Technology Transfer in the Automobile Industry in Malaysia*

-PROTON and Vendors-

Makoto Anazawa

This paper discussed technology transfer in the automobile industry with special reference to PROTON (Perusahaan Otomobil Nasional Berhad) the national car producer in Malaysia and its vendors. It examined what kind of technology was transferred through which channels. In the real world, the process of technology transfer is rather complicated so that simple classification of technology and technology transfer channels described in the first section will help to clarify technology transfer in the automobile industry. Intra and inter-firm technology transfer, together with other factors that promoted technology transfer, are examined in the remaining sections.

Classification of vendors by their nature contributed to analyze and evaluate inter-firm technology transfer by PROTON

1. Technology Transfer - A Framework for the Analysis-

Technology can be defined in many ways depending on the focus and the purpose of the research. It is beyond the scope of this paper to conduct

* The intensive interviews and research of PROTON and its vendors were conducted from July to December in 1993. The author deeply appreciates the help of all the managers and engineers of PROTON and more than 70 vendors for their kind cooperation with this study.

a thorough survey of the definition of technology. We only attempt to describe the conceptual framework necessary for the analysis in the following sections.

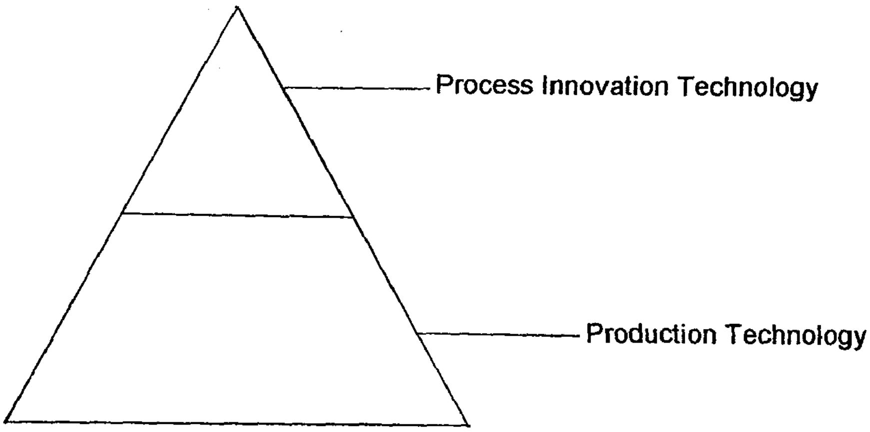
In the broadest sense, technology is defined as all skills, knowledge and procedures required for making, using and doing useful things. Technology in this definition includes not only the hardware of production but also the software, which is comprised of managerial, marketing, and other business related skills. A narrower meaning of technology is technical information contained in patents or technical knowledge communicable in written form.[1] In this paper, we focus more on production and production related technology found on the shop floors so that technology is defined as knowledge, technique, and skills necessary for production and production related activities. This mainly refers to operation technology in production, quality control, and production management. The simplest way of transfer is the movement of technology from one place to another, or from one organization to another. Technology transfer is completed when the adopted technology is mastered by the recipients.

In order to prepare for the analysis in this paper, it is useful to classify technology into two main categories. These are production technology and process innovation technology. The former is essential for producing goods and the latter is comprised of devices that improve productivity, quality and/or reduce cost, which can be found on the shop floors and accumulated

---

[1] The definition of technology and technology transfer is different from person to person. Edward K.Y. Chen, for instance, briefly reviewed technology transfer to developing countries by MNCs. It will help to understand the concept of technology transfer. See Chen Edward K.Y., "Introduction: Transnational Corporations and Technology Transfer to Developing Countries," in Edward K.Y. Chen, ed., *Transnationnal Corporations and Technology Transfer to Developing Countries*, (United Nations Library on Transnational Corporations Volume 18), Routledge, London and New York, 1994.

Figure 1. Technology Classification



on the former (see Figure 1). The technology, whether production or process innovation, used for manufacturing is different from product to product and it changes over time. Moreover, it is not always easy to distinguish between the two types of technology. This simple classification of technology, however, will help to understand the technology transfer process in the automobile industry in Malaysia.[2] We assume that transfer process of production and process innovation technology will include introducing and improving functions. In general, technology is introduced and adopted by the recipients. Technology, however, should be upgraded continuously to keep up with the technological changes or to improve the productivity and quality of the products. This improving function should also be recognized as technology transfer if recipients can not cultivate it by themselves and de-

[2] Prof. Asamuma referred to the two type of skill, namely basic and relation specific skill, which could be observed among the vendors in the automobile and electronics industries in Japan. See Asamuma Banri, "Manufacturer-Supplier Relationships in Japan and the Concept of Relation Specific Skill," *Journal of the Japanese and International Economies*, Vol. 3, No. 1, March 1989.

pend on other organizations.

