

## Research on Lean manufacturing Process Management of Electric Locomotive

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**Abstract.** From the perspective of lean production, this article multi-angle analysis of all-round enterprise potential problems of process management, which include processing, testing, logistics and assembly. It also provides some specific solutions to solve these problems from some aspects, such as shorten work period, reducing stocks, and so on. Finally, we can eliminate waste thoroughly, and achieve the goal of lean process management in daily production.

### Introduction

Process management [1] is a process of planning, organizing and controlling all process stages properly. On the one hand, exist in the whole process of making the materials, semi-finished products into finished goods; make the implementation of the manufacturing technology with scientific and systemic management. On the other hand, it's also a social and scientific way to handle and solve the problems which caused by the relations of production between people. With the rapid development of the manufacturing industry today, the level of process management has become an important factor restricting the development of all enterprises, establishing a sound, consistent and efficient process management system is the basic guarantee for corporate to achieve production targets. Lean production [2] combines the advantages of mass production and single piece production, and strives to implement in the mass production of multi-variety and low-cost production of high quality products. In short, lean production is manufactured in a timely manner, eliminating faults, eliminating all waste, marching towards zero defects, zero inventory [3]. For electric locomotive which involves machinery manufacturing industry, line configuration, as well as processes is important factors affecting the productivity and quality, therefore, there will be more emphasis on standardization, just in time production (JIT) [4] and zero-inventory.

### Problems in Traditional Production

**Mass Production Methods and Organizational Structures.** The traditional production of electric locomotive is mass production. It has achieved a large and rapid production, and costs decrease with increase in volume, but the disadvantages are equally obvious: production process is too long, causing the delivery period becomes longer fine division of labor, employee motivation is high, productivity is low, resulting in a waste of human resources; Lack of flexible production, cannot quickly adapt to the needs of the market. Under the old organization structure, the manufacturing factory is divided into sectors, each sector is responsible for a fundamental process of electric locomotive, but because of each sector is independent, so every batch of parts undergo these departments will engender waiting time, thus lengthens the delivery time.

**All Kinds of Waste in Production Processes.** As a manufacturing company, in order to achieve the target, the waste will be appeared under the old modes of production. The early production may result in overproduction, then bring about wasting of human resources, equipment, raw materials, and even increasing inventories; inferior products will appear during the production process, you have to took these parts reworked or abandoned directly; when machining, the machine appeared

fault, or parts supply not on, that will makes the whole production stagnated; workers for nonstandard operation, will produced extra action, also will cause the cycle extended; because of the unreasonable of production lines or tooling layout, cause extra handling distance and makes the product's delivery cycle extension; due to the increasing of inventories, produce an extra of inventory management fee.

**Irrationality of Assembly Line.** Due to the different Assembly sequences, the Assembly by machines and artificial will cross, thus prolonging the production period; since the independence of the different production sectors, there will be a waiting time in the Final Assembly; during the Assembly procedure, some workers busy as bee, some workers are idle.

**Study on the Lean Process Management**

The goal of lean manufacturing is through constant improvement to eliminate the waste completely. Apply lean manufacturing to process management to solve problems. Thus, we can create a lean process management model, and the specific goals it can reach as Figure 1 shown.

