The transfer of the Toyota Production System: A Case of Indonesia

Keisuke Nakamura

Professor, Dr., Institute of Social Science

The University of Tokyo

1. Introduction

What innovations have Japanese manufacturing multinationals brought to the workplace in Asian countries? Or have they encountered any problems in operating their transplants? What causes the success or failure? This paper discusses these questions, based on our in-depth case study of Toyota- Astra Motor in Indonesia[1], applying the following analytical framework.

The Toyota Production System (TPS), which is well known globally for its high efficiency or “lean production system”(Womack, Jones and Roos 1990), is the system which is organized and run under the concept of “arranging all the processes in the production sequence in a single, smooth flow”(Toyota Motor Company (TMC) 1995: 12). The arrangement begins with the final process or the sale of products. To put it rather simply, the TPS is a system where one makes only what is needed, only when it is needed, and only in the amount that is needed at each process from the procurement of raw materials to final assembly to sale of the final product (TMC 1995: 12; Monden 1985: 37).

How the system runs can be simplified as follows. The first step involves dealers who order various models and types of vehicles from an automobile maker. Then, final assembly lines produce the models and types of vehicles in the given quantity and ship them to dealers within the terms specified in the dealers’ orders. Parts suppliers produce the needed type of parts in the needed quantity and deliver them on time to the final assembly lines according to the assembly plants’ requests. Every process starts its operation according to its next process’ request. Every process is pulled by its next process. This pulling process is why the TPS is also called a “Pull System”.

The TPS involves every element of Japan’s production management characteristics. Since only what is needed is produced in the needed quantity under the TPS, quantity of

[1] As for detailed analysis, please refer to Nakamura=Wicaksono(1999).

stocks in any type is minimized. Defects in the minimized stocks disturb the smooth running of the production. Since the needed product or part is produced only when it is needed, the disturbance caused by defects further worsen the smooth running. Strict control on quality is, hence, strongly required. Any delay in the production threatens the “Pull System” with minimized stocks. Strict control on progress is also strongly required. Since the production is carried out according to dealers’ orders, the production should be run flexibly. Continuous improvement is needed in order to lower the minimum level of stocks, decrease defective rates and delays of production, and increase the flexibility. In sum, the strictness and the flexibility of production management and the orientation toward continuous improvement are indispensable to the smooth running of the TPS.

These elements are attained by workers’ groups on the shop floor in the case of Japan’s production system and naturally in the case of the TPS. Workers with intellectual skill are engaged in unusual operations where workers deal with changes in products, production volume, production line and workers composition and handle problems with production process, quality, machines and so on (Koike 1991). In other words, workers usually participate in production management tasks such as progress control, quality control and cost control, and hence work is not organized following the principle of separation between planning and execution, but it is organized to the integration principle (Nakamura 1996).

Work organization on the integration principle, thus, is a requirement for successful transfer of the TPS. It takes a long time to transplant the work organization overseas, because the organization principle is different from the principle to which local managers and workers are accustomed, that is, the Tayloristic separation principle (Taylor 1911). It is also because it takes time to bring up workers with intellectual skill. Failure in organizing work in such a way does not necessarily results in failure in transplanting factories. Such elements as the strictness of production management could be obtained in another way. In this case, however, the TPS could not be successfully transferred.

Appropriate human resources management (HRM) practices are requirements for successful organization of work on the integration principle basis. Among HRM practices, the remuneration system and the training policy are especially important. The remuneration system should be designed to give workers an incentive to acquire intellectual skill and to carry out production control tasks. The training policy should be designed to give them opportunities to obtain the intellectual skill. The HRM practices designed and brought in by multinationals do not necessarily adjust to country's original social and historical context where HRM practices usually have developed. Failure in designing good HRM practices leads to malfunction of the work organization.

In sum, the paper will analyze the questions about work innovation and problems on the shop floor, focusing on the TPS, the work organization and HRM practices and their inter-relationships.

First, the paper briefly describes how well the TPS works in Toyota-Astra Motor. Second, it discusses the functioning of work organization which enables the TPS to work smoothly. Third, it touches upon Human Resources Management (HRM) practices that give workers strong incentive and opportunities to improve their skill. Finally it sums up the argument and discusses backgrounds of the successful transfer of the TPS.

2. Flexible Leveled Production at TAM

2-1. The Order Confirmation System

The Order Confirmation System (OCS) is a system under which dealers forecast the following month's sales for each model and type of vehicle and place orders with TAM. The OCS was installed in TAM in the early 1990's, and now five main dealers of TAM have been integrated into TAM's OCS. Naturally, Toyota Motor Company (TMC) in Japan has already employed OCS, while TAM is the first overseas plant to install and utilize the system. Based on the dealers' orders given through the OCS and availability of parts imported from Japan, TAM works out a monthly production plan, according to which plan TAM produces various models and types of vehicles and delivers them daily to the dealers.

The OCS aims at reducing waste in stocks of final products in both TAM and dealers. The system allows dealers to obtain what they really need in short lead time and also enables TAM to produce to real orders. Dealers need not to have an excessive inventory of final products, while TAM ships all automobiles to dealers immediately and therefore has a very small amount of final products.

In comparison with the OCS at TMC (as described in TMC 1995:13; Monden 1985:150-154; Monden 1991:156-160), TAM is behind TMC in terms of flexibility. While TAM produces to dealers' orders based on their forecast, TMC produces to actual customers' orders conveyed by dealers. The lead time from order to deliver is ten days at TMC, while one month at TAM.

Despite this backwardness TAM is the first overseas plant to install the OCS and has steadily progressed toward the TPS.

2-2. Leveled production

TAM assembles various types of a single model or various models in a mixed way on the same assembly line. Suppose that four types of Kijang[2] - the Grand Luxury, the Deluxe, the Standard and the Diesel- are produced with the ratio of the first three types standing at 2/7 and the ratio of the last type standing at 1/7. At TAM these four types are all assembled in a mixed way on the same assembly line, with the production sequence being kept constant. TAM uses the same system to produce three passenger car models - the Corolla, the Starlet, and the Corona.

---

[2] Kijang, which literally means a deer in English, is the most popular automobile in Indonesia.

The mixed production line produces each type or model regularly to a set production sequence. Every seven units of the Kijang coming off the line includes two Grand Luxury vehicles, two Deluxe vehicles, two Standard vehicles, and one Diesel vehicle. The mixed production system with a constant production sequence is called “Leveled Production” in TPS terminology(TMC 1995:13).

2-3. Designing leveled production

The leveled production system has to tackle the problems caused by the fact that different models and types require different time to assemble. Different models require different parts and there are different methods of assembly with different jigs and tools. This situation can exist even in the production of different types of the same model. Frequently changing models and types coming through on the assembly line requires time to allow for the change of parts, jigs and tools. Hence, a poorly considered mix of vehicles may result in various types of inefficiencies. Since assembly time varies from one type of vehicle to another even when the model is the same, it is very difficult to assemble different models and types on the same assembly line with the conveyor speed remaining constant. The leveled production system solves these problems.

Takt time and cycle time are critical to the designing of the leveled production. “Takt time is the German word for meter, as in musical meter” (TMC 1995:22). Actually takt time refers to conveyor speed. A finished vehicle is completed every takt time. Cycle time refers to the time necessary for a worker to finish one cycle of his job with one automobile. The length of cycle time depends on how many tasks are included in a worker’s job. On the assembly line every worker completes his job in the same cycle time. Otherwise, production would not proceed steadily.

Before production is set up, the takt time and the cycle time must be determined according to the monthly production volume. Table 1 provides information on production targets for three vehicles which are to be assembled over a month with 20 working days and eight-hour shifts. In the discussion below, night shifts are excluded from consideration.

Table 1. Monthly Production Volume

Model	Monthly production volume	Ratio of manufacturing time
Corona	100 units	12
Corolla	500 units	11
Starlet	100 units	9

Note: The Corona takes the longest time to assemble, the Corolla the second longest, and the Starlet takes the shortest. The figures presented here for the production volume, takt time, and cycle time are not actual figures, but have been devised to facilitate the explanation.