What ever the definition of technology transfer, it is observed where there is a technological gap between organizations. The possible forms of technology transfer between organizations were summarized into ten categories by Buckley. They are, (1) wholly-owned foreign subsidiaries; (2) joint ventures; (3) foreign minority holdings; (4) "fading-out" agreements; (5) licensing; (6) franchising; (7) management contract; (8) "turnkey ventures"; (9) contractual joint ventures; and (10) international subcontracting.[3]

This classification will help to categorize technology transfer into two major segments, intra-firm and inter-firm, based on the nature of organizational relationships or equity participation. Intra-firm technology transfer is more often discussed in line with foreign direct investment (FDI) by multinational corporations (MNCs). Through FDI, MNCs transfer management resources, including technology, which is sometimes indivisible from other management resources, to their subsidiaries.

A firm with more advanced technology will maintain a more advantageous position or be more competitive in the market. Those who prefer to keep a competitive edge will make use of their technology within organizations so that technology will be transferred only inside of the organizations. Intra-firm technology transfer would be promoted by parent firms, which are more eager to transfer technology to their wholly owned subsidiaries. Managers and engineers from parent firms play important roles in transferring it. Technology transfer to the wholly owned subsidiaries can be explained by the internalization theory, which shows us that in an imperfect market, firms prefer to make use of organizations rather than the market.

---

[3] See Buckley P. J., "New Forms of International Industrial Co-operation," in P. J. Buckley and M.Casson, *The Economic Theory of the Multinational Enterprise*, Macmillan, London, 1985, p.51.

Transaction of technology in a market will face more difficulties than tangible goods. Purchasers generally underestimate the value of technology and once it is shown to them to evaluate, it is not worth paying for it any more. On the other hand, technology sellers want it to be sold at a price which will make up for the cost spent on developing it. It seems very difficult to find a price which will reconcile both sides in the market. Furthermore, the transaction cost within the organization will be much lower than that spent in the market.[4]

Intra-firm technology transfer to joint venture projects can be divided into two types. One is found in the case of majority owned subsidiaries and the other is seen in minority owned ones. The former will not cause serious problems for parent firms as it is possible for them to control their subsidiaries by being the majority shareholders. Technology will be transferred through factory managers and other engineers sent from parent firms to their subsidiaries in the daily operation. In the case of technology transfer to minority owned subsidiaries, however, it will be more complicated. The attitude and the technological capability of the partners will affect the technology transfer processes. In general, unless parent firms can control the subsidiaries, they will not be very eager to transfer their technology to minority owned subsidiaries.

In the cases of joint ventures with foreign firms, equity share composition does not always reflect the controlling power of the foreigners. The host country government may restrict the foreign equity shares to encourage the participation of local shareholders. The automobile industry, which is a typic-

---

[4] For further understanding of internalization theory, see, for instance, Raguman Alan M., *Inside the Multinationals: Economics of Internal Markets*, Croom Helm, London, 1981, Buckley P.J. And M. Casson, *The Future of the Multinational Enterprise*, Macmillan, London, 1976.

al import substituting one in developing countries is generally subject to this policy.

Inter-firm technology transfer will be observed among inependent organizations or, in other words, among firms without equity participation with each other. We can assume two possible ways through which technology will be transferred. Firstly, under contract basis, technology will be transferred. Here again, because of the imperfect technology market, it is quite difficult for the firms to price the technology concerned. As they can not use organizations instead of the market, it may cause pricing problems. If the agent that can evaluate the technology concerned acts as a go-between, it may lessen these problems. The second channel will be found between assemblers and their vendors or subcontractors. Assemblers need reliable parts and components for producing final goods. If some vendors can not fulfill minimum quality requirement of parts and components, technical support will be directed towards them. In that case, some technology would be transferred to the suppliers not under contract but sometimes at the assemblers' cost. This kind of technology transfer can be observed in the developing countries, where supporting industries are not fully developed.

Both intra and inter-firm technology transfer will include channels from foreign to local firms and within local firms. The possible technology transfer patterns are summarized in Table 1, based on the classification of channels, form of cooperation, technology and functions.

If we apply the above-mentioned technology transfer model to the automobile industry in Malaysia, particularly to PROTON and its vendors, intra-firm technology transfer is found between Mitsubishi Motors Corporation (MMC) and PROTON, PROTON and its subsidiaries, and among foreign parent firms and their Malaysian subsidiaries. The inter-firm technology transfer is observed between PROTON and its vendors, and from foreign

Table 1. Technology Transfer Framework

Channels	Forms of Cooperation	Technology	Function
Intra-Firm	Equity Participation		
Foreign-Local	(1) FDI (Subsidiaries)	(a) Production	(i) Introduction
	Wholly Foreign Owned		
	Majority Foreign Owned	(b) Process	(ii) Improvement
	Minority Foreign Owned	Innovation	
Local-Local	(2) Local Subsidiaries		
Inter-Firm	Contract/ Non-Contract		
Foreign-Local	(1) Licensing	(a) Production	(i) Introduction
Local- Local	(2) Subcontracting	(b) Process	(ii) Improvement
		Innovation	

licensers to Malaysian firms. Most of the foreign firms are those in developed countries such as Japan, USA, and Germany. Classification of production and process innovation technology will be more meaningful when we discuss technology transfer from PROTON to its subsidiaries and vendors. In the case of technology transfer to vendors, production technology is one area where PROTON can not always look after and process innovation technology is one area, which gives more room for PROTON to cooperate.