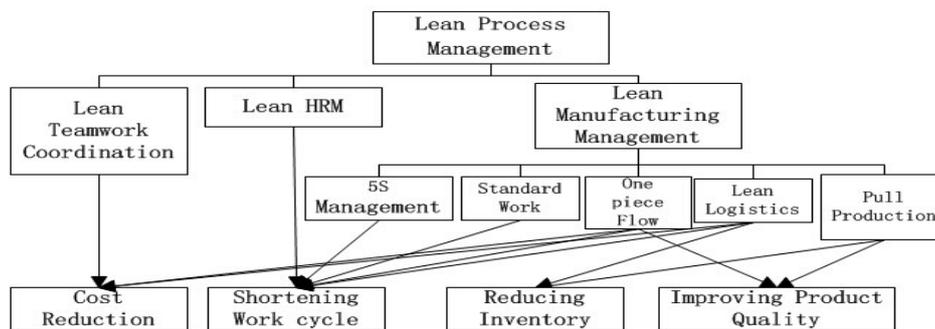


Fig.1. Lean Process Management Model

**Lean Production Mode and Management Structure.** In the production activities, we often use different methods of manufacturing to different types of parts. The products with high precision should be produced separately from which Easy manufacturing. To the defect of mass production, we can introduce the pull production to the manufacturing of high-precision products. Pull production is a mode of production that performed by the customer's need of products, that is, strictly in accordance with the customer's orders and corporate marketing plans to organize production [4]. This can meet customer's needs in a timely manner, it can also prevent a backlog of inventory caused by blind production and high failure rate caused by mass production can be reduced. In the process of implementing pull production, the most commonly used tool is the "Kanban". "Kanban", is the transfer of logistics or the information flows in the same process or between processes. The kanban management is meant to convey information: what, when, how many and where producing and transporting, the components it included is: the part's number and name, the number of the kanban, the appearance of the part, and so on. Production system model of Pull production is shown in figure 2.

In daily production, the manufacturing and Assembling often not synchronization, it may cause long of waiting time and increasing in work-in-progress inventory, in order to solve this phenomenon, not only can using "kanban management", but also can set a integrated production management sector [5], analysis the feedback information of manufacturing sector and Assembly sector, then make adjustments of the whole production activities, and also can makes whole production activities liquidity enhanced. At the organizational level, we should also introduced into the "team" concept as the figure 3 showing, which facilitates the management regrouping, streamline the number of managers, saving costs , and defining their respective responsibilities.

**Lean manufacturing management.** To implement the lean process management, we must achieve the lean manufacturing management, which included: 5S management, lean-renovation of production lines, and achieve the lean logistics during manufacturing and selling.

**5S management.** As the foundation of lean production, 5S management [2] an essential part of lean process management. 5S management refers to the sorting, Reorganization, cleaning, clean,

and literacy, the key is to improve the quality of people. Sorting is take the unnecessary things out of the production site, such as: cut off chips, rubbish, waste materials, scrap, excess tools, scrapped equipment, worker's personal effects and so on. Doing this, not only ensuring channels are unblocked, increasing the productivity, but also eliminating confusions in management, improving product quality, reducing inventory. Reorganization or rules placed neatly necessities in terms of a sequence, such as placing according to frequency of use, so you can not waste time to find material and reduce production cycle and improve efficiency. Cleaning is to remove stain, clear work area of the material in the site spam, including the cleaning of equipment or tools, so you can discover the problem and ensure the normal operation of the machine. Clean is organized, clean up, clean implementation of institutionalization and standardization. Literacy for all in accordance with the rules, and strive to increase the sense of self to make the habit of strict compliance with rules and regulations and style, but also the core of "5S" activities.

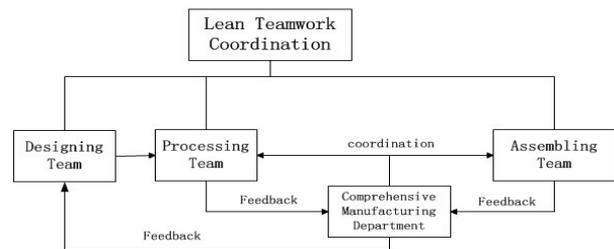
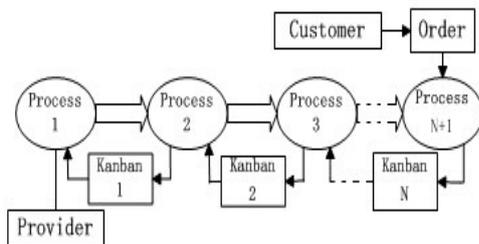


Fig.2. The System of Pull Production

Fig.3. The Corporation of Lean Teamwork Coordination

**Lean transformation of production and assembly lines.** Field implementation of 5S management provides the possibility for formation of a flow-type manufacturing. An example for early production is that we may incorporate timely production of quick set-up machine tool, namely, when the latter process has called part of the point of the produced, the former process is capable of rapid reproduction of small component, so that part of production to achieve mobility, shorten delivery cycles, and reduced inventories.