Takt time is calculated by dividing the total number of effective operating minutes by the planned production volume. Total effective operating minutes per day might be calculated as follows: 480 minutes (8 hours) minus 25 minutes of relief time plus 60 minutes of over time equals 515 minutes. Total monthly production volume of 700 units divided by 20 working days equals to 35 units per day. The takt time is about 15 minutes (= 515 minutes ÷35 units).

The cycle time for each model is worked out by using the above determined takt time. Suppose that the takt time is applied to the production of the Corolla. In other words, each job with a Corolla is designed so that the cycle time is equal to the takt time. The conveyor speed allows each station on the assembly line 15 minutes, during which a worker completes his work for one unit of the Corolla. The ratios of manufacturing time in Table 1 show that every worker requires more time to complete one cycle of his job with the Corona, and less time with the Starlet. The cycle time for the Corona becomes 16.36 minutes (=15 minutes x 12/11), while that for the Starlet is 12.27 minutes (=15 minutes x 9/11). With a 15 minute takt time, production of the Corona would cause many line stops due to a lack of time to complete the job. With the Starlet, every worker would have some waiting time.

In order to solve the problems stemming from building multiple models on the same assembly line, the sequence of production must be considered as well. In this illustration, the production sequence should be determined as CCCCCCSN (where C stands for Corolla, S for

Starlet, and N for Corona). After finishing five Corolla units, workers assemble one Starlet. It takes the worker 12.27 minutes to complete his work, leaving him with 2.73 minutes of idle time (=15-12.27). When the worker starts to assemble a Corona after finishing the Starlet, he has 17.73 minutes (=2.73+15) to complete his job on the Corona. Since the cycle time for the Corona is 16.36 minutes, the 17.73 minutes is enough time for the worker to complete his job. Only 1.37 minutes of waiting time is yielded during one round of the production sequence (producing seven vehicles), providing there are no line stops.

In comparison with the designing of the leveled production at TMC in Japan (as described in Monden 1991:145-146, 147-148), there appears to be no big difference between TAM and TMC.

2-4. Flexible leveled production

One of the most striking features of the TPS is the ability to change takt time in order to adjust to market fluctuations. Since takt time is calculated from planned production volume and total effective operating hours, in case of a large change in production volume takt time is also changed. When production volume largely goes down (up) and total operating time remains the constant, takt time is lengthened (shortened). Lengthened (shortened) takt time means slower (faster) assembly line speeds and extended (narrowed) intervals during which an vehicle is completed. It also means lengthened (shortened) cycle time. At the extended (narrowed) intervals, the volume of production reduces (increases) automatically even though total operating time remains constant. How is takt time lengthened?

Let us examine the example of passenger cars again. Were monthly production volume of the Corona reduced form 100 units to 80 units, the Corolla, from 500 units to 300 units, and the Starlet, from 100 units to 80 units, takt time would be 22.4 minutes (515 minutes/[460 units/20 days]). The cycle time of the Corolla is, then, equalized to the new takt time. The cycle time for the Corona becomes 24.4 minutes. For the Starlet it becomes 18.3 minutes.

When cycle time is lengthened, more tasks are added to each job and the number of workers is reduced. The length of the cycle time depends on how many tasks are included in a job. As more tasks are added to jobs, the number of workers required to staff the assembly line decreases, since the total number of tasks on the assembly line is constant. How does TAM reduce excess workers? The first course of action is to dismiss contract workers who are hired on a temporary basis. After that, some workers are removed from assembly operations and reassigned to other assembly lines or placed on task force teams in order to facilitate continuous improvement activities. If these measures are inadequate, some regular workers will be temporarily laid off or dismissed.

When there is a large increase in production volume, the reverse occurs. Takt time and cycle time are shortened (i.e. the assembly line speed is increased). Every worker's job is reorganized, reducing the number of tasks and new contract or permanent workers are hired.

The ability to flexibly adjust takt time enables TAM to produce according to fluctuations in the market without excessive inventory in any form and to fully utilize its human resources. Change in takt time is not easy to execute, since it is accompanied by change in cycle time and reorganization of each worker's job. Moreover, it takes workers a while to adjust to the changed cycle time and reorganized jobs.

Compared with flexible leveled production at TMC (as described in TMC 1995: 22; Monden 1985:210-212, 218-220; Monden 1991:142), the flexible leveled production at TAM is built on the same basic principles.

2-5. The TPS at TAM

The TPS has been transplanted to TAM, although there are still some differences in comparison with the TPS at TMC. TAM is the first overseas plant that has installed the OCS.

Their version is less flexible and less sensitive than the OCS as utilized by TMC. The basic principle of leveled production and flexibility in takt time has been adopted by TAM.

Successful transfer of the TPS means that production management necessary to run the TPS has been also transferred from TMC in Japan to TAM in Indonesia. The next question is who support the smooth running of the TPS, or who has the production management technology. Is the technology transferred from Japanese expatiates to Indonesian engineers, managers and workers? The next chapter examines the technology transfer to workers.

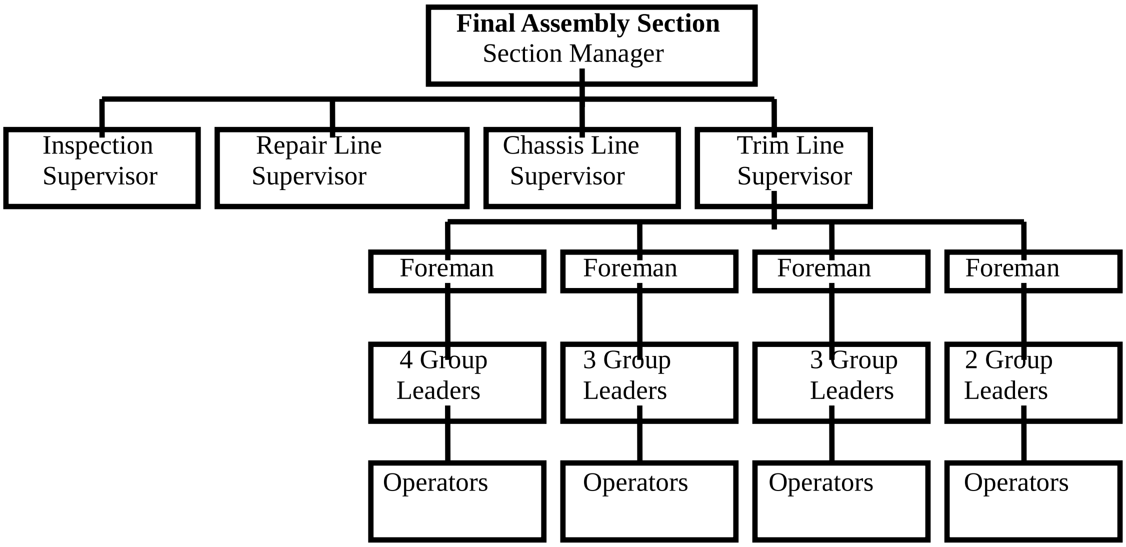
3. Work Organization at a Kijang Trim Line

3-1. A Trim line

A Trim Line is an assembly line where various parts are assembled into a car body. For example, parts such as speakers and regulators are assembled into the inside of a door in the Trim Line. A glance at the assembly line gives one the impression that workers are engaged in monotonous, hard jobs without much time for rest. It is difficult to notice that flexible leveled production producing high quality products is being conducted.

The Kijang Trim Line assembles 22 types of Kijang and is run by a supervisor, four foremen, 12 group leaders, and 80 operators as is shown in Figure 1. The Grand Luxury (GL), Standard (STD) and Deluxe (DLX) are the three basic types of the Kijang. Each of the basic types has several subtypes with two different types of engines, two different sizes of body, two different types of transmission and other option packages. Cycle time differs among each of the three basic types. The cycle time for the GL is set at 260 seconds, for the STD it is 232 seconds, and for the DLX it is 246 seconds with takt time being set at 246 seconds. The production sequence is GL, STD, and DLX.

