

Managing a Manufacturing System with Integration of Walking Worker and Lean Thinking

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Abstract—A product goes through various processes in a production flow which is also known as assembly line in manufacturing process management. Toyota created a new concept which is known as lean concept in manufacturing industry. Today it is the leading model in manufacturing plants through the globe. The linear walking worker assembly line is a flexible assembly system where each worker travels down the line carrying out each assembly task at each station; and each worker accomplishes the assembly of a unit from start to finish. This paper attempts to combine the flexibility of the walking worker and lean in order to quantify the benefits from applying the shop floor principles of lean management.

Keywords—Toyota Production System, TPS, Lean Manufacturing, Walking Worker, Lean Management, Management, Linear Assembly Lines, U-shaped Assembly Lines, Shop Floor Management

I. INTRODUCTION TO LEAN CONCEPT

LEAN Manufacturing refers to a term/concept promoted by Toyota company (Japan), which emphasizes on the “flow” of work/smoothness of the work during the manufacturing processes. “Mura” is a Japanese expression which represents Unevenness”. Lean Manufacturing processes, adopted and promoted by Toyota, ensure to eliminate “Mura”, thereby, increasing the efficiency at the workplace. The term was remiered by John Krafcik in 1988 during his thesis at MIT. Based on his research, a program titled as (International Motor Vehicle Program) IMVP was initiated at MIT [1]. A second perception about Lean Concept of Management is about the generalization of this term for many professionals, which stand for identifying tools and eliminating them steadily and slowly, in order to increase the efficiency at the workplace. Improvement in efficiency and removal of “waste” from the workplace reduces costs and time required manufacturing and improves quality as well. The difference between these two concepts lies in the implementation of each of them. Quality problems are exposed as a result of application of an even process flow, which results in eliminating of waste. Improving quality refers to finding and eliminating waste in a process flow. However, at the other end, focusing on waste and bypassing the process flow at the first stage may shift the focus to another direction and does not allow the same quality to be achieved.



Fig 1 Showing a Lean Manufacturing Assembly Line at one of the Toyota plants

II. SHOP FLOOR MANAGEMENT

A. Importance of Shop Floor Management

Rainer Shmucke, of DMC stated, “With Shop Floor Management, we stabilize our processes and bring leadership and co-operation in production to a new level.”[2]

Shop Floor Management ensures the:

- Basis for the deployment of lean concept of management
- Dialogue between worker and the manager
- Manager being in control of the floor

B. Principles of Shop Floor Management

Effectiveness of the Shop Floor Management is due to its effective and simple techniques. Once, put into action, the principles become the gateways to the elimination of waste from the workplace and increasing efficiency of the workforce. Shop Floor Principles are as follows:

- Shop Floor is the Core
- Manage at the shop floor, not at the office
- Make data visual and transparent. Commit to action plans
- Control standards and improve systematically
- Managers check critical processes and offer support to the workers
- Managers Support problem solving through escalating process

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Fig 2 Shop Floor Management in action at Toyota

III. MULTI-SKILLED WALKING WORKERS

Multi-tasked workers are the heart and soul of the lean manufacturing system. They are required to staff the manufacturing facilities in order to improve the work performance as assured by the lean concept of manufacturing. Designing facilities for Lean necessitates an arrangement in which only few people can perform their jobs. This requires all of them to be multi-tasked to perform duties simultaneously and in a way that concept of implementing lean management is not lost. Multi-skilled workers can be explained as the core of flexibility promised by Lean concept of manufacturing. [3] A normal western manufacturing plant conceives problems as a thing to hide or shred off. However, at Toyota, the lean manufacturing concept follows an entirely different technique towards problem solving. Line operators are allowed to shutdown the entire assembly lines, once a problem is highlighted. Problem solving is conceived as a way to improve the system at TPS. And the whole process of escalation of problem to its remedy can only be achieved through multi-tasked workers, trained effectively in a lean system in the given timeline set by TPS.

A. Improvements through Lean Concept of Manufacturing by Mazak

At Mazak, once the column is centered on to the base, a single worker can finish assemble the machine in 8 hours. The goal for delivering the order from the date of receipt to the date of delivery is 3 weeks and it can reduce upto 2 weeks in case of urgent orders. Process time has been reduced to 39.4% and overall throughput time has been reduced to 54.7% as compared to previous methodology [4].

B. Shop Floor Principles in Action at Mercedes-Benz

At Mercedes-Benz, Shop Floor principles are applied at assembly line to optimize performance. Daily schedules show an adherence to the work of managers and workers. Managers are also responsible to perform standardized work checks at the assembly line and discussing ideas for the improvement of the processes. Those improvement ideas obtained by the managers at the assembly lines are noted as actions on the daily sheet and practiced at CI areas. There is a problem solving board at each

assembly line to discuss the problems and highlight the quality through visualization of data. Simple problems are handled at the assembly lines by the managers and the teams. Complex problems are raised by the managers through the initiation of A3 problem solving process. Communication for quality checks and progress takes place every 2 hours between managers and production teams. [5] At Mercedes-Benz, company trains its workers to be multi-tasked and be ready to handle almost all the stages of vehicle manufacturing. For this specific purpose company trains its manufacturing staff in a VEM (Virtual Environment Manufacturing) scenario and allows the user to pass through different stages of vehicle manufacturing in a virtual environment before being ready to handle the manufacturing stages in reality [6].

