

The Application of Value Stream Mapping Based Lean Production System

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Abstract

Many enterprises in Chinese Mainland have deployed lean production in consideration of its great success in other countries, but many of them failed to realize their original targets because they began to deploy lean production from tool level and haven't understood the actual value stream of their business, which is essential for an enterprise to implement lean production and keep improving. The paper proposes a value stream mapping based lean production system for Chinese enterprises to help them deploy lean production systematically, which can make them have an overall look at total efficiency, tell them where they are, where they want to go and map a route to get there. We hope the paper will help them eliminate roots of wastes, rearrange overall value stream better and increase the competitive ability of Chinese enterprises.

Keywords: Lean production, Value stream, Value stream mapping, Lean production system, Continuous improvement

1. Lean Production in China

Since Toyota Motor put forward Toyota Production System (TPS) in 1930s, its great success in waste elimination made it spread all over the world and developed to lean production (LP), which is called "The Machine That Changed the World".

1.1 The course of Chinese enterprises' deploying lean production

Chinese enterprises have been studying and learning lean production for more than thirty years since First Automobile Works (FAW) dispatched a delegation with forty members to visit Toyota in Japan in 1978. FAW also invited one of the founders of TPS Taiichi Ohno to give lecture on TPS, tried it in selected plant, built a TPS sample production line, and started two vigorous campaigns for studying TPS in 1980s and 1990s.

From then on, more and more Chinese enterprises in Mainland began to deploy lean production. On one hand, they are encouraged by other enterprises especially the Sino-foreign contractual joint ventures that have deployed LP successfully in product quality and cost reduction. On the other hand, various lean training organizations emerge as bamboo shoots after a spring rain; they bring new thinking of LP and make it spread in enterprises quickly.

1.2 The effect of Chinese enterprises in deploying lean production

So many Chinese enterprises deploy lean production blazingly, but they meet many problems that make them puzzled since few of them get the success that Toyota has experienced, especially after a series of recall event of Toyota at the beginning of 2010. Some of the enterprises that have practiced LP benefit from it, but most of them haven't realized their original targets as expected. In general, we can make a conclusion that gains and losses coexist in Chinese enterprises' implementation of LP over thirty years.

Firstly, it makes lean thinking and tools spread all over the country, most enterprises know what lean production is and what it can do for them, and a few of them get some success in deploying LP, for example, the Chassis Branch of FAW reduced its work-in-process by 70% by deploying LP. Secondly, we met so many problems in

deploying LP that made us puzzled if LP is suitable for Chinese enterprises.

We discovered by investigation in more than twenty enterprises ever deployed LP that some wrong thinking and doing commonly made in deploying LP such as only paying attention to lean tools and wishing to achieve quick results, which directly resulted in their failure. Most of Chinese enterprises start from tools such as 5S, total productive maintenance (TPM), error-proofing, single minutes exchange die (SMED) and so on, which are just stopgap measures with some effects and can't improve production radically because they seldom analyze the whole value stream before eliminating waste, which maybe add cost and expenses contrary to their original intention, just as the president of Lean Horizons Consulting Mark Deluzio says: "Most companies start at the tool level, with no tie back to a business strategy". So we suggest enterprises implement lean production by applying value stream mapping (VSM) to identify overall value stream of the supply chain and realize what Ohno Taiichi said "Decrease all waste of the whole process".

2. VSM Based Lean Production System

The fundamental of lean production is to identify and eliminate wastes, all work of an enterprise can be classified into three parts, the first is value-added work includes essential activities that add value to a project in a way the customer is willing to pay for. The second is incidental work includes the auxiliary activities that don't necessarily add value, but must be done to support value-added work. The third is non value-added work or waste includes non-essential activities that add time, effort, cost, but no value, which we are familiar in production site that has not implemented lean production including superfluous inventory, unnecessary transportation, waiting, excess processing, wasted motion and products with defects.