Figure 1 Organizational Chart of the Kijang Trim Line



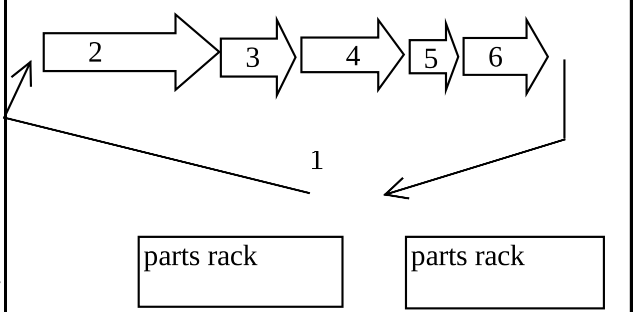
Source: TAM's company data "Struktur Organisasi Final 2".

3-2. Daily work of the operators

Operators in the Trim Line at TAM are required to perform repetitive work within the takt time strictly following the standard work sheets and keeping the quality standard. Standard work sheets precisely script all tasks of a job including walking, and the time necessary for each task. They also show the sequence of tasks, jigs and tools needed and the location of stock. Figure 2 illustrates a standard work sheet.

Figure 2 A standard work sheet

No.	Task	Time(seconds) operation	walk
1	Watch *Harigami* (a standard manifest)	2	
	Pick up the tool and parts	10	
	Walk to a body		6
2	Install the five clamps in the wireharness	30	
3	Put the wireharness in an engine room in order and cut the clamps	15	
	Install the grommet of the turn signal	5	
4	Install the two clips of the hood lock control cable	10	
	Install the dumper fender into the hood	5	
5	Shoot the bolts	10	
6	Install the fuel filter and shoot the flange bolts	15	
	Return to the right position		4



Source: Drawn up from TAM's company data "a standard work sheet in the Trim Line".
Note: Some modifications are made.

In order to meet the quality standard, an operator has to pay attention to the standard operation procedure. The standard operation procedure is shown with three kinds of instructions. There is a standard manifest (*Harigami*), an assembly manual, and a work ability sheet. The manifest is put on the inside of a hood and tells the type of Kijang being assembled[3]. The assembly manual depicts the sequence for the assembly of the parts. The work ability sheet shows the difficulty of operation, safety check points, and the jigs and tools used on the job.

In sum, operators are expected to follow directions exactly as prescribed in a pre-determined way.

When a problem happens, an operator is to call his group leader immediately. While the group leader attends to the problem, he may engage in other tasks or may watch the group leader fix the problem. Operators are responsible for finding problems as soon as possible, not for fixing them. Trouble shooting is not operator's job but it the responsibility of the group leader.

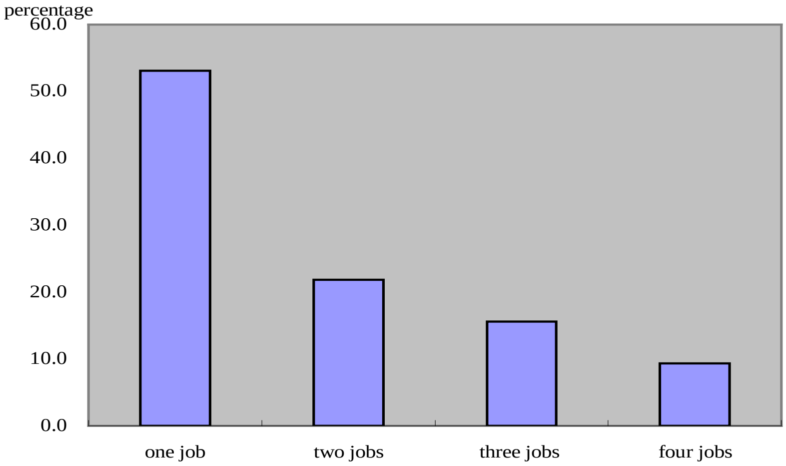
Although an operator repeats his job following the standard work sheet and is not involved in trouble shooting on the spot, he may not assemble the same parts in the same way on every job. An operator assembles twenty two types of the Kijang, each of these types requires different parts. For example, GL with a gasoline engine has an air conditioner, while DLX with a gasoline engine does not have an air conditioner. Furthermore, cycle time of basic three types differs from each other, as mentioned above. Although the repetitive nature of the job continues, an operator must pay close attention to his job since there is a large variety of parts in both number and type.

Furthermore, operators are trained as multifunctional operators through job rotation. The term 'multifunctional' in the Trim Line means that an operator is able to perform more

[3] The manifest (Harigami) specifies such items as the type of Kijang, engine type, body type, whether the

than one assembly job. For example, a worker can assemble window regulators into doors and also install side glass into doors. Figure 3 says that about 20 percent of the 32 operators in the Trim Line can perform two jobs; 15 percent, three jobs; and about 10 percent, four jobs. These figures might underestimate the percentage of multifunctional operators, because the Trim Line was just reorganized and the verifying test was not completed yet when this research was conducted.

Figure 3　The Percentage of multifunctional operators (n=32)



Source: Derived from TAM's company data, "Multifunction work in the Trimming Line".
Note: If an operator is evaluated and rated at more than 50%, we suppose that he can perform the operation 100% for calculation.

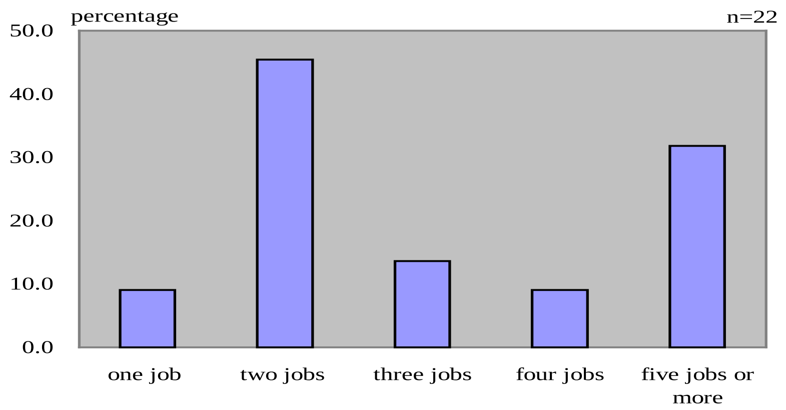
A look at the Chassis Line, next to the Trim Line, illustrates the high ratio of multifunctional operators, as is shown in Figure 4.

Multifunctional operators are one requirement for the flexible leveled production and the TPS at TAM. Takt time at TAM varies according to production levels. A change in the takt time results in each job being reorganized. Reorganization is not just for some jobs; it occurs for all jobs. With multifunctional operators changes in takt are much easier to implement, since the reorganization can be done without being obstructed by the limits of operators' job capability, or with less training.

---

vehicle has an air conditioner, what type of audio system, cylinder type, how many doors, etc.

Figure 4 The Percentage of multifunctional operators in the Chassis Line (n=22)



Source: Derived from TAM's company data, "Multifunction work in the Trimming Line".
Note: If an operator is evaluated and rated at more than 50%, we suppose that he can perform the operation 100% for calculation.

