Technology Transfer Strategy of Japanese Automakers in the United States

——New United Motor Manufacturing, Inc. Case Study——

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Contents

Summary

There is no doubt that the American Big Three, GM, Ford and Chrysler, dominated world motor manufacturing from the 1920 s to the end of the 1960 s. As a leading sector of the American economy they had the automobile market practically to themselves and they made great contributions towards establishing the Golden Age, which was based mainly upon motorization after the Second World War.

The two oil shocks in the 1970 s sparked off a great change in strategy in world motor manufacturing, heralding a tendency towards the production of smaller, more economical energy-saving car models. The Big Three, with their production up to this point strongly weighted in favor of mid-to-large sized cars, began gradually to lose power in world competition.

On the other hand, the Japanese automobile industry, the late-comer to the field, had specialized from the first in the production of small-sized cars and was able to take advantage of the new world trend towards energy saving, fully utilizing the production system and rising to become the world leader in motor manufacturing from the end of the 1980 s to the present.

The eventual development of the full-scale operation of US-based Japanese car manufacture was closely related to the threat to the Big Three presented by Japanese car exports, even though car exports had been under voluntary restriction since 1981. However, a more important and essential point is that this expansion of Japanese

automakers into US-based production has led to a situation where the Japanese production system is being exported to the US, where it is influencing the American production system.

In contrast to the active Japanese automobile industry, the Big Three have been forced into successive close-downs and mass lay-offs, continuing up to the present time.

From the spring of 1987, I was in the US for a year as a visiting scholar under the International Motor Vehicle Program, at the Massachusetts Institute of Technology. During that time I often had the opportunity to visit the Big Three and also US-based plants of Japanese automakers. The purpose of my study was to elucidate the unique features of the technology transfer to the US and to gauge what kind of impact the Japanese automakers' entry to the US was having on the production system of the American automobile industry.

The outcome of this study, in short, was to demonstrate that the result of the rush by Japanese automakers to branch out into US-based production was to rapidly develop the harmonization of the production systems of Japan and the US through the development and production of small cars. In other words, although at the political level there is hostility or competition, as shown by the current issues involving trade friction, at the automakers' or partsmakers' level the actual situation is somewhat different. While there is of course competition, there is also, on a practical level, a certain amount of cooperation and mutual understanding, especially involving the technology transfer of the Japanese production system to the US.

An important point worthy of special mention is that with just this kind of harmonization of the production systems, the international competitive power of the American automobile industry can be raised. Furthermore, it has the possibility of becoming a potent tool for solving the issue of trade friction between Japan and the US.

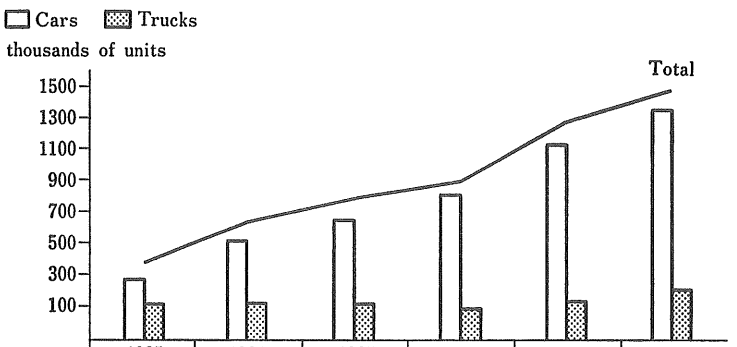
Currently there are seven US-based plants of Japanese automakers in operation. This paper will focus on NUMMI (New United Motor Manufacturing Inc.), which was established in 1984 as a joint venture of Toyota and GM, each investing 50%. My particular emphasis will be on examining and clarifying the actual process of the technology transfer leading to the harmonization of the production systems.

1. Unique features of Japanese Automakers' US-based Plants

Most of the direct investment by Japanese automakers in the US was made in the mid-1980 s. By 1989, the production projects of seven major Japanese automakers had started operation. In 1983, the annual output of Japanese automakers in the US was 55, 000 Honda units only, but by 1990 it had become 1, 480, 000 and the estimated output in the mid-1990 s, with the shift to full-scale operations, will be more than 2 million (See Table 1).

The US-based plant projects of Japanese automakers are characterized as follows.