Much research has already been conducted on intra-firm technology transfer by MNCs. Intra-firm technology transfer from MMC to PROTON is a necessary condition for further intra and inter-firm technology transfer by PROTON. From the view point of development of the automobile industry as a whole, not only intra-firm but also inter-firm technology transfer should be emphasized.

2. PROTON and Intra-Firm Technology Transfer

Intra-firm technology transfer from MMC to PROTON and from PRO-

TON to its subsidiaries will be examined in this section. Before examining intra-firm technology transfer, we briefly review the history and role of PROTON.[5]

The main goals of the national car project were (1) development of the automobile industry including supporting industry, through acquisition and improvement of technology and skills, (2) enhancement of Bumiputera[6] participation into automobile industry. Together with these goals, PROTON was expected to be a model case of producing trained Bumiputera engineers. PROTON was established in May 1983 to achieve these goals as a joint venture of Heavy Industry Corporation of Malaysia (HICOM), Mitsubishi Motors Corporation (MMC) and Mitsubishi Corporation (MC) to produce national cars. HICOM, a public company established in 1980 to promote heavy industries,[7] acquired 70% of the equity and both MMC and MC received 15% of the equity. In September 1985, commercial production started and PROTON was listed on the Kuala Lumpur Stock Exchange (KLSE) in 1992.[8]

Before embarking on the national car project, the automobile industry in

---

[5] Main references on PROTON and automobile industry in Malaysia are as follows; Chee Peng Lim, "The Malaysian Car Industry at the Crossroads: Time to Change Gear?," in Lim Lin Lean & Chee Peng Lim eds., *The Malaysian Economy at The Crossroads: Policy Adjustment or Structural Transformation*, Malaysian Economic Association, Kuala Lumpur, 1984. Chee Peng Lim, "The Proton Saga-No Reverse Gear! The Economic Burden of Malaysia's Car Project," in Jomo K.S. ed., *The Sun Also Sets Lessons in 'Looking East'*, Insan, Kuala Lumpur, 1985. Doner Richard, *Driving a Bargain: Automobile Industrialization and Japanese Firms in Southeast Asia*, University of California Press, Berkley and Los Angels, 1991. Jayasankaran, S., "Made-in-Malaysia: The Proton Project," in Jomo K.S. ed., *Industrialising Malaysia: Policy, Performance, Prospects*, Routledge, London, 1993. Jomo K.S., "The Proton Saga Malaysian Car, Mitsubishi Gain," Machado Kit. G., "Proton and Malaysia's Motor Vehicle Industry National industrial policies and Japanese regional production strategies," both in Jomo K.S. ed., *Japan and Malaysian Development In the Shadow of the Rising Sun*, Routledge, London, 1994.

[6] Bumiputeras are the indigenous Malay people.

[7] HICOM was privatized in 1994.

Malaysia was characterized by tough competition by many completely knocked down (CKD) plants, all of which were joint ventures with MNCs with quite limited participation of Bumiputeras. A small domestic market made it impossible for all the plants to benefit from an economy of scale. Even the largest passenger car producer, Tan Chong Motors[9] produced only about 23,000 cars per year in the early 1980s. Too many CKD plants and low productivity were pointed out in the Long and Medium Term Industrial Master Plan (IMP).[10] PROTON was established in order to restructure the automobile industry, which was also expected to be a strategic industry under the second stage of the import substituting industrialization in the early 1980s. Some scholars, however, pointed out that the national car project would not be large enough to enjoy scale merit and they worried that lay offs in existing plants would cause unemployment problems.[11] Since 1985, PROTON increased its market share as seen in Figure 2, and took a majority share of more than 70% in the passenger car market, forcing other plants to change their strategies drastically.

Technology transfer by MMC was a necessary condition for PROTON, the first integrated car assembler in Malaysia. It was also expected to be a