Let us examine multifunctional operators' role further by looking at two extreme cases. Suppose two extreme cases:

1. None of six operators are multifunctional
2. All six operators are multifunctional

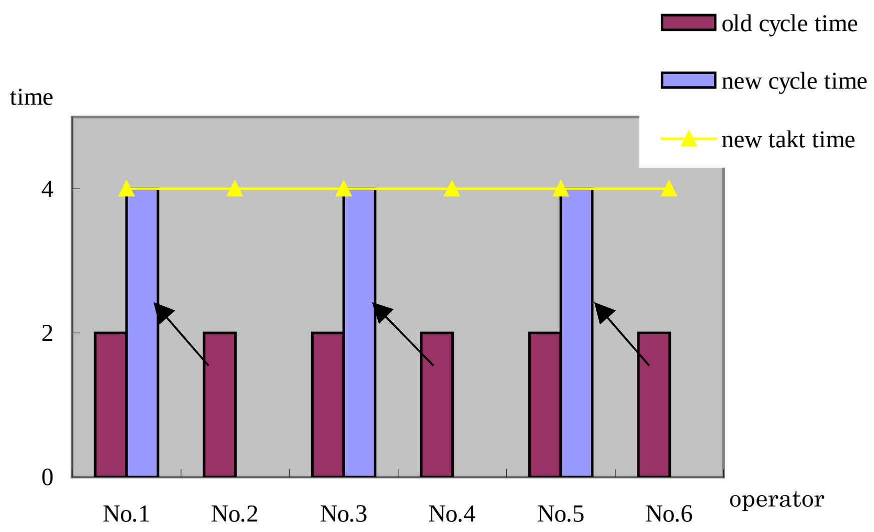
When takt time lengthens due to a decrease in production volume, say from two minutes to four minutes, what happens in these two cases? Since takt time is doubled, the number of operators needed is reduced by half[4], from six to three. Each of three jobs left is reorganized as to include new tasks which were previously performed by the next three operators.

Figure 5 illustrates the reorganization. Under the new takt time of four minutes, operator no. 1 performs both his previous job and the job that was performed by operator no. 2. Operator no. 2 becomes redundant. This process repeats itself with the other four operators. Considering the same case with no multifunctional operators, all three of the operators would

[4] Since the quantity of man hours necessary for line is constant, the number of operators is calculated by 6 persons x 2 minutes/4 minutes.

have to be trained. None of the multifunctional workers would require any training and they could perform the reorganized jobs at once.

Figure 5　An Increase in Takt Time and Job Reorganization



When takt time is shortened to support an increase in production volume, say, from 2 minutes to 1.7 minutes, the number of operators increases by one person, from six to seven[5]. All seven jobs would have to be reorganized. In this case, reorganization is more difficult. Jobs would be reorganized so that cycle time would equal 1.7 minutes.

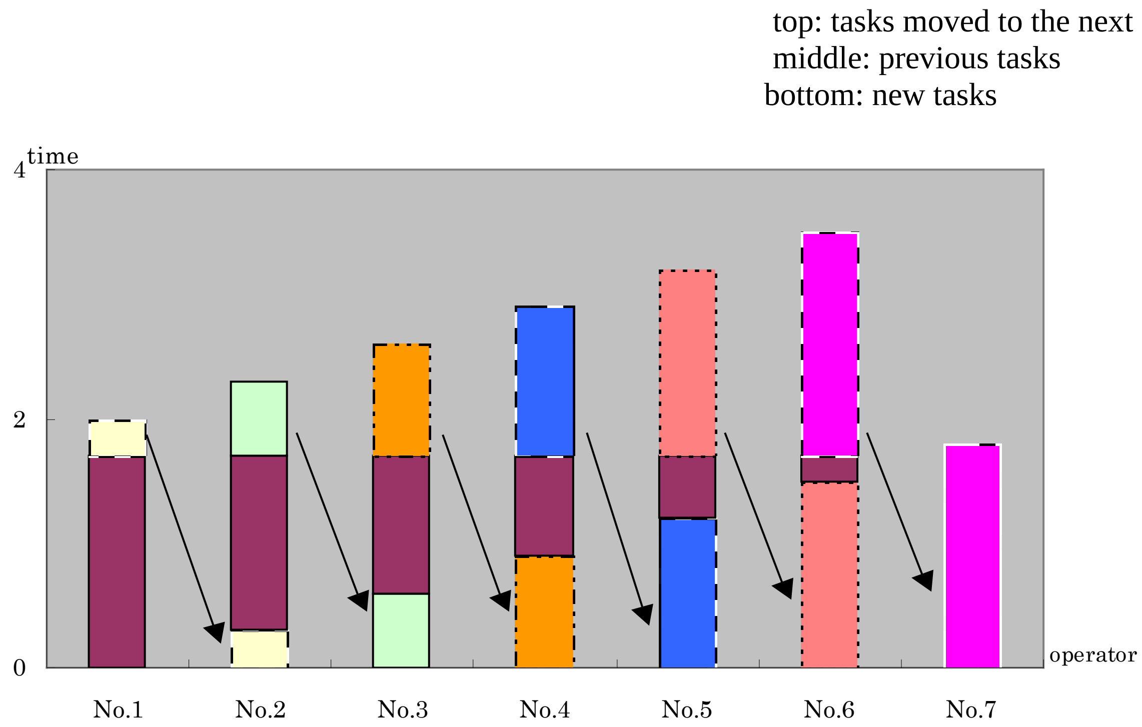
What is important is setting up new jobs so that production flows smoothly. One possible solution would be to pick the tasks requiring 0.3 minutes from each of previous six jobs and then bundle all the tasks together to create a new seventh job. However, this method does not result in a smooth production flow. Another possible way of reorganizing the jobs is that the tasks requiring 0.3 minutes from job (1) are moved to job (2) and tasks requiring 0.6 minutes from job (2) are moved to job (3) and so on[6], as is shown in Figure 6.

---

[5] 6 persons x 2 minutes/1.7 minutes = approximately 7 persons

[6] In other words, all tasks in the line are distributed to seven jobs, following production flow, so that cycle time

Figure 6 A Decrease in Takt Time and Job Reorganization



Every operator except for operator no.1 are engaged in somewhat different jobs tasks than before. In the case where there are no multifunctional operators, everyone except for operator no.1 should be trained. However, only one operator, the newly assigned operator no.7 receives training when all operators are multifunctional.

Multifunctional operators make the change in takt time much easier, and thereby increase the flexibility of the production line to a greater extent. In sum, multifunctional operators are one of the most important elements in attaining flexible leveled production and thus the TPS.

3-3. Daily work of the group leaders

The Trim Line has 12 group leaders, with each supervising seven to eight operators. Group leaders perform multiple roles on the shop floor: they prepare for production, relieve operators, solve problems on the spot, and engage in quality control and labor management functions. Relief, problem-solving and quality control roles are described below.

---

may be at 1.7 minutes.

When an operator needs relief from his operation, a group leader takes his job. Another group leader or a foreman then fills in for the group leader. Hence, group leaders must be able to perform all the jobs under their supervision.

When an operator discovers a problem during the assembly process, he is supposed to pull a “line stop cord” to call his group leader. The group leader responds immediately to fix the problem without stopping the line. If the leader cannot fix the problem within the cycle time, he stops the line. Problems can arise when an operator assembles the wrong parts, forgets to install parts, uses the wrong bolts or other fasteners, or the quality of parts is unacceptable. Also when an operator has difficulty finishing his job within the cycle time, a line stop occurs. The following two points are important concerning trouble shooting.

First, problems do not always mean line stops. Group leaders try hard to avoid line stops. Targets are set for line stop time. For example, they may be 20 minutes per day per supervisor, seven minutes per day per foreman and two minutes per day per group leader. Group leaders are thus encouraged to fix problems within the cycle time as often as possible.

Second, group leaders have to be able to perform every job in their area. Otherwise, they could not fix problems effectively. While group leaders fix many problems by themselves, there are some problems that cause line stops and the group leaders need assistance in order to correct them. When such problems arise, group leaders report to their foreman and asks for further instructions.

Every hour group leaders go to the final inspection line to check whether defects have occurred in their area. The inspectors in the final inspection line display tables showing the types and number of defects produced in each group leader’s area. When the same defect is rediscovered on the final inspection line in two or three units in a row, the information about the defect is immediately conveyed to the group leader. The group leader then goes to the operator responsible for the defect and search for the cause. Characteristic of these quality control activities is the quickness with which group leaders are notified, but this process focuses on handling problems and defects that have already occurred.