Table 1 Production at U. S. Manufacturing Operations



	1985	1986	1987	1988	1989	1990
Honda	145,337	238,159	324,064	366,335	361,670	435,438
Nissan	43,810	65,147	117,334	109,897	115,584	95,844
*NUMMI	64,610	191,549	143,652	129,978	192,235	204,285
Toyota	—	14,264	43,726	18,527	151,150	211,131
*Mazda	—	—	4,200	167,205	216,200	184,368
*Diamond Star	—	—	—	2,409	90,741	148,379
SIA	—	—	—	—	2,600	32,377
Subtotal Cars	253,748	509,101	632,976	794,371	1,130,180	1,311,822
Nissan	107,422	108,048	102,718	95,919	123,056	139,404
SIA	—	—	—	—	—	34,489
Subtotal Trucks	107,422	108,048	102,718	95,919	123,056	173,893
Total	361,170	617,149	735,694	890,290	1,251,734	1,485,715

Note: Figures include units produced for joint venture partners (NUMMI/GM, Mazda/Ford, Diamond Star/Chrysler).
Source: JAMA(Japan Automobile Manufacturers Association, Inc.)

Firstly, they involve comparatively recent large direct investment, and are aimed mainly at evading Japan-US car trade friction.

Secondly, although the USA is one of the world's leading countries in car production, the system and the model emphasis differ from the Japanese. This has meant that from the beginning there have been a lot of issues to be overcome in the process of technical transfer from Japan to the US. These issues include, for example, finding ways of smoothly transferring the general components of the "Japanese-style Production System" such as highly advanced research and development, production technology, manufacturing technology, purchase management technique, labor management, etc.

Thirdly, there has been a qualitative impact on the American automobile production system, resulting from the rush by the Japanese automakers to branch out into US-based production, and a harmonizing of the production systems of both countries through the development and production of small cars.

During the period from the latter half of the 1970 s to the first half of the 1980 s, Japanese automakers one by one started to announce their plans to establish US-based plant projects. The first was Honda Motor Co. Ltd., announcing that they were to start producing cars in the USA from 1982. Next was Nissan Motor Co. Ltd., with a project to begin production of Datsun trucks from 1983 and cars from 1985. After

Table 2 Japanese Automakers' Manufacturing Operations in the U. S. A.

Japanese Maker	Honda			Nissan	Mazda	Mitsubishi	Toyota	Toyota		Fuji, Isuzu
Type of Entry	Sole Entry			Sole Entry	Sole Entry	Joint Venture with Chrysler	Joint Venture with GM	Sole Entry		Joint Venture
Name of Company	Honda of America Mfg., Inc.			Nissan Motor Manufacturing Corporation USA	Mazda Motor Manufacturing (USA) Corporation	Diamond-Star Motors Corporation	New United Motor Manufacturing Inc. (NUMMI)	Toyota Motor Manufacturing U. S. A., Inc.		Subaru-Isuzu Automotive Inc.
Established	February 1978			July 1980	January 1985	October 1985	February 1984	January 1986		March 1987
Share in Equity	Honda of America 97.58% Honda 2.42%			Nissan (U. S. A.) 100%	Mazda 100%	Mitsubishi 50% Chrysler 50%	Toyota 50% GM 50%	Toyota 20% Toyota (U. S. A.) 80%		Fuji 51% Isuzu 49%
Location	Marysville, Ohio			Smyrna, Tennessee	Flat Rock, Michigan	Bloomington Normal, Illinois	Fremont, California	Georgetown, Kentucky		Lafayette, Indiana
Vehicles/Parts Produced	First Plant	Second Plant	Engine Plant	Nissan Truck (1-ton pay load), Sentra, Engines	MX-6, 626, Ford Probe	Mitsubishi Eclipse & Mirage, Eagle Talon & Summit	Prizm, Corolla, Small Truck	Camry	Engines & Axles	Legacy (Fuji), Small Truck (Isuzu)
	Accord, Civic	Civic	Engines, Steering Components							
Start-Up	Nov. 1982	Dec. 1989	Sept. 1986	June 1983	Sept. 1987	Sept. 1988	Dec. 1984	May 1988	Nov. 1988	Sept. 1989
Annual Production Capacity	360,000 units	150,000 units	500,000 engines	240,000 units (440,000 in '92)	240,000 units	240,000 units	200,000 units	200,000 units	300,000 units	160,000 units
Employees	6,300	500	1,600	3,300	3,500	2,900	3,100	3,000	500	1,900
Total Investment	$883 million	$380 million	$670 million	$745 million	$550 million	$600 million	$800 million	$800 million	$300 million	$500 million
Affilliated Technical/Design Centers	Honda R & D North America, Inc. Honda Engineering North America			Nissan Research & Development, Inc. Nissan Design International, Inc.	Mazda R & D North America, Inc.	Mitsubishi Motors America, Inc.	Toyota Technical Center USA Inc. Calty Design Research, Inc.			Isuzu Technical Center of America, Inc. Subaru Research & Design, Inc.
Local Content	75%	75%	75%	75%	75%	60%	60%	75%	75%	65%