---

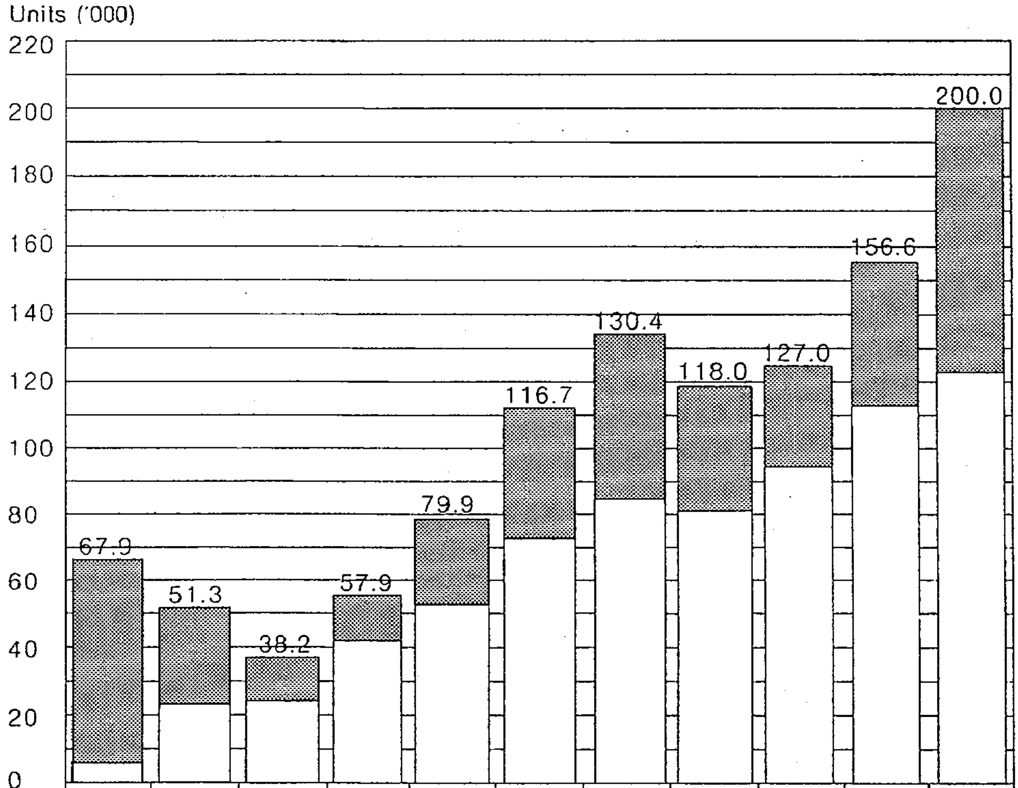
[8] PROTON's equity share composition in March 1995 was as follows;
HICOM Holdings Berhad 27.5%
Hazanah Holdings Berhad 17.5%
Mitsubishi Corporation 8.6%
Mitsubishi Motors Corporation 8.6%
Government Agencies 9.5%
Other Local and Foreign Investors 28.3%

[9] Nissan owns the minority equity share of Tan Chong Motors.

[10] MIDA/UNIDO, *Medium and Long Term Industrial Master Plan Malaysia 1986-1995*, Volume II Part 9 Transport Equipment Industry, MIDA, Kuala Lumpur, 1985, pp.13-16.

[11] Chee Peng Lim (1985), *op.cit.*, pp. 387-401.

Figure 2. Production Volume and Market Share of PROTON



	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Other Passenger Cars	60.4	27.2	13.3	15.4	27.2	44.2	45.6	37.6	32.9	45.3	56,000
Proton Cars	7.5	24.1	24.9	42.5	52.7	72.5	84.8	80.4	94.1	111.3	144,000
Market Share (%)	11	47	65	73	66	62	65	68	74	73	72

Source: PROTON Corporate Profile

successful model of technology transfer from Japan to Malaysia. Japanese firms have been generally criticized that they are reluctant to transfer their technology to developing countries. Unlike other Japanese joint ventures, MMC had to be more cooperative to transfer technology to PROTON because of the nature of the national car project. Besides the financial and technical support, MMC provided assistance with construction of the factory, supply of the equipment and knock down parts and components.

Intra-firm technology transfer from MMC to PROTON was identified from foreign to local joint venture with minority equity shares held by foreigners based on the classification in Table 1. Irrespective of the limited equity participation, MMC made much effort to introduce and improve both production and process innovation technology for producing passenger cars continuously. Just after the establishment of PROTON, in July 1983, 12 plant engineers were sent to the MMC Mizushima plant in Okayama Prefecture, Japan for training. Since then 323 engineers and other staff were sent to Japan by 1986.[12] Almost all the engineers did not have work experience in the automobile industry before, thus they were not familiar with technology necessary for producing passenger cars. In the Mizushima plant, a training center for the PROTON project was set up to provide sufficient training for engineers and other staff from PROTON. The center prepared necessary materials and English manuals for training. MMC had a policy that the continuous training should be provided not by Japanese staff but by Malaysians. Therefore those trained in Japan were expected to become the tutors to transfer to their successors skills and knowledge acquired in Japan.[13]

MMC and MC, on the other hand, selected 26 engineers, technicians and managers, who were sent to Malaysia in 1984 to prepare for the production of the national car PROTON Saga. When the first Saga rolled out from the PROTON plant located in Shah Alam, near the capital city of Kuala Lumpur, in August 1985, about 100 Japanese engineers and other staff were working in the plant. The number of Japanese engineers and managers in the Shah Alam plant decreased to 26 in 1995. The main role of Japanese engineers on the shop floor is to advise about technical matters to Malaysian engineers. Through daily communications between Malaysian and Japanese engineers,

[12]Shiode Hirokazu, *Japanese Investment in Southeast Asia Three Malaysian Case Studies*, Center for the Progress of People, Hong Kong, 1989, p.31.