While these activities constitute a portion of the quality control process, other quality control activities are also used in order to “build in quality in the production process”. To assure that high quality is produced, the occurrence of defects must be prevented. Group leaders are responsible for keeping records of line stops and defects. They usually draw graphs pictorially illustrating the performance of their area. The records and graphs are utilized in other quality related activities, which activities are discussed below.

3-4 Daily work of the foremen

According to the “Manual on Supervisory Staff’s Roles at TAM” (Imai 1991:127), foremen are mainly responsible for cost reduction and productivity improvement. There are four foremen in the Trim Line, each of whom supervises two to four group leaders and fourteen to twenty nine operators.

During daily operations, a foreman collects data on costs through his group leaders to draw tables and charts. A foreman is supposed to watch four kinds of costs: 1) labor costs, 2) direct material costs, 3) indirect costs, 4) energy costs. Labor costs are measured by labor hours per unit and are called “*kosu*”. Direct material costs are the funds spent on bolts, nuts, jigs and tools. Indirect costs are expenses on items that are consumable such as gloves and other supplies used in the assembly process. Energy costs refer to the cost of water, electricity, heat, and air conditioning. The latter three kinds of costs are measured by the consumption. In other words, a foreman collects data on how many bolts were used, how many gloves are consumed, how much electricity is used, and etc.

A target is given as a coefficient for each item in the case of the latter three costs by the Cost Control Department. The coefficient instructs the quantity of consumption of an item per unit. Suppose that the coefficient for gloves is determined at 0.0356 and the planned production volume stands at 320 units. Hence, targeted consumption of gloves is 11 pairs of gloves (320 x 0.0356= 11.392). When actual consumption exceeds the targeted consumption, a foreman has to search for the causes and take some counter measures.

Kosu is an indicator of labor costs[7] and "kosu is a very realistic indication of productivity improvement and cost reduction…"(Imai 1991:131). *Kosu* is calculated by the following formula: the actual number of workers multiplied by total actual working hours divided by actual volume of production per unit time. *Kosu* indicates to the extent that actual man-hours exceed planned man-hours and hence, it is an expression of labor productivity. When production is disrupted, actual volume of production may not reach the planned volume of production, and actual working hours may be extended to attain the target. As a result *kosu* increases and labor productivity decreases. *Kosu* also indicates whether the current number of workers is proper number or not, whether the takt time can be further shortened. Using kosu, a foreman is able to check the development of labor productivity in his processes and also compare labor productivity with other lines.

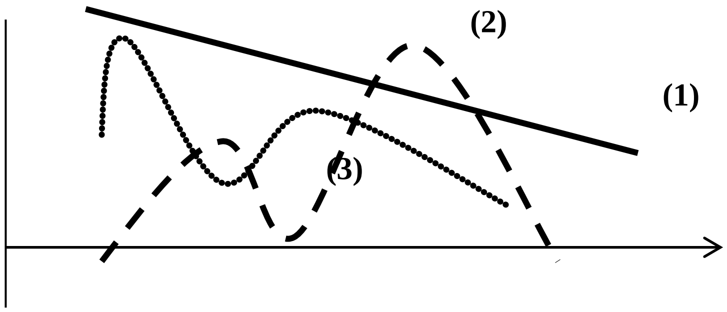
A target on *kosu* is also given by the Cost Control Department. When actual *kosu* exceeds the given target, a foreman has to investigate the reasons why the target was missed. They also will take some counter measures, as is the case with other costs.

A foreman is expected to discover the reasons why the four kinds of costs rise above the targets, to search for the causes, and get rid of them. These activities serve to reduce costs. A foreman is also required to find measures that prevent problems from recurring. The activities improve the process and also serve to reduce costs. When improvements are devised to reduce *kosu*, they result in an increase in labor productivity. A foreman turns in a report on costs to his supervisor weekly. This report describes actual costs, variance from targets, problems, and causes. Since "problems occur everyday" a foreman has to tackle

[7] For more detailed explanation about *Kosu*, please refer to Nakamura and Wicaksono (1999), pp.57-59.

problems on a daily basis.

Figure 7　The Necessity for daily improvements



Even when problems do not occur, a foreman is still required to make improvements to the process everyday. Let us explain the continuous improvement process, using Figure 7.

First, a target for each of the four costs is gradually reduced to reflect a desire for shop floors to continually improve their performance as is shown with a curve (1). Since operators are gaining experience and performing their jobs more efficiently, part of this decrease in the target can be obtained without much effort on the part of operators, group leaders or foremen. However, in order to obtain the target some actions have to be taken to ensure that the target will be met. For example, operators may need to be trained, or improvements may have to be generated by the foremen.

Second, when the data goes beyond the target as is shown with a curve (2), potential causes must be investigated and corrective actions need to be implemented. In this case, problems can be solved either by getting rid of causes or by devising measures that prevent problems from recurring.

Third, when the cost figures continue below the target line as is shown with a curve (3), improvements are needed to raise the target (this would move target line down in the Figure 7).

3-5. Quality control activities

Other than daily work, workers at TAM are engaged in quality control activities: a daily quality meeting, the suggestion plan and quality control circles (QCCs). The three types of quality control activities are discussed below.

After each production shift, a quality meeting is held daily for 30 minutes[8] to deal with problems that were encountered that day, especially the items that affected Quality, Cost, Delivery, Safety and Morale (QCDSM). A group leader and his operators attend the meeting, supervised by a foreman. Several features of these meetings are important.

First, the meeting gives operators an opportunity everyday to think about the nature of their problems and to consider possible solutions. Second, the meeting considers concrete issues that relate directly to problems of production, such as balancing jobs, line stops, quality, and new takt time. Third, some operators are more actively involved in solving problems than others. Multifunctional operators may be more active because they know many jobs and they tend to have more experience with solving problems.

Operators spend almost all of their time on repetitive, physically hard assembly work, and the 30 minutes they spend on problem solving may not appear to be enough time to make significant contributions to the smooth and efficient running of the assembly line. However, the workers do come up with devices that error-proof their processes so that problems do not reoccur.

The quality meetings, then, are closely tied into the idea suggestion plan. Two kinds of preventive measures are proposed at the daily quality meeting. One is to revise the way of performing jobs, the location of parts and the jigs and tools used, and to add other instruments. The other does not need such revision. In the latter case, the operator who is found to have caused problems is given advice on how to more strictly follow the standard work sheet and standard operation procedure. The former type of measure is usually thought out and submitted as a written suggestion.

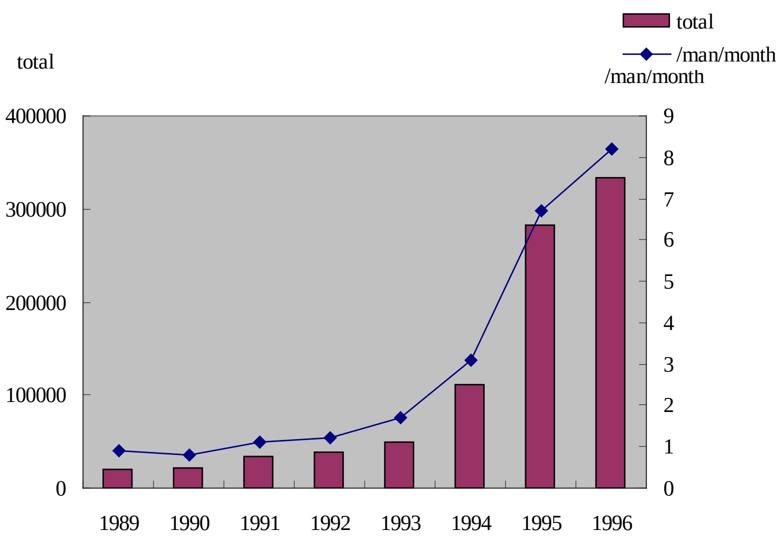
---

[8] The daily quality meeting may be temporarily set because of the severe market situation. Unfortunately we do

An operator who comes up with a concrete idea shares it with his foreman and asks for his opinion and advice. After approval by the foremen, the operator fills out a suggestion form. When filling out the form, one is expected to explain the problem, analyze its cost, depict its current condition, suggest an improvement, explain new method and/or new process, and evaluate the result of improvement suggestion using data and cost analysis.