SOURCE: JAMA member firms' official announcements as of May 1991.

this, Mazda Motor Corporation, Mitsubishi Motors Corporation, Toyota Motor Corporation, Fuji Heavy Industries Ltd., and Isuzu Motors Ltd., announced their projects one after another. In this manner the seven major automakers, all of which produce cars, commenced their actual US-based plant projects. The form taken by each automakers' project, however, varied in many ways (See Table 2).

If we classify the automakers by capital investment, Nissan, Mazda and Toyota made sole entries contributing 100% capital. Toyota, however, also undertook a joint venture with GM. Mitsubishi's entry took the form of a joint investment with Chrysler, while Fuji and Isuzu collaborated with each other.

The establishing of the local corporate bodies was mainly concentrated in the mid-1980 s with the exception of Honda in 1978. This was because most of the Japanese automakers adopted this kind of project as a way of overcoming the Japan-US car trade friction, and this friction worsened around 1980. In parallel with this, a policy was adopted of voluntary restriction of car exports to the USA.

This paper will go on to elucidate the unique features of Toyota's technology transfer strategy at NUMMI. I will begin by summing up the process of establishing NUMMI, and go on to analyse the actual conditions of the production system, parts procurement system, and the policy of labor management at the US-based plant. Through this analysis, I will investigate the harmonization of the production systems of the Japanese and American automobile industries.

2. Technology Transfer Strategy of Toyota

(1) Process of Establishing NUMMI

The entry process of Toyota into the US can be classified into two periods. The first period (1957-81) was the period of market cultivation and extension, and the second period (1982-present), the period of production development in the US. Toyota Motor Corporation resulted from the merging of TMC (Toyota Motor Corporation) and TMS (Toyota Motor Sales Company). In this paper, unless stated otherwise, "Toyota" will refer to the newly established Toyota Motor Corporation.

To begin with the first period, in 1957 TMS established TMS (Toyota Motor Sales USA Inc.) in California, its main business being the import and sale of finished cars. This establishment was the first business investment on a commercial basis by the Japanese automobile industry in the US. After that, TMS established CALTY (Calty Design Research, Inc.) in California in 1973 to develop car designs suitable for the US market; then TTC (Toyota Technical Center, USA, Inc.) in 1977 for testing, studying and correcting information. In this first period, TMS was the leader among Japanese automakers in developing market cultivation and extension through making a priority investment.

The second period is the period when, through well-systemized efforts towards internationalization by the newly established Toyota, investment in the US-based plant

became full-scaled. That is to say, in 1984, NUMMI was established in what was previously GM's Fremont Plant in California, in a joint venture with GM. In 1986 TMM (Toyota Motor Manufacturing, Canada, Inc.) was established in Ontario. This second period, from 1982 to the present, can be called the period of localbased production development, based on production investment. Nineteen eighty-two, especially, is noted as the year of gradual systemization towards internationalization by the newly established Toyota[1].

It was under these circumstances that Toyota and GM reached and signed a protocol on cooperative production which included the following items[2]:

① The purpose will be to jointly establish a new company which produces brand-new small-sized cars.
② The ratio of investment by GM and Toyota will be 50 : 50.
③ This joint venture company is to be run by managing directors half of whom are to be appointed by GM and half by Toyota; and the president is to be elected by Toyota.
④ Production will be at the previous assembly plant of GM, in Fremont, California.
⑤ Production is to start early in the 1985 model-year, and the annual output is set at 200, 000 units.
⑥ The joint venture will be for a period of 12 years from the start of production.

On this basis, NUMMI was established in 1984 as scheduled.

Production also began in 1984, and in 1986 the level of output nearly reached the production goal, but after that there was a period of unavoidable sluggishness and the output was reduced by about half to 128, 417 in 1988. However, in 1990, the level of output reached 200, 000 (see Table 1). And in 1991, NUMMI produced 111, 335 units of the Toyota brand passenger car "Corolla", 95, 099 of the GM brand "Prizm" and also added the Toyota brand of small-sized truck "Hilux" (production started from October 1991); altogether 209, 012 automobiles.