[13]Nishihara Takashi, "National Car Project Proton Saga Hasshin," (Starting of National Car Project Proton Saga), *JACTIM Kaihou* (JACTIM Bulletin) No.9, 1985, p.29.

technology transfer has been promoted.[14]

PROTON has been sending their staff to MMC in Japan for training. Continuous training in Japan was inevitable for introducing new models, Wira (in March 1993), Perdana, a middle class car (in January 1995) and building new plants, as well. Assembling of engines started in June 1989, followed by building a new engine and transmission factory in the Shah Alam plant in December 1990. An R & D center was established in March 1993, to reinforce design capability. PROTON started construction of a casting plant in December 1992 in Glenmarie HICOM Industrial Estate, near Shah Alam, at a cost of 260 million rinngit (Malaysian dollar), and commercial production started in April 1994. In each stage of the introduction of the new plant and other facilities, MMC's technical support contributed to strengthen the technical bases of PROTON. Thus, continuous introduction and improvement of technology has been carried out.

Except for the technology necessary for car production, in-house production of parts and components promoted transfer of technology for producing these items. The in-house production ratio of parts and components in Japanese car assemblers has been rather low. Owing to the very efficient subcontracting system in Japan, MMC and other car assemblers rely greatly on the subcontractors for their parts and components supplys. Assemblers mainly concentrate on producing the crucial parts and components such as engines and transmissions. None the less, as a purchaser, it is necessary for MMC to evaluate the quality of the parts and components supplied by ven-

---

[14]"Prime Minister Mahathir criticized MMC for being slow in tranferring technology to PROTON and said that Malaysia might source knowledge from manufacturers other than the Japanese partners". Machado Kit.G.(1994), *op.cit.*, pp.308. In September 1995, PROTON concluded an agreement with Citroen to manufacture modified model of Citroen. It suggests that PROTON obtained a new channel of technology transfer.

Table 2. Localization by PROTON (In-house Production of Components)

Year	No. of Items
1985	176
1986	47
1987	14
1988	108
1989	174
1990	5
1991	4
1992	-269
1993	135
1994	-
1995	-
Total	394

Source: PROTON Corporate Profile

Note: In 1992, stamped parts transferred to PHN

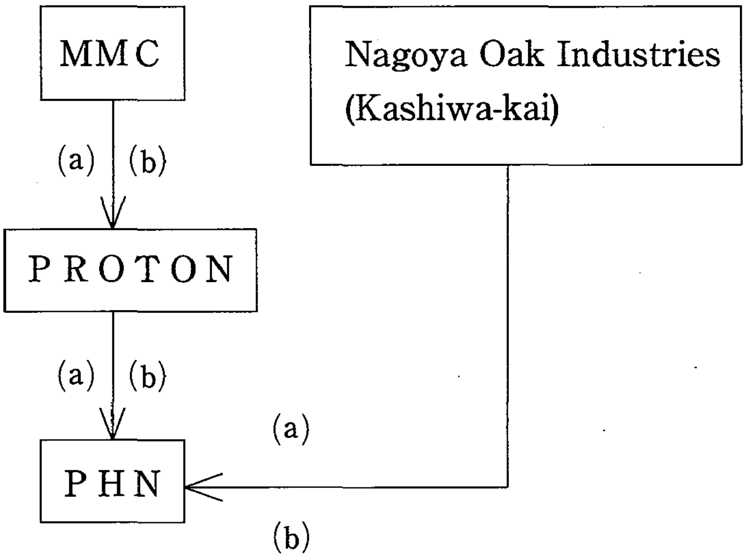
dors. In the development stage of the new models, MMC and its vendors cooperate to prepare new parts and components, which enables MMC to catch up with basic production technology to produce them. Moreover MMC used to produce some parts and components in its plants in the past and thus this technology has been maintained by the engineers. MMC was encouraged to transfer basic production technology to produce certain parts and components to accelerate localization attainment. Table 2 shows the in-house localization achievement, indicating the number of products produced by PROTON. From the table, it was observed that in 1985, when PROTON started commercial production, as well as in 1988, 1989, and 1993, in-house production was enhanced to promote localization of the materials.