2.1 The definition of VSM

Value stream mapping is a technique or tool with a pencil and paper that helps people to see and understand the flow of material and information as a product makes its way through the value stream. The elements of VSM include customer loop, production control, supplier loop, manufacturing loop, information flow and lead time data bar with critical path that make us have a full view of the whole supply chain from customer's requirements to supplier's delivery (Figure 1).

2.2 Why do VSM First

Value stream mapping helps us understand where we are (Current State), where we want to go (Future State) and map a route to get there (Implementation Plan), which can create a high-level look at total efficiency, not the independent efficiencies of individual works or departments, visually show three flows - material flow, product flow and information flow to identify improvement opportunities, and help identify applicable lean improvement tools and plan for deployment. The practices of enterprises have successfully implemented lean production prove that VSM can eliminate 50% waste process/steps, shorten cycle time by 30%, reduce variation from 30% to 5% and improve product quality greatly. So we should implement lean production first from VSM.

Insert Figure 1 here.

2.3 The structure of VSM based lean production system

We propose a VSM based lean production system (VSM-based LPS) consists of a foundation and a series of lean tools commonly used for identifying and eliminating wastes (Figure 2), which can help enterprises deploy lean production systematically.

2.3.1 The foundation of VSM-based LPS

The prerequisites and foundation for an enterprise to deploy LP include:

(1) Combine lean thinking with business strategy

Thinking lean means we should keep firmly in our mind that we only do those things that create or add value, for which customer is willing to pay and all other activities are waste. At the same time, only combining it with the business strategy of an enterprise can make it effective, or else, it will rest on the surface and tool level.

(2) Integrate with suppliers and customers

The ultimate target of LP is to realize pull system that mean an enterprise should take its suppliers and customers as a community, consider your benefits together to realize lean supply chain. When deploying LP, it should integrate with suppliers and customers, or else, pull system and just in time will not come true.

(3) Management commitment

Chinese like to follow their leaders, so management in different level should provide complete, real and visible

support for lean production. This could be done in different ways such as providing enough resources, visiting lean production areas, conduct audits, present awards for significant achievement and other ways to get involved on a regular basis.

(4) All-staff involvement

All-staff involvement is critical for an enterprise to successfully implement LP. Moreover, employees' work habits will influence their behavior and behavior determines success or failure, so we must change employees' work habits to comply with lean standards: employees should conduct "continuous improvement" events, document results in one-point lessons and complete daily check to engage in lean production passionately, which help build pride.

Insert Figure 2 here.

2.3.2 The lean tools of VSM-based LPS

During the formation of LP, many lean tools are created and proved to be effective such as 5S, TPM, standardized work, setup reduction, error-proofing, which make Chinese enterprises dazed and not know which one to take. As a result, they learnt several tools and can't get the success that Toyota has experienced at all. We suggest that Chinese enterprises select suitable lean tools systematically according to the results of value stream mapping rather than following others blindly and realize kaizen gradually.

3. Steps to apply VSM-based LPS

3.1 Identify product families

Usually, an enterprise manufactures products different in volume and variety according to business environment. So the first step is to identify product families by matrix methods, namely, to classify products into different product families according to formula (1), which is the basis for applying VSM. Generally, total work content for producing one part should be within 25 to 30 percent (range) of all other different parts in one product family.

$$(Highest\ value - Lowest\ Value) / highest\ value \quad (1)$$

For example:

$$(20 - 10) \div 20 = 50\% \text{ (out of range)}$$

$$(14 - 10) \div 14 = 29\% \text{ (within range)}$$

3.2 Analyze business to prioritize product families and selected one to implement LP

After identifying product families, we should prioritize them according to their size, share of the business contribution to the net profit, criticality for the business, market position, technology outlook, potential for gainful growth, expected impact from lean and resource requirements, etc. Then we select a product line at a time to implement lean production according to the prioritization.

3.3 Draw current state map of the selected product line and analyze the whole process for improvement

We should walk the process on the spot to gather first-hand and practical information required for a good VSM and effective deployment of lean production, by doing so we can avoid fighting only on paper. Then we ask questions on each element of VSM and begin to draw current state map with a pencil and a piece of paper from the customer, the shipping end, and work upstream through the process (Figure 1). The bursts in the figure show the processes need to improve.

