

The Toyota Production System

A Case Study of Creativity and Innovation in Automotive Engineering

R. Balakrishnan

INTRODUCTION

Automobile Manufacturing

Forty years ago, Peter Drucker dubbed it "the industries of industries." Today, automobile manufacturing is still the world's largest manufacturing activity. After First World War, Henry Ford and General Motors' Alfred Sloan moved world manufacture from centuries of craft production (led by European firms) into the age of mass production. Largely as a result, the United States soon dominated the world economy.

Toyota Production System

After Second World War, Eiji Toyoda and Taiichi Ohno at the Toyota motor company in Japan pioneered the concept of Toyota Production System. The rise of Japan to its current economic pre-eminence quickly followed, as other companies and industries copied this remarkable system. Manufacturers around the world are now trying to embrace this innovative system, but they are finding the going rough. The companies that first mastered this system were all head-quartered in one country—Japan. However, many Western companies now understand Toyota Production System, and at least one is well along the path of introducing it. Superimposing this method on the existing mass-production systems causes great pain and dislocation.

This essay, I believe, is an effort to explain the necessary transition from mass production to revolutionary production called Toyota production System. By focusing on the global auto industry, this essay explains in simple, concrete terms what the Toyota Production System is, where it came from, how it really works, and how it can spread to all corners of the globe for everyone's mutual benefit. The global adaptation, as it inevitably spreads beyond the auto industry, will change everything in almost every industry—choices of customers, the nature of work, the fortune of companies, and, ultimately, the fate of nations.

What is Toyota Production System? Perhaps the best way to describe this innovative production system is to contrast it with craft production and mass production, the two other methods humans have devised to make things.

Production methods

The craft producer uses highly skilled workers and simple but flexible tools to make exactly what the customer asks for—one item at a time. Few exotic sports cars provide current day examples. We all love the idea of craft production, but the problem with it is obvious: Goods produced by the craft method—as automobiles once were exclusively—cost too much for most of us to afford. So mass production was developed at the beginning of the twentieth century as an alternative.

The mass-producer uses narrowly skilled professionals to design products made by unskilled or semiskilled workers tending expensive, single-purpose machines. These churn out standardised products in very high volume. Because the machinery costs so much and is so intolerant of disruption, the mass-producer keeps standard designs in production for as long as possible. The result: The customer gets lower costs but at the expense of variety and by means of work methods that most employees find boring and dispiriting.

The Toyota motor corporation, by contrast, combines the advantages of craft and mass production, while avoiding the high cost of the former and the rigidity of the latter. Toward this end, they employ teams of multi-skilled workers at all levels of the organisation and use highly flexible and increasingly automated machines to produce volumes of products in enormous variety.

The Toyota Production System is also defined as Lean Production because it uses less of everything compared with mass production—half the human effort in the factory, half the manufacturing space, half the investment in tools, half the engineering hours to develop a new product in half the time. Also it requires keeping far less than half the needed inventory on site, results in many fewer defects, and produces a greater and ever growing variety of products.

Perhaps the most striking difference between mass and Toyota production system lies in their ultimate objectives. Mass-producers set a limited goal for themselves— "good enough," which translates into an acceptable number of defects, a maximum acceptable level of inventories, a narrow range of standardised products. Lean producers on the other hand, set their sights explicitly on perfection.

TOYOTA PRODUCTION SYSTEM

Basic idea and Framework

The Toyota production system is a technology of comprehensive production management the Japanese invented a hundred years after opening up to the modern world. The basic idea of this system is to maintain a continuous flow of products in factories in order to flexibly adapt to demand changes. The realisation of such production flow is called Just-in-time production, which means producing only necessary units in a necessary quantity at a necessary time. As a result, the excess inventories and the excess work-force will be naturally diminished, thereby achieving the purposes of increased productivity and cost reduction.

The basic principle of Just-in-time production is rational; that is, the Toyota production system has been developed by steadily pursuing the orthodox way of production management. With the realisation of this concept, unnecessary intermediate and finished product inventories would be eliminated. However, although cost reduction is the system's most important goal, it must achieve three other sub-goals in order to achieve its primary objective. They include:

1. Quantity control, which enables the system to adapt to daily and monthly fluctuations in demand in terms of quantities and variety;
2. Quality assurance, which assures that each process will supply only good units to the subsequent processes;
3. Respect-for-humanity, which must be cultivated while the system utilises the human resource to attain its cost objectives.

It should be emphasised here that these three goals cannot exist independently or be achieved independently without influencing each other or the primary goal of cost reduction. All goals are output of the same system; with productivity as the ultimate purpose and guiding concept, the Toyota production system strives to realise each of the goals for which it has been designed. Before discussing the contents of the Toyota production system in detail, an overview of this system is in order. The outputs or result side as well as the inputs or constituent side of the production system are depicted.

A continuous flow of production, or adapting to demand changes in quantities and variety, is created by achieving two key concepts: Just-in-time and Autonomation. These two concepts are the pillars of the Toyota production system.

Just-in-time basically means to produce the necessary units in the necessary quantities at the necessary time.

Autonamation ("Jidoka" in Japanese) may be loosely interpreted as autonomous defects control. It supports Just-in-time by never allowing defective units from the preceding process to flow into and disrupt a subsequent process. Two concepts also key to the Toyota production system include Flexible work force ("Shojinka" in Japanese) which means varying the number of workers to demand changes, and Creative thinking or inventive ideas ("soikufu"), or capitalising on workers suggestions.