In October 1990, PROTON (with 35% equity shares) set up its associate company, PHN sdn. bhd., as a joint venture with HICOM (42.5% of equity), Nagoya Oak Industries (20%) {established by 25 MMC's vendors association (Kashiwa-kai) member companies in Nagoya} and MC (2.5%) so that production of 269 items, mainly stamped parts, were taken over by PHN in 1992, when it started commercial production. The participation of Nagoya Oak Industries with PHN suggests that MMC vendors have been playing important roles in producing parts and components. Both basic production technology and process innovation technology would be transferred from PROTON to PHN and further technology would be transferred from Nagoya Oak Industries to PHN to reinforce the technology transferred from PROTON. Each MMC vendor, on the other hand, could reduce the risk to establish its own joint venture by being a shareholder of Nagoya Oak Industries. Even though Nagoya Oak Industries has been a minority shareholder, as it was a joint venture with PROTON and HICOM, it was Nagoya Oak Industries that was expected to take care of technological matters.

When PHN was founded three managers moved to PHN from PROTON to transfer not only technology but also other management resources. Including these managers, all together 40 ex-PROTON staff were working for PHN in 1993. PROTON's support was reported as very helpful to improve productivity and quality of the products. In the past, PHN sent engineers to PROTON for on the job training and engineers are still sent to PHN from PROTON. PHN has been producing the same products that had been produced by PROTON and most of the technology was transferred by PROTON. Besides the introduction of basic production and process innovation technology from PROTON, further introduction and improvement of technology by Nagoya Oak Industries was also observed. PHN engineers have been sent to Nagoya for training. Engineers from Nagoya were also working for PHN to take care of technical matters.

All the processes of intra-firm technology transfer related PROTON are summarized in Figure 3. MMC transferred both production and process innovation technology to PROTON. PROTON, on the other hand, transferred technology of producing stamped parts by assigning the production to PHN. Participation of Nagoya Oak Industries contributed to technology transfer to PHN. In July 1995, the technical assistance agreement between PHN and Nagoya Oak Industries expired and PROTON took over Nagoya Oak's role

Figure 3. Intra-Firm Technology Transfer of PROTON



Note: ——: Intra-Firm Technology Transfer
(a): Production Technology
(b): Process Innovation Technology

of technology transfer to PHN, which suggests the accumulation of technology bases in PROTON.

3. Inter-Firm Technology Transfer by PROTON

One of the main purposes of establishing PROTON was to cultivate supporting industries which were inevitable for enhancing industrial bases. In the 1960s and 1970s, in spite of the high growth rate of the manufacturing sector, the low local content ratio was observed except in the resource-based industries such as rubber, wood, and food. The participation of Bumiputeras in the manufacturing sector was rather limited both in terms of equity shares and labour force, especially specialists such as engineers.

The automobile industry needs a lot of supporting industries, which made it one of the most suitable industries for developing local vendors. It

Table 3. Local Vendors and Localization of Components

Year	No. of Vendors	Localized Items
1985	17	52
1986	16	50
1987	7	59
1988	6	19
1989	21	190
1990	11	110
1991	21	159
1992	7	131 (+269)
1993	19	1,439
1994	9	532
1995	4	66
Total	138	3,076

Source: PROTON Corporate Profile

Note: Localized items in 1992 includes those transferred to PHN

was estimated that 20,000 to 30,000 parts and components would be necessary to produce a car. PROTON, a national car producer, was expected to increase its vendors to achieve the localization target for parts and components. Table 3 shows the number of vendors and the localization of parts and components. A steady increase in the number of vendors can be observed, on the other hand, items supplied by local vendors increased drastically after 1989. Data shown both in Table 2 and 3 revealed that until 1988, the localization effort concentrated more on in-house production. The tremendous increase of local parts and components in 1993 was attributable to the introduction of the new model PROTON Wira. Existing vendors could supply additional parts and components similar to the previous models.

The year 1988 was an epoch making year for PROTON. A new Japanese managing director sent from MMC encouraged the enhancement of the local content ratio. Localization was also promoted by the appreciation of yen. The strong yen after the Plaza Agreement in 1985 pushed up the production cost of PROTON cars since major parts and components had been imported from Japan. It was necessary for PROTON to decrease imports from Japan to reduce the production cost. Exports to the United Kingdom (UK) was the other factor which encouraged the localization of parts and components. The generalized system of preference (GSP) in the UK required at least 60% local content ratio. For this purpose, some foreign firms in Malaysia were appointed as new vendors. For further localization of parts and components some measures which will be referred later were introduced to prepare for PROTON Saga Iswara, the second model of PROTON Saga. It also contributed to enhance the local content of the new model, PROTON Wira.

Inter-firm technology transfer by PROTON should be understood as a part of the total vendor development system. The procurement and vendor development (PVD) office of PROTON is in charge of vendor development with assistance from other departments. PROTON's vendor development process can be summarized as follows;[15]

(1) identification of parts,

(2) identification of vendors,

(3) selection of vendors,

(4) ongoing assistance, and

(5) long term objective.