Regarding the issue of productivity at NUMMI, especially worth mentioning is the success in setting up what can be called Japanese-style favorable industrial relations with the UAW-affiliated labor union. These relations are of vital importance in the development of the Toyota production method. At NUMMI, the workers from the ex-GM Fremont plant were employed preferentially, and their ratio to the newly employed is more than 80%. From the beginning of NUMMI, Toyota made great efforts to stabilize the relationship between labor and management, a relationship which has a direct bearing on productivity and quality improvement. The high ratio of absenteeism and the conflict between labor and management had never been settled during GM's time.

With good industrial relations Toyota has attempted to raise the level of production technology and parts procurement.

(2) Production Technology and Parts Procurement of NUMMI

Toyota went to enormous effort in the US to emulate the successful production system, manufacturing techniques, and parts provision system of the mother plant of Toyota in Takaoka. In these areas there are big differences between Japan and America, and Toyota thought that, for the efficient production of small-sized cars at least, the essential elements of the Toyota method should be adopted.

The main priorities of the Toyota production control system, the "Kanban System", are as follows. Firstly, to produce what is necessary, as much as necessary, when it is necessary, while keeping minimum stock. Secondly, to encourage all employees to become voluntarily involved in the improvement of the production system.

But these essential conditions did not form overnight in Japan in the first place[3]. Therefore, in the cooperative production with GM, where there was of course no historical continuity, precedent, or accumulation of experience upon which to build, there were many issues which had to be confronted right from the beginning concerning the matter of technical transfer.

Table 3 indicates the production techniques and parts procurement system which were adopted by NUMMI. Of the 15 sub-headings, eight apply to the former (①②③④⑥⑨⑪⑫), seven to the latter (⑤⑦⑧⑩⑬⑭⑮), and four apply to both (②③⑦⑩). Following are further details of some of these items, beginning with the production system.

Among the items in (A) which were adopted directly from the Toyota system,

Table 3 Production Technology and Parts Procurement of NUMMI (as of May 1989)
(Source: compiled from Toyota's publicity data, partly revised.)

Adopted System	Production Technology and Parts Procurement
(A) Toyota (Japanese) System	① New setting up of press shop in the plant
	② An Introduction to the Toyota production system
	③ Quality Control
	④ Realization of work standard through improvement ("Kaizen") activity
	⑤ Adoption of Toyota-standard drafting system
(B) Partly Adjusted Toyota (Japanese) System	⑥ Placement of hardware at the coating process
	⑦ Parts procurement system in the plant
	⑧ Toyota drafting system and inspection system (problems occurred)
(C) NUMMI Original System	⑨ Inclusion of repair process in each assembly line
	⑩ Setting up vanning center in Toyota's Kamigo plant
	⑪ Quality control (introducing the inspection process into the assembly process)
(D) GM (US) System	⑫ Basic lay-out of the first and second floors in the plant
	⑬ Parts procurement from outside the plant
	⑭ Quality control (die and gauge)
	⑮ GM Information Network system

① Shows the new setting up of a press shop in the plant. GM had constructed their assembly shop and press shop separately, and had depended on long distance transportation to bring pressed parts to the assembly factory. However, Toyota set up a press shop near the body-process in the assembly factory, taking into consideration that using long-distance transportation would have a tendency to heighten the ratio of rejected parts and to cause difficulties in feed-back.

② Comprises the adoption of measures such as: the supply of parts in small lots; a teamwork system based on group-leaders and team-leaders; a rotation system in each group aiming at the equalization of job functions; and the use of electronic bulletin boards known as "Andon" in Toyota.

③ Shows the setting up of an inspection shop to evaluate materials urnished in the US. Inspection processes were also set up in each manufacturing process and an inspection standard was introduced which aimed to reach or surpass the quality level at the Takaoka Plant in Japan.

④ Shows Toyota's intention to realize a high work standard by the introduction of improvement activity[4].

Among the items in (B), which show the partially adjusted Toyota system, the placement of hardware at the coating process is of particular interest. In this process, the GM system involved applying one undercoating using the electrodeposition method, and two top coatings; altogether three coats of paint. In addition to this, GM had also set up an independent repair booth. At NUMMI, Toyota set up hardware equivalent to the number of processes and included the repair process, using a partially revised Toyota system.

The items in (C) were implemented with the aim of facilitating the smooth and trouble-free operation of the Toyota production system in the US. The first strategy was to reconstruct the conveyers into a form which would include the repair processes in each line. The second was for Toyota to introduce the inspection processes into each line, in contrast to GM's method which was for the inspection processes to be at the end of the production flows. Toyota expected the new method to encourage prompt quality control feed-back.