3.4 Draw future state map

The bursts in current state map show us improvement direction, so we need to make preparations for future state map. We summarize several principles practically used for drawing future state map.

(1) Combine process steps

Lean production needs processes done in one activity by one person in one place, or even better, at one time with no human intervention. We should be "reluctant" in adding activities and resources to the process. When design a process so one person can move through it and efficiently perform all the work elements, we should combine process steps by avoiding isolated islands of activity, minimizing material and information between processes, eliminating excessive walking, therefore to reduce cycle & total lead time.

(2) Adopt continuous flow to build speed

Continuous flow manufacturing (CFM) means processes flow smoothly through all operations without stopping, which increases production speed as shown in Figure3.

(3) Think parallel not linear layout

When study the layout of a production line, we should consider building it in parallel to realize make-one-move-one that save space and eliminate waste of operators' unwanted walking (Figure4).

Insert Figure 3 here.

Insert Figure 4 here.

(4) Reduce sources of variation by 6 sigma management

6sigma management has gotten great success in many well-known companies such as GE and Motorola. We suggest adopting DMAIC (define, measure, analyze, improve and control) method of six sigma management to eliminate waste associated with adding spare capacity and contingency into processes to reduce variation and improve process efficiency.

(5) Re-design a process

Re-designing a process for a future state map requires participants who can step back and look at the process with a fresh set of eyes. And, ask ourselves how we would design this process if it had no restrictions. We need to be visionary, system-level thinkers that can see the total flow as it cuts across functional boundaries. Most often, these are management type, with no direct connection with the current process.

3.5 Implement future state

If we don't make great effort to realize future state, the map is meaningless at all. We propose steps for an enterprise to implement future step designedly as shown in Figure5.

3.5.1 Prioritize the kaizen "bursts" on the future state map

We should invite all the stakeholders including all functions, all levels, all concerned shop floor employees to discuss which tools are required to achieve the goals for each loop and estimate the benefits and implementation costs of all the opportunities, and prioritize by rating them from 1 to 5 with 5 being the most important in consideration of necessary skills, availability of potential resources and the thoughts of plant management on the identified opportunities.

3.5.2 Develop master plan

We need to develop a master plan for the improvement with higher prioritization and put it in practice as a project including scope/strategy, work breakdown structure, activity list in logical order, required durations and dependencies, resource requirements, risk analysis, training needs and plans, performance measures to be impacted, goals, and communication plan. Level of details should be proportional to the scope and benefits.

Insert Figure 5 here.

3.5.3 Develop metrics

We should set performance metrics to review if the goals of improvement are realized. When identify performance metrics, we should keep them simple that means understandable for all and link lean (shop-floor) measures to the plant-level measures and goals (strategy). It is more important that lean measures must be reviewed regularly to check if they are suitable for Kaizen and therefore to promote an enterprise and its employees to make progress continuously, which is the core thinking of lean production. The performance metrics actually used in a plant are shown in Table 1.

Insert Table 1 here.

3.5.4 Monitoring the implementation

Value stream manager should be in charge of monitoring the implementation of the plan with active participation of plant staff managers. They should identify a systematic process & structure for reporting progress, issues, needs, and integrate monitoring with their normal business processes such as staff meetings, quality council meetings, daily production meetings, etc. The objective of monitoring is to make lean production on the way and obtain continuous improvement.

3.5.5 Communication

We should employ all possible means especially visual means to make all the information easy to understand and accessible to all; encourage internal communications on the objectives, goals and approach before starting; facilitate communication of periodic progress, broadcast the successes loudly to all, communicate failures and the lessons learned.