The work of suggesting an idea does not seem easy. It requires a different set of skills from the physical skills that are normally associated with production work. Workers must have intellectual capability to solve problems effectively and to submit suggestions that improve the process. In 1997, an operator or a group leader submitted about eight suggestions per month on average. Figure 8 shows the development of the idea suggestion plan.

Figure 8 The development of the idea suggestion plan



Source: Tomura (1997), p.18.

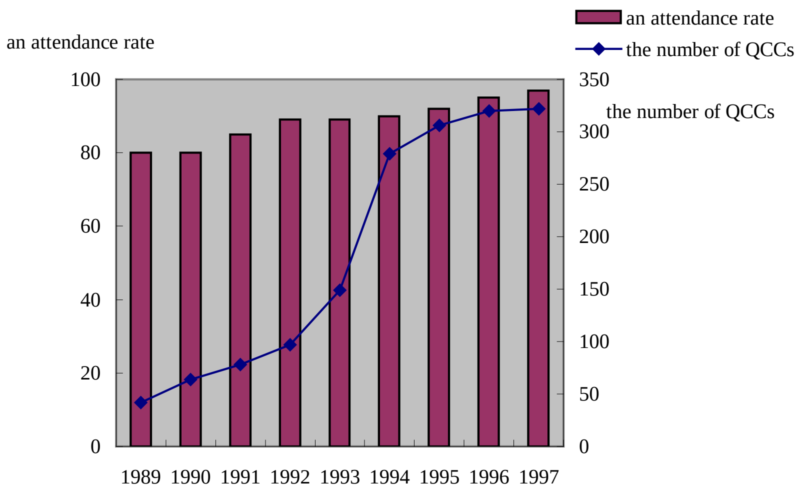
The idea suggestion plan leads up to QCCs. Some problems recur again and again even though ideas to solve them have been suggested and implemented. Other problems take long time to solve. When these types of problems arise, QCCs attempt to bring resolution to these difficult issues.

A QCC at TAM is usually organized with seven to ten members and is headed by a

not have data to identify how often a quality meeting is normally held.

group leader. There are about 320 QCCs throughout the plants at TAM in 1997 and almost all of the workers participate in QCCs. Figures 9 shows the development of QCCs.

Figure 9 The development of QCCs



source: Tomura (1997), p.18

QCCs are expected to have a meeting for one and a half hour every Tuesday after the end of the shift. In reality, how often QCCs hold meetings is left to the members. Some QCCs hold a meeting every week while others meet less often up to once a month.

A QCC consists of a circle leader, a theme leader, a facilitator and members. An engineer is not formally involved in a QCC formally and in fact, a QC seldom ask for an engineer's support. The QCC leader is a group leader and the facilitator is a foreman. A theme leader is an operator whose job is subject to the improvements being considered. The theme leader actually leads the QCC, because he knows the situation best. Other multifunctional operators including a group leader may be active since they too will be familiar with the problem.

Between 1996 and 1997 five QCCs in the Trim Line actively tackled difficult problems and produced remarkable results[9]. They reduced the defect rate from 0.02 to 0.006 percent in one instance; and from 0.3 to 0.09 percent, from 0.23 to 0.05 percent, from 0.042

[9] The result about the QCCs in the Trim Line is drawn from TAM's company data, "A QCC Report in the Trim

to 0.005 percent in three others; the fifth QC obtained a reduction in the number of broken parts per week from 77 to 2.

In sum, operators in the Trim Line at TAM perform some production control tasks, during daily quality meetings, the suggestion plan, and QCCs. Through each of these activities the workers contribute to smooth and efficient production.

3-6. Change in takt time

Takt time is usually changed several times a year at TAM, following a large change in the volume of production and when a new model is introduced. Among the takt time change procedure, job reorganization is the most difficult and requires most of energy necessary for the procedure. Job reorganization proceeds as follows.

First, a group leader arranges all the job tasks under his supervision. The time necessary to complete each task is pre-determined with standard time data. The group leader, together with his foreman, combines the tasks into jobs with ensuring a smooth production flow. He also determines the sequence of assembling parts, so that cycle time of each job will be equal to the takt time. Because TAM assembles various types or models in the Trim Line, the group leader has to reorganize jobs many times to accommodate the different types of vehicles assembled. With some types of vehicles, the cycle time of each job may exceed the takt time. With other types, the cycle time may fall below the takt time.

Reorganizing all jobs so that cycle time is equal to takt time (or takt time plus seconds or takt time minus seconds) is not easy. In practice some of the reorganized jobs take more time than pre-determined cycle time during the trial stage. When the reorganization of some jobs is discovered to be technically impossible, improvements become necessary. Improvements are devised on the layout of equipment, parts rack, jigs and tools as well as the way the work is performed.

Line".

A group leader performs the reorganized jobs to see whether the cycle time is equal to takt time (takt time plus or minus seconds). If the test succeeds, he draws up standard work sheets and submits them to his foreman. The foreman examines them and makes some modifications on them. When the foreman approves the standard work sheets, the takt time change procedure finishes.

After the takt time change is fully implemented, a further search for better quality and higher productivity begins. Let us examine this process using the launch of the new Kijang, at the beginning of 1997, as an example.

During the initial stage of process design, the production engineering division calculated takt time to be 2.9 minutes. However, this target proved to be difficult to attain. Thus, production started at a takt time of 3.2 minutes. After launching the production of the new Kijang, takt time shortened from the initial 3.2 minutes to the planned 2.9 minutes. Takt time was further reduced to 2.55 minutes. How was this accomplished?

Takt time was shortened as a result of the continuous improvement activities that were conducted by operators, group leaders and foremen at the daily quality meeting, through idea suggestions and QCCs. The way of performing jobs was checked everyday and some tasks in some jobs were moved to other jobs. Some jobs were modified when excessive walking was discovered and subsequently removed. Other jobs were changed when parts racks were relocated closer to assembly line or special drawers for jigs and tools were devised. These small step-by-step improvements took place while the operators were getting used to their new jobs. The result was a 20.3 percent reduction in takt time compared with the actual start up takt time and a final outcome, and 12.1 percent below the targeted takt time calculated by the production engineering division.

3-7 Flexible leveled production and work organization

Flexible leveled production with assuring high quality is supported by a group of operators, group leaders and foremen. While operators repeatedly assemble parts into a car body closely following the work sheets and standard operation procedure and keeping takt time during daily production, they also engage in production control tasks at the daily quality meeting, through the idea suggestion plan and QCCs. Group leaders are responsible for daily trouble shooting, and also play an important role when the takt time is changed and jobs are reorganized. Foremen are engaged in continuous improvement and cost reduction. Operators and group leaders, together with foremen, implement many kinds of improvements to ensure a smooth launch of the production with new takt time.

3-8 Career and the transfer of the technology

Group leaders and foremen play a critical role in smooth and efficient production as well as operators. How are they selected?

Group leaders are promoted from among operators. In the Trim Line, on average, a group leader who finished high school (junior high school) worked as an operator at TAM for 11 (14) years and has an experience in the Trim Line of 8 (11) years before promotion, shown in Table 2.

Table 2 Careers of the Group Leaders in the Trim Line

Education	Number	Range of seniority	Average seniority	Range of seniority before promotion	Average seniority before promotion	Range of seniority before promotion in the Trim Line	Average seniority before promotion in the Trim Line
Junior High School	3	18 years	18 years	10 to 17 years	14 years	9 to 15 years	11.3 years
High School	10	8 to 23 years	15 years	4 to 20 years	11.1 years	0* to 15	7.9 years

Source: Data is from interview record with an Indonesian assistant manager, three supervisors and three foremen conducted on April 24, 1998.