Section (D) shows where the GM system was adopted. To mention an example, the layout of the GM assembly line on the first floor and coating line on the second floor were adopted by NUMMI without any changes.

Regarding parts procurement, (A) ⑤ shows that the Toyota-standard drafting system was introduced, because it was felt to be superior to GM's. Section (B) shows the partly modified Toyota system, ⑦ referring to purchase management. In Japan, partsmakers are flexible in adjusting to changes in the automaker's quantity of output, and so stock turnover is good. But at GM the custom had been to keep a large storehouse full of factory and safety stock because of the American partsmakers' custom of supplying large quantity lots to a plant. Toyota implemented a policy of stock control, reducing the amount to about five days' stock.

(B) ⑧ shows the introduction of Toyota-style parts design drafting and inspection forms. But this resulted in some disorder in the parts procurement at NUMMI. GM's parts designs contained all the information needed to produce the parts without further information, and also the finished parts could be checked against the design draft. Toyota's had no checking system. This meant that in cases where the initial draft was modified, difficulties arose in communicating the new information thoroughly to the partsmakers.

(C) ⑩ shows the parts procurement method which was established at NUMMI. Toyota set up a vanning center (packaging and shipping center) at their Kamigo plant and transported a large quantity of parts (parts for 30 cars/lot) to the US. But in the NUMMI plant there had not been enough space set aside for the sorting out of these parts, and some confusion resulted.

Finally, section (D) shows where the GM method was adopted. Item ⑬ indicates parts procurement from outside the plant. GM had been using train transportation for the supply of parts in large lots. Toyota introduced the "Kanban System" in an attempt to lay down the foundation for a scheduled, quantitative and small-lot procurement system. But Toyota could apply this system to only about a dozen out of seventy or so partsmakers, including those involved in Japan-US tie-ups. As for the rest of the makers, NUMMI had to depend on daily transportation from Chicago.

Item ⑭ shows how NUMMI adopted the GM system of quality control, whereby GM had been lending the die and inspection gauges to the partsmkers, and then performing another check-up themselves on delivery. Toyota adopted this system at NUMMI after special preparation: for example they performed 100% inspections at first, and then if no items were rejected they later shifted to random sampling.

Item ⑮ shows Toyota's decision to use "GM-Net", the exclusive network connecting all GM plants and partsmakers comprehensively.

As can be seen from the above, most of the fifteen items concerned with production techniques and parts procurement at the local production of NUMMI come under (A), (B) and (C), indicating clearly that quite a lot of Toyota-style method was adopted. This was a significant factor behind the excellent results which followed soon after the establishment of NUMMI. In fact the results were more than had been anticipated from the technology transfer, which was Toyota's first experience of local production in the US. In other words, this was a successful transfer of Toyota's own "Kanban System" to GM, which had not been able to surpass Japanese automakers even when they tried to produce small-sized cars after the two oil shocks of the 1970 s. The success is particularly notable because the four main elements comprised in "An Introduction to the Toyota Production System" (namely, small-lot parts provision to the assembly line, the introduction of the "teamwork system", the implementation of group job rotation, and putting up an "Andon" monitoring signal) had all been looked at by GM and other US automakers but had not taken root.

The introduction of the "Kanban System" can be assumed to be an important

factor worthy of comment. The transaction relationship between partsmakers and automakers was very different in the US and in Japan, and because of this difference there was some doubt about the feasibility of transferring the "Kanban System" directly to the US. In Japan, there is comprehensive cooperation regarding the division of labor through the close relationship of automakers and their affiliated partsmakers which is not seen in other countries. It is considered to be a major factor in raising the international competitive power of Japanese automakers to the highest level. In contrast, in the US, as is clear in the GM example, in most cases automakers make most of the parts themselves, from the battery right down to the small pressed parts. Therefore the relationship of automakers and partsmakers has been thought of as horizontal[6].

The introduction of the Toyota system in the area of parts procurement has proved to have value even though it has been only partly implemented among US partsmakers (including Japanese subsidiary partsmakers) because of the difficulties encountered up to this point.

We cannot overlook another favorable condition which has backed up the development of the Toyota production system in the US in regard to local parts procurement. This is that in 1989 NUMMI was supplied by approximately seventy parts manufacturers, with about 600 parts being supplied by them. Ten of these partsmakers were actually GM's own parts divisions. NUMMI could also take advantage of GM's long history of transaction with local superior partsmakers, being in a position to establish a business relationship with them in advance of other Japanese or joint venture automakers setting up in the US.