To realise these four concepts, Toyota has established the following systems and methods:

1. Kanban system to maintain Just-in-time production
2. Production smoothing method to adapt to demand changes
3. Shortening of set-up time for reducing the production lead time
4. Standardisation of operations to attain line balancing
5. Machine layout and the multi-function worker for flexible work force
6. Improvement activities by small groups and the suggestion system to reduce the work force and increase the worker's morale.
7. Visual control system to achieve the Autonamation concept
8. Functional Management system to promote company-wide quality control.

Just-in-time production

The idea of producing the necessary units in the necessary quantities at the necessary time is described by the short term Just-in-time. Just-in-time means, for example, that in the process of assembling the parts to build a car, the necessary kind of sub-assemblies of the preceding processes should arrive at the product line at the time needed in the necessary quantities. If Just-in-time is realised in the entire firm, then unnecessary inventories in the factory will be completely eliminated, making stores or warehouses unnecessary. The inventory carrying costs will be diminished, and the ratio of capital turnover will be increased.

However, to rely solely on the central planning approach which instructs the production schedules to all processes simultaneously, it is very difficult to realise Just-in-time in all the processes for a product like an automobile, which consists of thousands of parts. Therefore, in Toyota system, it is necessary to look at the production flow conversely; in other words, the people of a certain process go to the preceding process to withdraw the necessary units in the necessary quantities at the necessary time. Then what the preceding process has to do is produce only enough quantities of units to replace those that have been withdrawn.

Kanban system

Many people think the Toyota production system a Kanban system: this is incorrect. The Toyota production system is a way to make products, whereas the Kanban system is the way to manage the Just-in-time production method. In short, the kanban system is an information system to harmoniously control the production quantities in every process. It is a tool to achieve just-in-time production. In this system what kind of units and how many units needed are written on a tag-like card called Kanban. The Kanban is sent to the people of the preceding process from the subsequent process. As a result, many processes in a plant are connected with each other. This connecting of processes in a factory allows for better control of necessary quantities for various products. The Kanban system is supported by the following:

- Smoothing of production
- Reduction of set-up time design of machine layout
- Standardisation of jobs
- Improvement activities
- Autonamation

A kanban is usually a card put in a rectangular vinyl envelope. Two kinds are mainly used: Withdrawal Kanban

and Production-ordering Kanban.

A Withdrawal Kanban details the kind and quantity of product which the subsequent process should withdraw from the preceding process, while a Production-ordering Kanban specifies the kind and quantity of the product which the preceding process must produce.

The Withdrawal kanban in fig.2 shows that the preceding process which makes this part is forging, and the carrier of the subsequent part must go to position B-2 of the forging department to withdraw drive pinions. The subsequent process is machining. The Kanban in fig.3 shows that the machining process SB-8 must produce the crank shaft for the car type. The crank shaft produced should be placed at store F26-18. These cards circulate within Toyota factories, between Toyota and its many co-operative companies, and within the factories of co-operative companies. In this manner, the Kanban can contribute information on withdrawal and production quantities in order to achieve Just-in-time production.

Suppose we are making products A, B, and C in an assembly line. The parts necessary to produce these products are a and b which are produced by the preceding machining line(fig.4). Parts a and b produced by the machining line are stored behind this line, and the production-ordering Kanbans of the line are attached to these parts. The carrier from the assembly line making product A will go to the machining line to withdraw the necessary part a with a withdrawal kanban. Then, at store, he picks up as many boxes of this part as his withdrawal kanbans and he detaches the production-ordering kanban attached to these boxes. He then brings these boxes back to his assembly line, again with withdrawal kanbans. At this time, the production-ordering Kanbans are left at store a of the machining line showing the number of units withdrawn. These Kanbans will be the dispatching information to the machining line. Part a is then produced in the quantity directed by that number of Kanbans. In this machining line, actually, parts a and b are both withdrawn, but these parts are produced according to the detached order of the production-ordering Kanbans.

Autonamation

In order to realise Just-in-time perfectly, 100 per cent good units must flow to the prior process, and this flow must be rhythmic without interruption. Therefore, quality control is so important that it must coexist with the Just-in-time operation throughout the Kanban system. Autonamation means to build in a mechanism a means to prevent mass-production of defective work in machines or product lines. Autonamation is not automation, but the autonomous check of abnormality in the process.

The autonomous machine is a machine to which an automatic stopping device is attached. In Toyota factories, almost all the machines are autonomous, so that mass-production of defects can be prevented and machine breakdowns are automatically checked. The idea of Autonamation is also expanded to the product lines of manual work. If something abnormal happens in a product line, the worker pushes stop button, thereby stopping his whole line. For the purpose of detecting troubles in each process, an electric light board, called Andon, indicating a line stop, is hung so high in a factory that it can easily be seen by everyone. The Andon in the Toyota system has an important role in helping this autonomous check, and is a typical example of Toyota's "Visual Control System."

CONCLUSION

Global adaptation

Since Toyota production system has been created from actual practices in the factories of Toyota, it has a strong feature of emphasising practical effects, and actual practice and implication over theoretical analysis. This system can play a great role in the task of improving the constitutions of the companies world-wide(especially those of the automobile industry).

BIBLIOGRAPHY

The Machine that changed the World - Womack, Jones and Roos

Toyota Production System - Yasuhiro Monden

TRANSLATION

KANBAN - CARD (INFORMATION)

JIDOKA - AUTONAMATION

SHOJINKA - FLEXIBLE WORK FORCE

SOIKUFU - CREATIVE THINKING; INVENTIVE IDEA

ANDON - ELECTRIC LIGHT BOARD