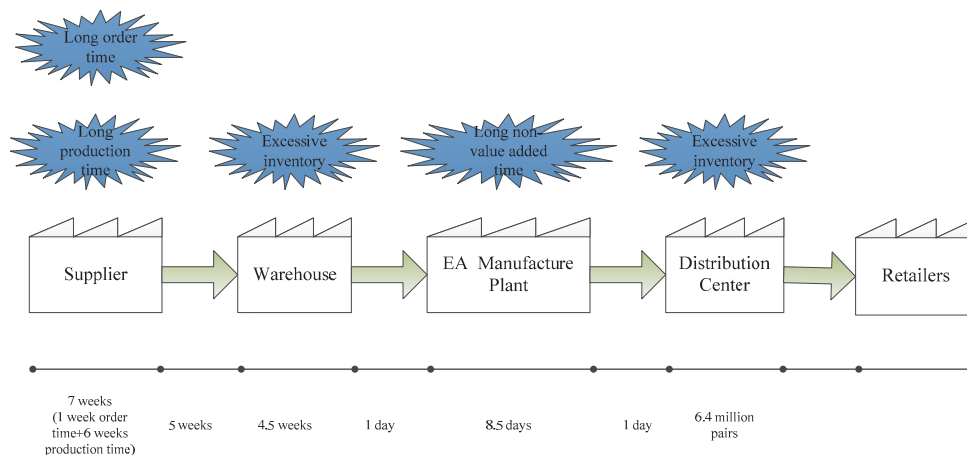


Fig 2. “Initial state” extended VSM

work station (i.e., Cutting, Pre-fit, Computer Stitching, Stitching and Assembly) respectively. Figure 1 shows the flow of material and information within EA. Due to the high range of work-in-process (WIP) and the long queuing time in the production line, the average lead time for a cut-through-assembly batch through a EA plant (measured from arrival of the raw materials to loading on truck as finished product) was roughly 8.5 days while the value added time was only 23 minutes. Before delivered to retailers and other customers, the finished shoes would firstly be sent to the distribution center where 6.4 million pairs of shoes, averagely, were waiting to be shipped. See Figure 2 for the initial extended VSM demonstrating the “big picture” of the whole supply chain. It can be discovered from the extended VSM that long lead time for purchasing orders from suppliers, the long non-valued added time in EA factory, as well as the excessive inventory in both raw material warehouse and finished product distribution center, all contribute to the large amount of waste, low productivity and slow market response of the value chain.

4 “CURRENT STATE” VSM

Having noticed the problem in the initial push-based value chain, the principles of Toyota Production System (TPS) is introduced to shoe production in the management of EA. The current value stream of the EA internal manufacturing plant follows the lean principle (See Figure 3 for detail). The first two stages, Cutting and Pre-fit Department, are processed in small batches, seven cases maximum according to the instruction of visual control system. As a result, work-in-process still exists, although having decreased from 400 cases to 20 to 25 cases since lean shoes making launched. When it comes down to the Computer Stitching Department, followed by Stitching and Assembly Department, the batch approach is replaced by the flow approach, and FIFO, maximum two pairs, is complied with between the cells of two adjacent departments. For all of

these five major internal processes, daily Heijunka Schedule is followed to achieve quick response to the pull of customer and low changeover time [12]. As a result, the production lead time reduces from 8.5 days in the initial “push” line to 2.5 days through significant attention to process improvement and work-in-process reduction within the plant. Also, several measures are taken to reduce the lead times from suppliers. First is to shift smaller purchasing orders of no more than 2000 pairs on a weekly basis, which not only increases the effectiveness of forecasting but also significantly reduces the production time of the suppliers. In addition, EA enables suppliers to “pre-buy” their own raw materials on behalf of EA, thereby further reducing the lead time required to produce an order. These efforts reduce the average time from placing a component order with a supplier to having those items available at the EA materials warehouses from 12 weeks to approximately nine weeks.

However, there is a paradox in the entire value chain. Although EA has successfully implemented the lean production system in its factory, the company has not yet built a lean supply chain by implementing lean with their suppliers and customers. More specifically, although the shift to placing smaller orders and the policy of empowering suppliers to pre-order raw materials on behalf of EA has shortened the lead time from Tier 1 supplier to materials warehouses from twelve weeks to nine weeks, suppliers’ manufacture time is as long as four weeks. It is due to their low productivity resulting from the long straight production lines. Consequently, the output of 80 to 100 staff in the suppliers’ plant is equivalent to that of 15 people in EA. The relative high level of inventory, \$9 million worth and \$6.4 million pairs respectively in the material warehouses and finished goods distribution center, is another manifestation of the “non-lean” supply chain (See Figure 4 for the extended VSM in the current state).