The latter has to be pointed out as a merit of joint venture. Similarly, at NUMMI, Toyota could utilize the special relationship with major Toyota-subsidiary partsmakers which were investing in the US one after another in the early 1980 s[6].

(3) Labor-Management Relations at NUMMI

The major priority in developing labor-personnel policy at NUMMI was to establish a line in union management cooperation conducive to the realization of high productivity.

Towards this end, Toyota repeatedly conferred with the UAW, and in 1983 they reached an agreement on the basic policy for establishing favorable industrial relations and signed a protocol, the main points of which were as follows. Firstly, workers who were previously employed by GM at the Fremont plant will be employed preferentially by NUMMI and the UAW will suport the fulfilment of the "Unique Production System" of the joint venture. Secondly, the wage levels and benefits of the US automobile industry are to be applied to the newly employed at NUMMI. Thirdly, the UAW will accept Toyota's production system at NUMMI, which is based on teamwork and the use of multi-skilled workers[7].

From April 1984 NUMMI began the practice of employing group-leaders and team-

leaders, with the intention that this would form the nucleus of the production field[8]. Twenty-five NUMMI employees were dispatched to the mother plant in Takaoka as the first batch for training in Japan, and they gained experience of the Toyota production system with on-the-job training[9].

In 1985, a labor agreement was concluded following the terms of the protocol of 1983. In the agreement it was confirmed that both labor and management would cooperate to produce the highest quality cars in the world at the lowest cost. The agreement aimed for the most innovative and humanitarian industrial relations and included an agreement that there would be no lay-offs except in the case of serious economic recession breaking down the business administration[10].

After the priority employment of group and team-leaders, NUMMI continued to take on more employees from the autumn of 1984, and with full attention being given to the business of employment the employee numbers increased, reaching 2500, as planned, by the end of 1985, and in the beginning of 1989 reaching 2700[11].

By occupational categories, employees can be divided into 400 office workers and the rest technical workers. An examination of the present condition of labor-management relations at NUMMI follows, with reference to Table 4.

Section (A) shows the items which were adopted directly from the Toyota system. Firstly, a generous education and training system for employees was enacted. This was not systemized at GM, but in the Toyota system it was given high priority. This was because, as mentioned before, it was considered an essential condition of quality

Table 4 Labor-Management Relations at NUMMI (as of May 1989)
(Source: compiled from Toyota's publicity data, partly revised.)

Adopted System	Labor-Personnel Policy
(A) Toyota (Japanese) System	① Generous education and training system
	② Simplified job function structure, introduction of rotation system
	③ Introduction of the Team and Group system
	④ Industrial harmony policy
(B) Partly Adjusted Toyota (Japanese) System	⑤ Promotion by seniority and ability
(C) NUMMI Original System	⑥ Detailed selection process at initial employment
	⑦ Rotation system aiming at the equalization of labor
	⑧ No wage distinction by functions or seniority
	⑨ Abolition of cafeteria and parking lot privileges and distinctions
(D) GM (US) System	⑩ No shift alternation between daytime and nighttime work
	⑪ No other allowances but living allowance
	⑫ Three-yearly wage negotiation
	⑬ No personnel assessment, no bonus system
	⑭ Community activities

control that employees voluntarily become involved in the prompt solution of production problems and the improvement and enhanced quality of the production system. With this in mind, at NUMMI, Toyota developed educational programs focussing on work standards, quality control, problem-solving, job training methods, human relationships, work safety, etc.

Secondly, there was a simplification of the job function structure, and the job rotation system was introduced into each team. At GM, the job function structure had been subdivided into about a hundred categories according to the wage-rate table, calculated by ten functions times ten wage rates. Toyota simplified this into three functions, namely, production (2000 employees), maintenance (200 employees) and die maintenance (20 employees). Two wage ranks introduced, one for production and one for maintenance (including die maintenance). The rotation system, which had not been used at all at GM, was also implemented, aiming for equalization in the labor field[12].