Note: One group leader had no prior experience in the Trim Line before promotion. However, he worked on the repair line in final assembly for 19 years where defects are discovered and repaired. Thus, he is presumed to have enough knowledge about the Trim Line. Other than this one exception, the least experience that a group leader had in the Trim Line before promotion is four years.

The competition form promotion to group leader is based on job capability and is very fierce. Among the group leaders with a high school degree, one was promoted to be a group leader in four years, while it took 20 years for another to be promoted. The fact suggests that promotion to group leader is not based simply on the length of service. It does not mean that the experience is not necessary. Experience is surely the most important requirement for promotion to group leader. The point is that promotion seems to be based on evaluation on job capability and that the competition is fierce.

Foremen are selected from the pool of group leaders using similar severe criteria. Another source of foremen are graduates from academies. Academy graduates are promoted to foremen after joining TAM and receiving one year of training. The two kinds of foremen are different from each other in terms of length of service, experience working in the Trim Line, and age. While there are two routes to become a foreman, foremen promoted from within the organization outnumber the academy graduates[10].

Operators, group leaders promoted internally and foremen promoted internally constitute workers' groups, and strongly support the smooth running of the TPS.

In the end of the previous chapter, a question is raised: Is the technology transferred from Japanese expatiates to Indonesian engineers, managers and workers? Judging from the analysis as is developed in this chapter, the answer is that some of the production management technologies have been successfully transferred to Indonesian workers' groups led by internally promoted group leaders and foremen. The next question is how are they trained and motivated.

4. Human Resources Management

4-1. Training

TAM provides its workers with various training opportunities both on the job and off the job, as is stated in the Collective Agreement, "Realizing that it is necessary to increase the

[10] Some foremen promoted from within are further promoted to supervisor, again using the same similar severe criteria. There is also another source for the pool of supervisors. University graduates are promoted to supervisors after joining TAM and receiving one year of training. These two different kinds of supervisors differ in length of service, experience working on the final assembly lines, and age. More supervisors are promoted

capability of work as the requirements in increasing the productivity, the Company will keep making efforts to increase the ability, knowledge and skill of the workers through education and work training"(article 26). The following takes up introductory training for newly hired operators, training for operators, training for group leaders and foremen, and training at TMC plants in Japan

Newly hired operators, who are usually graduated from high schools, receive a one-week classroom training, where they are given a general overview of TAM, TAM culture, *Kanban* system[11], suggestion system, QCC and other relevant topics. After the classroom training, they are assigned to departments in the plant and are instructed on the job by group leaders for three months. This three month on-the-job instruction is called OJT at TAM.

After initial training, operators are supposed to acquire skill through daily activities. Workers learn from performing their daily operations, through rotation, by using the suggestion plan, and QCCs. For example, operators receive training on a daily basis on the job by group leaders concerning the proper use of the Kanban. Foremen sometimes give operators instruction about how to generate improvements. Also, every operator is required to make at least one suggestion monthly under the terms of the suggestion system. These suggestions are examined by a group leader and a foreman. This process of making a suggestion provides a training opportunity for operators as is also the case with QCCs.

In 1997, a training course for operators was developed and delivered at TAM. This class increases the skill of operators and follows a similar course at TMC in Japan. Each skill specific to each job, such as welding, assembly and painting is taught in the training.

While training programs for foremen and group leaders are numerous and very

---

internally following the path from operator to group leader, to foreman and to supervisor

[11] *Kanban*, or signboard in English, are "usually no more than printed pieces of cardboard sandwiched between clear plastic covers."(TMC 1995:19). Kanban is a tool for operators "to operate the production system as a pull system" (TMC 1995:15). There are usually two kinds of *Kanban*, withdrawal *Kanban* and production instruction *Kanban*. The former Kanban specify the types and quantity of parts and materials that the following process is to take, while the latter Kanban specify the types and quantity of parts and materials that the

substantial, the Compulsory Training and the TPS training are particularly important. It is because they give foremen and group leaders opportunities to systematize knowledge and experience and to brush up their skills.

The Compulsory Training[12] continues for three consecutive months. Participants receive two days of classroom training every two weeks for about two months. This is followed by a presentation that the participants make about their problem solving experience during the last training session. Concerning the Compulsory Training the following three points should be stressed.

First, various production control techniques such as the problem solving process, fish bone, scatter diagram, histogram, control chart, and pareto diagram are taught as well as the TPS. While they are thought to have already obtained these techniques through the suggestion plan and QCC's before being promoted to group leader, the training presents them with the opportunity to add to their knowledge and experience and increase their skill level.

Second, instructors are TAM personnel, usually supervisors or foremen, which fact suggests that TAM already has a group of people who fully understand production control techniques and the TPS. Without a deep understanding of these techniques, TAM could not utilize their personnel to teach. Furthermore, since the instructors possess a deep understanding of the plants, they may use concrete daily examples in the classes. This could further help participants to understand the subject matter of the training of a deeper level.

Third, the techniques and concepts of the TPS are taught not only in lectures, but also on the shop floor. Participants get to observe problem solving discussions, plant conditions, and they also get to make a final presentation.

---

proceeding process is to produce (Monden 1985:55).

[12] The Compulsory Training was first introduced in 1995, by combining various training courses that had been already imported from TMC in Japan.

The TPS training[13] is forty hour classroom training and has two courses for foremen and supervisors and for group leaders and newly hired technical staff, where they are taught elements of the TPS such as *Kanban*, just-in time, standardization of work, and *Kaizen* (continuous improvements). As described before, foremen are daily engaged in continuous improvement and cost reduction, while group leaders contributing to the smooth running of the TPS. Hence these courses provide foremen and group leaders with an excellent opportunity to systematize their knowledge and experience. The classes are taught with instructors from TAM, usually supervisors or above, which fact means that TAM has already brought up employees with deep understanding of the TPS. The internally trained instructors can give participants better opportunity to deepen their knowledge about the TPS.

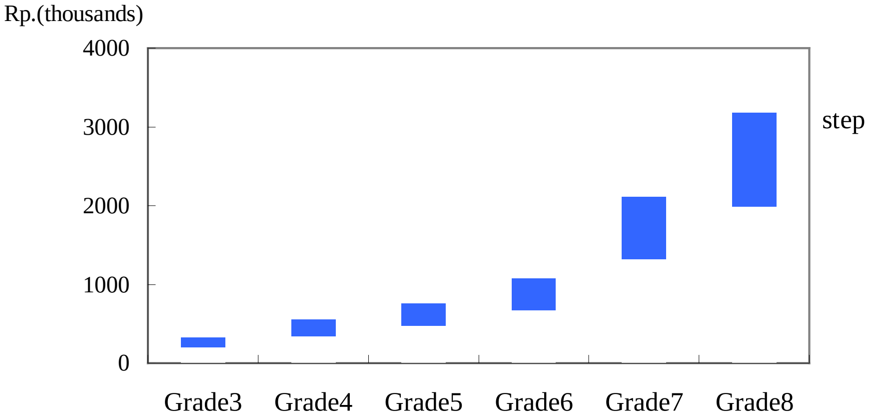
Another important aspect of the training program at TAM is the practical experience that some employees receive when they attend training that is conducted in TMC in Japan. Recently sixty to eighty employees have been sent to TMC, where they receive training for between three months and one year.

Operators, group leaders and foremen, being sent to TMC, work together with Japanese workers on the production lines for two to three months. This provides a unique opportunity to take a closer look at Japanese workers' methods under the TPS. Some of the dispatched employees are likely to deepen their understanding of the TPS. The program of sending employees to TMC also helps to improve their practical skill and abilities.

4-2 Remuneration

[13] The TPS training was imported from TMC in Japan in 1993, with some modifications being made.