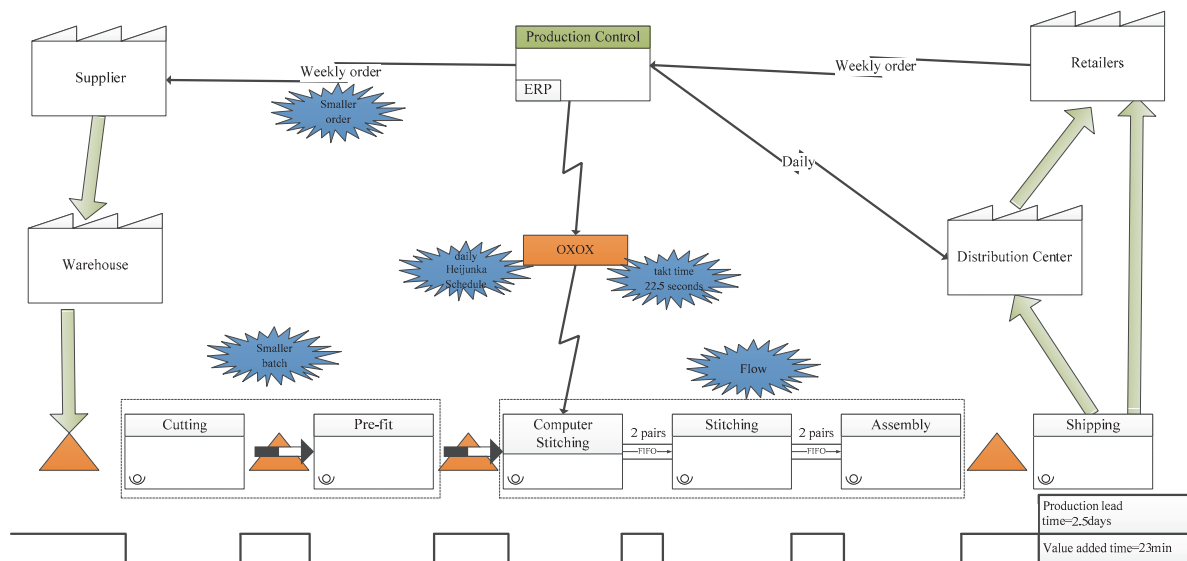


Fig 3. “Current state” VSM

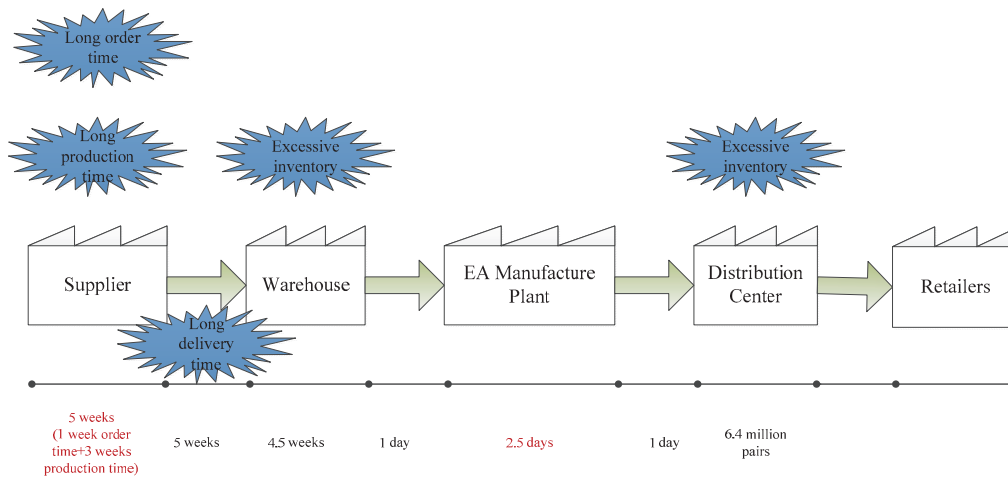


Fig 4. “Current state” extended VSM

5 “FUTURE STATE” VSM

In the future state value stream (see Figure 5), EA Manufacturing Plant implements supermarket system and Kanban system replacing work-in-process and preventing over production. A supermarket is set up at the beginning of the internal value stream, with a withdrawal Kanban

system, instructing materials handler to get and transfer items from the supermarket to cutting stage. There are another two supermarkets after cutting and pre-fitting respectively, each one working with a production Kanban telling how many what can be produced^[13].