Thirdly, the team and group systems were introduced. A team is composed of five to six workers and a group is composed of three to four teams. This kind of organization is indispensable for the Toyota system which is based on teamwork. There was nothing equivalent to team-leaders in GM, which instead had a perpendicular unitary system of administration of all employees by managers or foremen. The big difference in this system was that although GM's foremen and NUMMI's group-leaders were both non-union members, the foremen had enormous authority, almost to the point of absolute power. A foreman administered 20–30 employees, and had employment and dismissal rights as well. Toyota, therefore, reduced the authority of group-leaders to prevent the demoralization of employees, and at the same time promoted the team-leader system, devoting the most effort towards establishing an atmosphere of teamwork and mutual cooperation.

Fourthly, Toyota undertook to establish industrial harmony. At GM it was taken for granted by both labor and management that there would be constant antagonism between them. In opposition to this idea, Toyota held a series of meetings promoting a different standpoint; that of acknowledging the necessity in the Toyota system of harmony and reciprocal trust in industrial relations. These meetings included round-table gatherings, production explanation meetings, safety meetings, meetings of the labor section and union, two-day study trips of the personnel section together with the union, etc.

Through these meetings Toyota tried to bring about better understanding, mutual trust, and a sharing of information between labor and management. Also, when problems arose at the working place, it was decided to cooperate to confirm facts instead of automatically assuming and insisting on opposite opinions as in the past.

Section (B) shows items which were adopted with slight adjustments from the Toyota system. While GM had set up estimate-standards for promotion based on a seniority rule, NUMMI added objective evaluations for the promotion of team-leaders.

For example, after closing the applications and nominations for team-leaders, which were open to all employees, the examiners' selected twe each from labor and management and tested them using such criteria as: Can he deal with all the functions of team? How much office eduction has he obtained? How much creative contribution has he made? How is his office attendance record? etc. Then there were interview tests carried out by one interviewer each from labor and management, and the prospective team-leader's ability was assessed in a summing up of all the tests.

Section (C) shows the adoption of NUMMI's original system. Firstly, they implemented a detailed selection process at the initial hiring of employees. Both the paper and interview employment tests of GM used to be simple and there were quite a few employments through recommendations from the union or through personal connections. In contrast, as mentioned before, a fairly detailed test was introduced by NUMMI including such elements as interview, discussion, an actual technique demonstration test, etc.

Secondly the rotation system was introduced, aiming at the equalization of labor, but as mentioned in Note 12, this did not lead to the development of multi-skilled workers and so did not contribute to the raising of productivity.

Thirdly, wage distinction by job or seniority was removed. That is to say, instead of using GM's complex wage ranking system, a simplified two-rank system was introduced[13]. There was no discrimination by seniority, however for employees of less than one and a half years the wage rate was set at 85%.

Fourthly, the hierarchical system in the use of the cafeteria and parking lot was abolished. In the GM period, the cafeteria and parking lot had separate areas distinguished by job classification, but this system was repealed in order to impress upon the employees the non-discriminatory nature of the Toyota management system[14].

Section (D) Shows items which were adopted from GM's system. Firstly, day and night shift rotations proved impossible to realize. This was said to be caused by the perception in the US of daytime workers as having relatively higher status than nighttime workers.

Secondly, GM's system of miscellaneous allowances was adopted; the living allowance and various kinds of insurance, and the additional payment of 60 cents/hour for team-leaders. It must be mentioned that compared with the Japanese system, GM's system was quite a simple one.

Thirdly, wage negotiations were set to be held every three years[15], and fourthly, Toyota's individual employee assessment system and bonus system were not adopted. It can be assumed that GM's customs were, in these cases, enforced by circumstances.

Fifthly, as a part of the community activity of large enterprises which is general in the US, NUMMI made donations to the local university and so on.

To sum up what has been mentioned above, the Toyota system has been adopted on the labor-personnel policy as well as for production technology and parts procurement. Out of fourteen items in Table 4, nine items come under (A), (B), or (C).

In fact, as a reflection of the success of the establishment of industrial harmonization, absenteeism decreased sharply from around 20% in the GM decade to around 3%. This highlights the effects of the labor-personnel policy. However, in comparison with the transfer of production technology and parts procurement systems, NUMMI's abor-personnel policy has not reached the level of Toyota's as yet. This is because the bases of the Toyota production system——positive development of quality control activities through the education and training system and teamwork, and promotion of multi-skilled workers through the rotation system——do not appear to have reached the planned level. It is not until these bases are firmly rooted and functional that Toyota's technology transfer strategy to the US can be said to be complete.

3. Conclusion

This paper presented a case analysis of NUMMI, the joint venture of Toyota and GM, for the purpose of elucidating the unique features of the technology transfer strategy of Toyota. From the analysis it can be seen that, in regard to production technology and parts procurement, Toyota has been highly successful. It has also been made clear that in regard to labor-management relations the transferral is not yet complete, but when we take into account the industrial relations and labor customs peculiar to the US this can be seen as a natural consequence.