Technology transfer to vendors and other supporting efforts can be found in stages (4) and (5), in which some measures were prepared to assist vendors. The most important measures to improve the technical ability of the vendors would be inter-firm technology transfer by sending engineers

[15]Ab. Rahim Husain, "Productivity Improvement Programme for Proton Vendors," paper presented in the National Productivity Center Seminar, on 18 May, 1993, p.13.

from PROTON. It was local to local inter-firm technology transfer, neither equity participation nor contract, but through subcontracting. This direct support and transferred technology was mainly process innovation technology and it seemed more effort was made to improve it. On the other hand, transfer of production technology was promoted mainly through match making, which is the other form of inter-firm technology transfer referred in the next section. Technical assistance arrangements between PROTON vendors and foreign firms, mostly MMC vendors would be the typical cases of match making. Except for direct inter-firm technology transfer by sending engineers, we observed other factors which contributed to promote inter-firm technology transfer, for instance PROTON component scheme (PCS), single sourcing, PROTON vendors' association (Persatuan Pembekal PROTON: PPP) and ex-PROTON staff. They are referred to in section 5.

The direct inter-firm technology transfer by sending engineers to vendors was the most crucial technical assistance by PROTON. Since 1988, when PROTON began to emphasize more localization and prepare for the new model, PROTON Wira, it introduced some measures to improve vendors' technical ability, especially those of new Bumiputera vendors. Sending engineers has been the most important and effective measure for supporting vendors, most of which are located in the Kelang Valley, near the Shah Alam plant for the just in time system employed by PROTON. Quality, cost, delivery (QCD) audit has been conducted by engineers from PROTON on the shop floor in each vendor since March 1992. They encouraged vendors to improve the quality of their products through focusing on layout of the factories, equipment and process, process control, production planning and control, and manpower utilization. In the course of achieving this, efficient delivery, reduction cost, shorter lead-times, and better management of inventories were expected to be achieved. These activities were realized based on the former 2S {Seiri, Seiton (arrangement)} and 3M {Muri (excess), Mura (irregularity), Muda (wastefulness)} activities.

Not only the PVD office but also other departments such as quality control, production planning & control, engineering, and R&D participated in QCD activities. Except for the annual QCD audit, ten QCD teams, each of which was comprised of five engineers and one Japanese advisor, visited vendors to investigate current conditions of QCD of their products. If QCD teams found some problems among vendors, they would be solved with the cooperation of PROTON. Through this process, it became possible for vendors to learn how to solve production related problems.

The PVD office introduced another activity that was called 4M, namely, Manpower, Material, Machine and Method. These four elements comprise the basis for mass production. In September 1992, PROTON started to assess these 4M elements in the vendors. Even though twenty 4M teams, each of which was comprised of four to five engineers including one Japanese advisor, were sent to one to four vendors in the development stage of PROTON Wira (September 1992- March 1993), the 4M concept still exists and is used to assess each item of QCD. Recently, PROTON is more conscious about reducing the cost of parts and components. Target cost achievement (TCA) was introduced in March 1993 to inspire vendors to reduce production costs.[16]

Sending engineers contributed to improve the technical levels of the vendors and to promote mutual communication. Their technical assistance,

[16]4M assessment was already completed in March 1993. QCD, however, continued at the time we visited vendors in the latter half of 1993. Other programmes such as PPCM (Production Preparation Confirmation Meeting), PPCQ (Production Quality Confirmation Meeting) were also introduced to improve productivity of vendors before starting mass production of Wira.