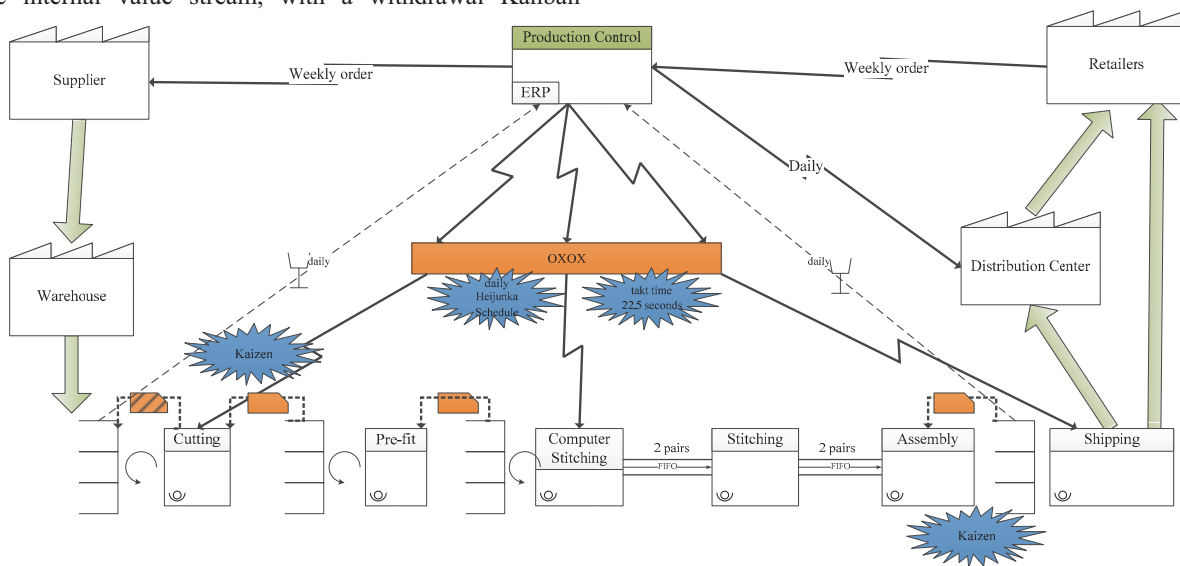


Fig 5. “Future state” VSM

As discussed earlier, the low productivity of suppliers leads to high non-value added total time along the supply chain. It is necessary and essential for EA to implement supplier development initiatives including direct involvement, competitive pressure, evaluation and certification systems, incentives^[14], and supplier associations adopted by Toyota. According to Krause, Scannell, and Calatone^[15], the most effective strategy tends to be the one of direct involvement, while other four playing facilitating roles in driving the success of the direct involvement. A bonus of direct involvement strategy through partial acquisition is to prevent counterfeiting and to keep control of the throughout manufacture, which is exactly the issue EA

concerning about. Nevertheless, the quick benefits do not indicate the direct involvement alone is adequate here, as suppliers would probably be unable to sustain the improvement once supplier development program ends. Considering the long-term development of EA, developing supplier capacity using externalized strategies is essential as well. Since there is more than one supplier providing the same range of products to EA, the company can increase volume of current business with anyone who performs better. The result of supplier development can be quite obvious: a one-week workshop at General Motors (GM) results in a 50% improvement in supplier productivity, up

to 75% reduction in lead time, and 70% inventory reduction [16].

In order to realize quick response, a highly integrated information system is required along the organization standing in the supply chain [17]. EA, as the core member in its supply chain, is suggested to collect and integrate the business progress and information system of its suppliers with those of retailers', sharing important data along the value chain. Manufacturing in EA's plant should be synchronized with retailers' ordering and products delivery, meanwhile the order management being intensively integrated with production schedule, production design closely coordination with order management, and producing processes keeping pace with the purchasing of key materials like soles and uppers [18]. The efficient and rapid flow of information drives the materials, products, and finance flow, thus creating faster speed, better applicability, and quicker responsiveness. These efforts should be made to change the whole supply chain into a customer-oriented closed-loop system, beginning with the identification and customer demand, ending until the feedback of end users.

In terms of the high inventory level and rare communication between upstream and downstream, there is internal relation between them actually. Inventory exists because of the difference in the timing or rate of supply and demand [19]. The less accurate the forecast is, the higher level of safety stock is required to avoid stock out. Effective communication, through sharing instant and accurate information via EDI and RFID, is believed to be a powerful tool to prevent and mitigate the impact of the bullwhip effect, thus reducing buffer inventory in the global supply chain. Moreover, information sharing and communication, together with mutual-trust relationship among EA, suppliers, and retailers, lays the foundation of Collaborative Planning Forecasting and Replenishment (CPFR) and VMI, both of which further lower inventory levels and total cost along the whole supply chain [20].

6 CONCLUSION

VSM illustrates all the activities, both value added and non-value added, that are required to take a product through the essential flows starting with raw material and ending with customer from raw materials stage into the acceptance of customers [21]. The traditional VSM is a "one page picture" of all the processes for a group of products that occur within an organization, from the arrival of the raw materials to the shipment of finished product. This paper extends the VSM to a value chain based version that illustrates the flow of products across the whole supply chain. From the "initial state" VSM to the "current state" VSM, considerable improvement has been made within the manufacturing plant of EA, resulting in the reduction of production lead time within the plant from 8.5 days in the initial "push" line to 2.5 days. However, the remaining issues of long purchasing lead time and the excessive inventory in both raw material warehouse and finished

shoes distribution center severely hinder the development of market responsiveness and competitiveness of EA. Accordingly, a "future state" VSM is proposed which not only presents the further improvement in EA's manufacturing plant, but also, more significantly, suggests the initiatives to promote the implementation of lean upstream and downstream throughout the supply chain.

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