The means usually used for communication include:

- Meetings including plant-wide meetings, departmental meetings, council meetings, team meetings, etc.
- Newsletters, regular reports, special bulletins, etc.
- Visual display of updates on individual product lines / lean tools events (VSM, TPM, 5S, etc.)
- Visual display of all the information related to standardized work, cell layout, Kanban, etc.
- Real-time visual display of production rate and goals
- Real-time visual display of potential of problem or existing problems

4. Conclusion

Lean production means continuous improvement, we must keep on changing future state into current state that will not end during our life. VSM have been proven to be a greatly useful tool to eliminate some waste in a cycle and find there are more waste for you to eliminate in next cycle, during which lean becomes a habit or culture. We hope that more and more Chinese enterprises carefully analyze their own value stream by applying VSM based LPS as we propose, dedicate to pursue a way suitable for China and become world-class manufacturers.

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Table 1. An example of performance measures in a plant

Measure	Current	Future
Cycle Time	1Hr. 46 minutes	21.9 minutes
Set up	3.2 hours	0.3 hours
People Travel	3600 feet	200 feet
W.I.P.	67 days	16 days
Inventory	RMB 3,270,000	RMB 650,000
Lead Time	67 days	16 days

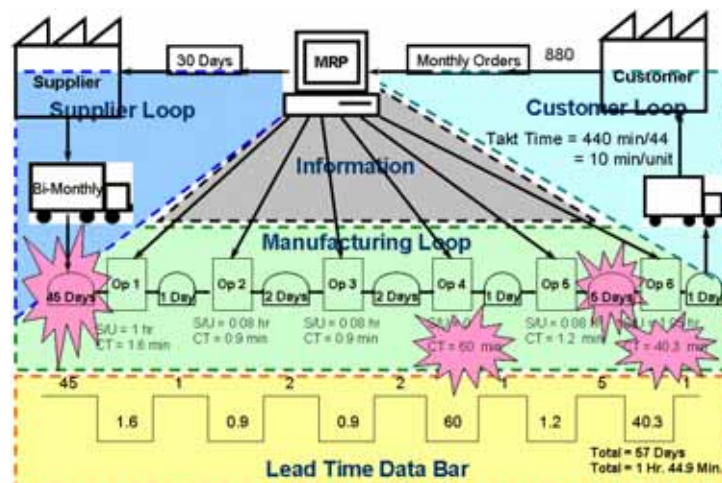


Figure 1. Sketch Map of VSM



Figure 2. The Structure of VSM Based Lean Production System

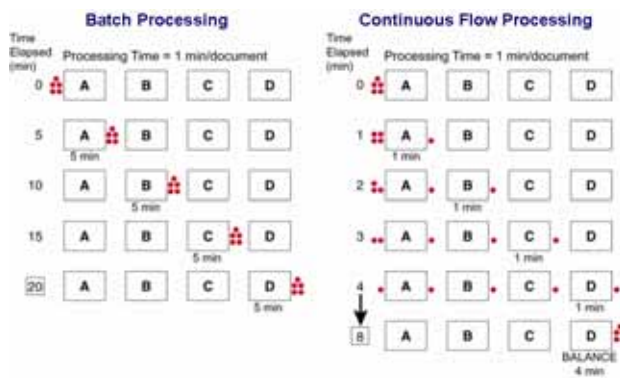


Figure 3. Comparison between Batch Processing and CFM

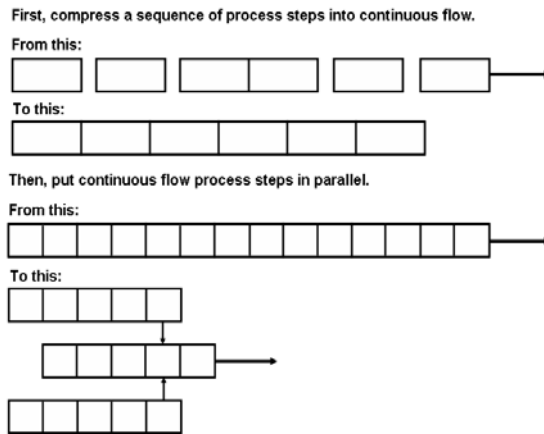


Figure 4. Think Parallel not Linear Layout



Figure 5. Steps to Implement Future State