Regarding the transferral of the production system, it is estimated that Toyota's technology-transfer strategy attained results even better than anticipated, and this success was brought about because Toyota was flexible in the implementation of the production system at NUMMI, not insisting exclusively on Toyota systems but making adjustments as necessary, introducing original NUMMI systems or American systems when called for.

At US-based plants of Japanese automobile manufacturers, as can be seen from the example of Toyota, a harmonization between Japan and the US is being attempted.[16] If this serves to boost the international competitive power of the American automobile industry, it could present the possibility of a promising solution to the recently worsening Japan-US automobile trade conflict.

Notes

(1) "Creativity Lasts Forever: 50 Years of Toyota History", (in Japanese; "Sozo wa Kagirinaku: Toyota Jidosha 50-nen Shi"). Toyota Motor Corporation, 1987. On page 743 there is a description of how, after the merging of TMC and TMS, the Overseas Technical Department of TMC was integrated with the Overseas Assembly Department of TMS to become the new Overseas Production Department. Similarly, the Overseas Business Department of TMC was integrated with the Export Business Department of TMS to become the Overseas Planning Department.

(2) Ibid., p. 717.

(3) "Control of Outside Orders and Subcontractors in Low Growth Economy Period" (in Japanese; "Teiseichoki ni okeru Gaichu-Shitauke Kanri"), Yoshio Sato (compiled), Chuo-Keizai-Sha, 1980, "Stagnation of Low Growth Economy and Transformation of the Make

or Buy Policies of Automakers", (in Japanese; "Teiseicho no Teichaku to Jidosha-Meikaa no Nai-Gai-Seisaku no Henbo", pp. 222–23.

(4) The work standard, as it applies to the Toyota production system, is implemented through the process of encouraging individual commitment towards the goal of attaining the most efficient production system, with each worker keeping in mind the constant improvement of each job sequence and method. Thus, when trouble occurs during operation, workers can stop the production line until the cause of the trouble has been pinpointed and improvement has been effected. In practice, the numbers of line stops is recognized as having a tendency to decrease as workers become adapted and accustomed to this work standard. In the beginning there was some anxiety about the frequency of line stops at NUMMI, but the end result was positive, and it was even mentioned that this practice had the merit of drawing attention to the issue of improvement.

(5) "Technological Strategy of Japanese Auto-parts Industry" (in Japanese; "Gendai Nippon no Jidosha Buhin Kogyo", Taku Oshima (compiled), Nippon Keizai-Hyoron-Sha, 1987, pp. 1–3.

(6) The Toyota-subsidiary major partsmakers investing in the US are: Nippon Denso, Aishin Seiki, Tokai Rika Denki Seisakusho, Toyota Gosei, and so on.

(7) "NUMMI Information", NUMMI, 1987, pp. 1–2.

(8) The team-leaders are the equivalent of "Hancho" in the Japanese system, and are union members. Group-leaders are the equivalent of "Kumicho" or "Kocho", but are not union members. Both leaders take on the duty of the education and training of members of the group or team.

(9) "Creativity Lasts Forever", op. cit., pp. 799–800.

(10) "NUMMI Information", op. cit., p. 4.

(11) ibid., pp. 2–3.
According to this, 3000 of 5000 ex-GM Fremont plant employees took the employment test and 2200 passed. That means that the rate of ex-GM workers to newly employed workers was as high as 80%.

(12) Toyota intended to introduce this system with the aim of producing multi-skilled workers, and thereby increasing productivity. At NUMMI the main priority was the equalization of labor, and according to Toyota the system was not a factor in raising productivity.

(13) According to Toyota's records, the average hourly wage for workers in production, maintenance or die maintenance is $15.00. The group-leaders standard annual salary (paid monthly) is 40–55 thousand dollars.

(14) In fact, in Japan, this privilege system has yet to be abolished. It is said that open cafeterias lose the merit of being possible venues for lunchtime meetings.

(15) The three-yearly wage negotiation is held for time-wage workers. Negotiations for monthly salary workers are held annually, in April.

(16) For a review of the Mazda situation, see Taku Oshima, "Technology Transfer Strategy of Japanese Automakers in the United States: Mazda Motor Corporation Case Study," (Report for the International Motor Vehicle Program, Massachusetts Institute of Technology), May 1989.