Figure 10 The basic wages



Source: calculated from the interview record with an Indonesian assistant manager of remuneration department of HRM, TAM, conducted on March 13, 1998.

The remuneration system at TAM enables operators to flexibly rotate among jobs and also offer workers strong incentive for skill improvement and promotion.

The basic wages are determined according to grades and steps within a grade. Every employee is ranked into a certain grade and then is assigned a step number. For example, an operator with three year experience is placed in grade 3 and given step 15. The basic wages for the operator are equal to the wages set for step number 15 in the grade 3. Figure 10 shows the basic wages that differ among grades and steps.

In order to gain a better understanding of the wage system, we take a closer look at the grade system. The grade system at TAM has 12 grades, each of which has 120 steps. The lowest two grades are for janitors and clerical office workers, while the highest four grades are for managers or above. These six grades are not taken up. The remaining six grades from grade 3 to grade 8 are related to position, as is shown in Table 3.

Newly hired operators, usually graduated from high schools, are placed into grade3, step 1, and then they get an increase in step every year. How many steps employees get differs according to their performance evaluation. When employees are evaluated as the best, they get fourteen steps added[14]. If employees receive the lowest evaluation, they do not get any steps added and remain on the same step. Thus, employees receive an increase in step every year unless they receive the lowest evaluation.

Table 3 Relationship between grades and positions

Grade 3	Operator					
Grade 4	Operator	Group Leader				
Grade 5	Operator	Group Leader	Foreman			Staff (Academy graduate)
Grade 6			Foreman			Staff
Grade 7				Supervisor		Staff (University graduate)
Grade 8				Supervisor	Assistant Manager	Staff

Source: Devised from the interview record with an Indonesian general manager of HRM, TAM on December 16, 1997, the interview record with the Indonesian assistant manager of remuneration department, and Collective Agreement 1975-1977 Article 16.

The increase in step is accompanied by an annual increase in the basic wages, but the wage increase differs among the grades even if the increase in step is the same in number. The higher the grade, the larger the annual wage increase per step, as would be estimated in Figure 10. Hence, upgrading brings employees higher wages.

Employees are moved to higher salary grades in two ways: through promotion and by accumulation of length of service. For example, when a group leader is promoted to foreman, he is upgraded from grade 5 to grade 6. When an operator works for certain period of time and he receives an appropriate evaluation, he is upgraded from grade 3 to grade 4. Concerning beyond grade 5, promotion is an only way of upgrading, as is shown in Table 3. Since positions such as foreman and supervisor are limited in number, grades 6, 7, and 8 for blue collar workers also have fixed numbers.

Upgrading result in an increase in the basic wages and in a greater increase in the

[14] If an operator with grade 3, step 15 is evaluated as the best, he will be placed into grade 3, step 29 (=15 steps + 14 steps).

annual wage increase per step as is shown in Figure 10.

4-3. The characteristics of the basic wage system

The characteristics of the basic wage system at TAM can be summarized as follows:

First of all, the basic wages are is not directly connected with jobs and this type of wage system helps a flexible reorganization of jobs in case of a change in takt time and also facilitates frequent job rotation.

Second, the basic wages increase with length of service and hence, TAM's system can be called a seniority-based wage. Wages increase annually as a result of an annual rise in steps, while wages can also increases by an increase in grades. Even if employees are not promoted in position, they can be moved to a higher grade within certain limits and receive higher wages.

Third, the basic wages can differ among employees even with the same length of service and the same educational background, through the annual performance evaluation.

Fourth, the wage system provides workers with strong incentive to improve their job capability. If operators can prove that they can perform their job well and that they are capable of making positive improvements to their work, they have better chance to moving to a higher grade and receiving a promotion. This will lead to higher wages. The large difference in the basic wages among the grades strengthen the incentive and thus makes competition for promotion and upgrading fiercer.

5. Conclusion

The TPS has been successfully transferred in TAM, Indonesia, and workers groups on the shop floor largely contribute to the smooth and efficient running of the TPS. Various training programs including on the job training facilitates the technology transfer. The remuneration system gives workers strong incentive to improve their job capability.

Work is organized according to the integration principle in TAM, and HRM practices appropriate for the work organization have been designed and installed. In other words, Japanese style organization of work and HRM practices can be found in a factory in Indonesia.

The following discusses the causes of the successful transfer of the TPS and its implication.

First, it has been almost thirty years since TAM began its operation. It takes quite long time to transfer technology, especially management technology.

Second, TAM has developed step by step. It started its operation as an importer and a distributor. Gradually, it added a manufacturing function. Steady development provided TAM with time to successfully diffuse the technology among Indonesian staff and workers.

Third, TAM has had devoted Indonesian and Japanese personnel. Anecdotal evidence can be found in Tomura (1997:4-6) concerning Japanese staff, and also in Imai (1997:126, 143-44) concerning Indonesian staff.

However these three conditions can be found among other Japanese multinationals. These include companies that have not successfully transferred the management technology yet. Thus, these three conditions alone could not have brought success to TAM.

Fourth, TAM has manuals about production system and production control techniques written in English and/or in Indonesian language[15]. The manuals are important at least for the following two reasons. They enable the local staff and local workers to easily understand the production management technology that TMC is attempting to transfer. Furthermore, they also give the Japanese staff a guide to management. It is often noted that the method of management varies depending on who is in charge of an overseas plant. The

[15] For example, there are "The Toyota Production System" in English (TMC 1995), a booklet titled "Toyota Production System" in Indonesian language, manuals on roles and responsibilities of first line supervisors written in Indonesian language (Imai, 1997), a booklet titled "Perlakuan Kondisi Kualitas yang Memburuk" (Trouble Shooting of Defects) written in both Indonesian language and Japanese, and "Petunjuk Ringkas

manuals may serve to decrease the variation on what are the proper methods to use.

Finally, the HRM practices have been developed internally by TAM's Indonesian staff, by referring to those of TMC and taking Indonesia's context into account.

In the meantime, TMC, like other Japanese multinationals, is planning to restructure its international division of labor in Asian area. To put it simply, it plans to produce important components and vehicles not only for each country market but for the whole Asian market. The work innovation in a transplant realized by multinationals, hence, affects work places in other countries in the era of global competition.

Aktivitas Q.C.C."(A guide to QCC activities" written in Indonesian language.

Reference

Imai, Masaaki 1997, *Gemba Kaize: A Common Sense, Low Cost Approach to Management*, New York: McGraw-Hill.

Koike, Kazuo 1991, *Sigoto no Keizaigaku (Economics on Work)*, Tokyo: Toyo Keizai Shiposha.

Monden, Yasuhiro 1985, *Toyota Sistemu (Toyota System)*, Tokyo: Kodansha.

--------------------- 1991, *Sin Toyota Sistemu (New Toyota System)*, Tokyo: Kodansha.

Nakamura, Keisuke 1996, *Nihon no Shokuba to Seisan Sisutemu (Japan's Production System and the Organization of Work)*, Tokyo: The University of Tokyo Press.

Nakamura, Keisuke and Padang Wicaksono 1999, *Toyota in Indonesia: A Case Study on the Transfer of the TPS*, Jakarta: The Center for Japanese Studies, University of Indonesia.

Ono Taichi 1978, *Toyota Seisan Hoshiki – Datu Kibo no Keiei wo Mezashite- (Toyota Production System: Beyond Management of Scale)*, Tokyo: Daiyamondosha.

Taylor, W. Frederic 1911, *Principles of Scientific Management*, New York: Harper and Brothers

TMC (Toyota Motor Corporation), 1995 *The Toyota Production System*, Toyota

Tomura, Kunio 1997, "Technological Transfer in Automobile Industry", submitted to the seminar on "Technology Transfer and Mutual Cooperation between Indonesia and Japan", held by the Center for Japanese Studies, University of Indonesia, on December 10th, 1997.

Womack, James P., Jones, Daniel T. and Daniel Roos 1990, *The Machine That Changed the World*, New York: Rawson Associates