IV. ANALYSIS OF LINEAR WALKING ASSEMBLY LINES AND WALKING WORKERS

Above discussion highlights the emphasis of multi-tasking in a Lean Manufacturing Environment. However, in order to successfully implement Lean Environment and develop multi-tasked teams, we have to carefully analyze the role of linear walking assembly lines.

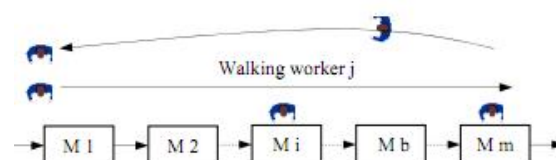


Fig 3 Linear Assembly Line

In a linear assembly line, each worker (trained according to the requirements of the product being manufactured) travels along with a moving linear assembly line downstream, stopping at each assigned station, carrying out essential tasks as scheduled. A new item of manufactured products goes through the line whenever a walking worker is on hand after a product assembly is finished by this walking worker at the end of the line. The worker, then, discharges the completed product and goes back to the primary location prepared to start a fresh item. Since an individual item can only voyage along with one walking worker who works on it by moving at all stations along the line, the number of items in the system is therefore predefined and theoretically it cannot be larger than the total number of workers used on the line. Therefore, this kind of structure naturally prevents unnecessary in-course inventory, thereby reducing the safeguarded inventory requirement. Moreover, as each walking worker on the line cannot be wasted away because each single worker is knitted to one single item all the time and it is his/her responsibility for completely assembling a product within an anticipated cycle time through training, this decreases the loss of labor efficiency and maximizes individual labor utilization in practice.

A study by Qian Wang, Sylvain Lassalle, Antony R. Mileham, and Geraint W. Owen showed the impacts of walking workers and linear assembly lines on the production time improvements in relation to the workers with equal and

unequal performance times. Study concluded that “effect of bottlenecks, which may lead to the in-process waiting time, can be simply reduced using the walking worker method. It is also of note that optimizing the number of walking workers (or stations) on the line can alter and decrease the in-process waiting time thereby increasing the worker utilization (e.g., in terms of the output per worker per hour).” [7] Advantages of walking workers over fixed position workers include: [8]

- Faster processing time, less material handling, less work-in-process inventory, and reduced setup time, all of which reduce costs.
- Providing some degree of increased flexibility. This aspect is greatly enhanced with FMSs
- More autonomy and job ownership.

A. Walking Workers and U-Shaped Assembly Lines

Advocates of the lean manufacturing and just-in-time (JIT) viewpoints state that U-shaped assembly systems present more than a few benefits over conventional straight-line layouts. Especially, upgrading in labor efficiency. U Assembly Lines have turned up to admired place through offering the key advantages of evened workload, multi-skilled workforce and other standards of the JIT way of life. Numerous investigators have the same opinion that U-lines are one of the most imperative constituents for a triumphant execution of JIT production systems. U-line is alike to the straight line for any distribution of jobs or machines to workers so long as a worker does not work mutually with their stations (avoid crossing the loop). The quantity of workers involved on a U line is never additional to that required on a straight line. Though, a worker can be either on the similar line or across from the front line to the back line or vice versa. In a study, conducted by Ronnachai Sirovatnukul and Parames Chutima on worker's walking time and U shaped assembly lines based on finding the correct type of U shaped

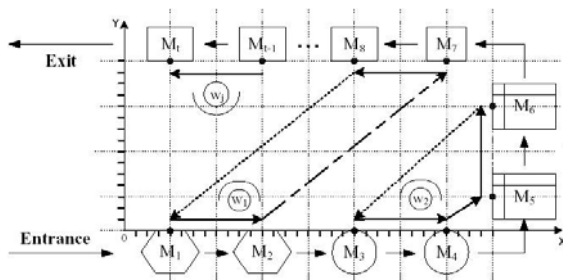


Fig 4 U shaped Assembly Line

assembly line for assembly of products under a 7-step to 297-step model, in order to reduce the number of workers on the floor as well as reduce the walking time, researchers found out that simple U shaped assembly line was as effective as any other linear assembly line for the reduction of workers and delivering the tasks in a given cycle time [9].

Lean Manufacturing Process invented by Toyota, also known as TPS has become a standard in vehicle manufacturing industry. Many western vehicle manufacturers including Mercedes-Benz, BMW, Ford, etc. are applying TPS techniques of Lean Concept of Management in manufacturing and have increased their efficiency many folds through this technique. Shop Floor principles are the basis of implementation of Lean manufacturing concept and they allow the managers and teams to perform with highest interaction as well as highest efficiency. Lean Manufacturing utilizes the concept of multi-tasked workers, who work across a linear assembly line to produce the finished goods, also called Walking Workers. These Walking Workers play a key role in the execution of the system through their multi-tasking. Their job descriptions and skillset, applied under the Lean concept of manufacturing as allowed the companies to substantially gain additional benefits and save huge costs during the manufacturing processes. It has allowed the company to enjoy faster processing times and reduce cost of inventory and time required for manufacturing a material with highest degree of customizations as in the case of Dell, USA. Lean Manufacturing concept has also been applied in other manufacturing industries apart from automobiles and has shown substantial results. On the other hand, It has improved the communication between managers and workers as well as allowing the workers to get rid of their boring routines and repetitive functions and perform in the production process on a wider scale. Also, it has helped enhance the skills of the workers and have allowed the manufacturing processes to enjoy maximum utilization of workers' abilities through reducing time wastage and fast communication infrastructure.

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