As subjects of production activity, People also play an important role in eliminating waste. During the production operations, standardize worker's action with effective way: "eliminate" unnecessary movements, "merge" small gestures, "rearrange" the process or action, and "simplify" complicated movements. Using effectively time standard such as MOD (Modular Arrangement of predetermined Time Standard) on workers' movements during processing, you can eliminate unnecessary movements and improve production efficiency. For processing high precision parts, training each worker in the work unit to become a "juggler" in allowed condition ( e.g. quick set-up machine tool available ), which can save human resources cost, and can achieved "single pieces flow" production. If means that different kinds of parts can be produced within a short time while handling and storage by needs of resources can be reduced, it also reduced possibilities of parts failure and damage. To achieve the "one piece flow" production, there must be a balanced production line: the interaction between the various processes on the production line, tend to minimize the cycle time or make the number of workers reaches a reasonable quantity. In production activities, such things will have an impact on production line balance: incorrect arrangements of the process order, improper processing methods, the operation proficiency of the staff. In order to solve these problems, we must to calculate the time of each part's processing, and make the appropriate selection of processing methods; for example: when the production rates need to be accelerated , we can drawing the time of the heavy labor process to other processes averagely, through this way, we can shorten takt time and improving productivity; when the production rates need to be slow down, we can cancel one of the processes, and other workers should be responsible for the amount of labor it released, therefore we can reduce the number of workers in this production line, and achieve the lean distribution of worker. Production lines should have a "u" shape in "one piece flow" production, so that workers movement could be reduced during operation between various procedure, thereby reducing work cycles within the unit.

As the final step in the production process, assembly had a decisive influence on product life cycle. Time for each procedure [3] should be determined. In order to estimate the take time for the

current line and as a basis for reordering the process, if necessary, you can singled out some high subdivided procedure to form a group of specific operations, thereby enhancing the efficiency of the whole assembly line.

To sum up, throughout the process of manufacture, production, none but establishing an orderly environment and workers become lean people can form a good site management model and better implement lean process management.

**Lean logistics.** Logistics in the production process as an important support for the realization of the lean process management plays a strong influence. The emergence of lean logistics can solve this problem. Lean logistics in accordance with service objects can be divided into internal logistics and lean external logistics. Lean in-house logistics services operate on site staff, and lean outside logistics for customer service, on time, quantity and customer delivery. To achieve lean logistics, we must do three things: overall planning, continuous improvement, lean service. Overall planning and are in various stages of the production process materials and tools in accordance with scientific production technology and conduct another time, spatial planning, layout, and according to a reasonable cycle times, and standardized operations and achieve timely production model, with at least some of the factors need to be considered material movement, unity, economy. Lean service that is able to do with the needs of customers as the Center, goods in circulation and to ensure accurate and timely reach customers or workers' hands. Continuous improvement is the embodiment of perfection in lean thinking principles, continues to find problems, find out the reasons, continually improving production methods and process routes during manufacturing, make enterprises become lean enterprises gradually.

## Conclusion

Enterprise's basic target is to maximize profits, and lean process management can be from several different ways for enterprises to achieve this objective, namely: reducing costs, reducing work cycles, reducing inventory, improving product quality [2]. In Figure 1 we can see that the single management may produce more than one impact, for example: single-piece flow production can reduce costs, shorten cycle time, improving product quality, and so on. But also the inextricable relationship between the various management measures, such as: 5S management provides conditions for standardized operation, single-piece flow production, and lean logistics. Quality is the bedrock on which a company stands, is the foundation of implementing process management. Reducing cost, shortening work cycle, and reducing inventory are the eventually targets of lean process management .if we want to achieve these targets, we must made the above measures well-executed, that's mean, we have to made the lean thinking become lean manufacturing through lean process management. Finally, make enterprises achieve the target of lean enterprise.

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