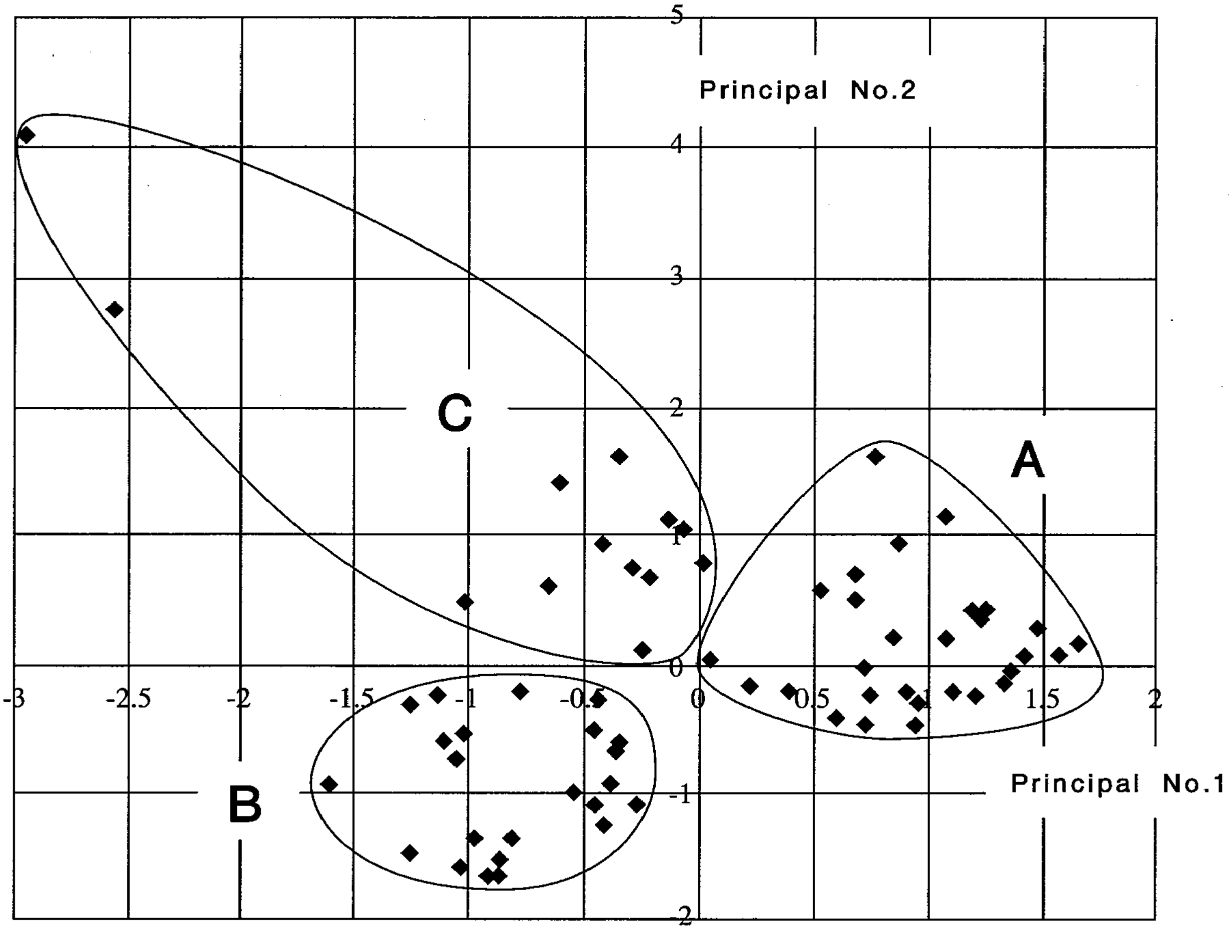
of course, concentrated more on improving process innovation technology. The vendors were divided into four or five groups based on the nature of their products such as plastic, stamping, machining, and electrical parts. PROTON, a car assembler, does not always have enough production technology necessary for producing specific parts and components. However, process innovation technology could be transferred by PROTON since MMC had experience in improving the production process of vendors by cooperating with its vendors in Japan and such experience enabled Japanese engineers to instruct PROTON engineers on how to upgrade the production process of the parts and components supplied by vendors. Further more, as a purchaser of parts and components, it is necessary for PROTON to have minimum knowledge of producing them and strict inspection of quality, cost and delivery was conducted from the purchaser's view point. It was expected that such knowledge, to some extent, helped its vendors to upgrade their technological ability.

In spite of the efforts made by PROTON, some vendors, mainly newly established small and medium industries (SMIs) with limited management resources, faced problems in quality, cost, and delivery. More effort was made to support Bumiputera firms as it was one of the major purposes of establishing PROTON. The Bumiputera firms sometimes coincide with the above-mentioned SMIs that face a shortage of management resources, among which technology seems the most crucial element.

Classification of vendors will help to analyze which vendors evaluated PROTON's assistance as beneficial to them and on what factors they put more value. We try to examine the assumption that the less management resources, including technology, were possessed by the vendors, the more assistance by PROTON would be recognized as beneficial to them.

Figure 4 shows a scatter diagram of the principal component score of

Figure 4. The Scatter Diagram of the Principal Component Score of PROTON Vendors



the PROTON vendors. It was calculated from the results of the principal components analysis of the variables such as business experience, paid-up capital, employees, equity shares held by Bumiputeras, other Malaysians, and foreigners, business experience with PROTON and their sales dependence on PROTON. Among principal No.1, equity shares by Bumiputeras, sales dependence on PROTON were important factors. Paid-up capital, number of employees and equity shares by foreigners were revealed to be more important in principal No.2 (see Appendix). From the figure we can identify three major groups, they are referred to as Group A, B and C.[17] Of the 67

[17]The author tried to classify PROTON vendors into five categories in his paper "Umbrella Concept and Proton's Vendors," presented in the Seminar on

firms from which basic data were available, most of the firms in Group A would be characterized as Bumiputera majority SMIs with short business experience and most of their products were supplied to PROTON. Those owned mainly by other Malaysians with longer business experience and diversified customers are found in Group B. Those in Group C were subsidiaries of MNCs, some of which were rather large in size.

The above-mentioned classification will contribute to examine which group put more value on PROTON's technical support since it seems possible to assume that firms with limited management resources, including technology, tend to fall in Group A. Firms in Group B will have more management resources than those in Group A and those in Group C will have the most affluent management resources among them. We tried to classify 37 firms, which gave us more information and answered the questions about technology and PROTON's technical support, into the above-mentioned three groups. Of the 37 firms, 15 firms were found in Group A, 12 in Group B, and 10 in Group C.

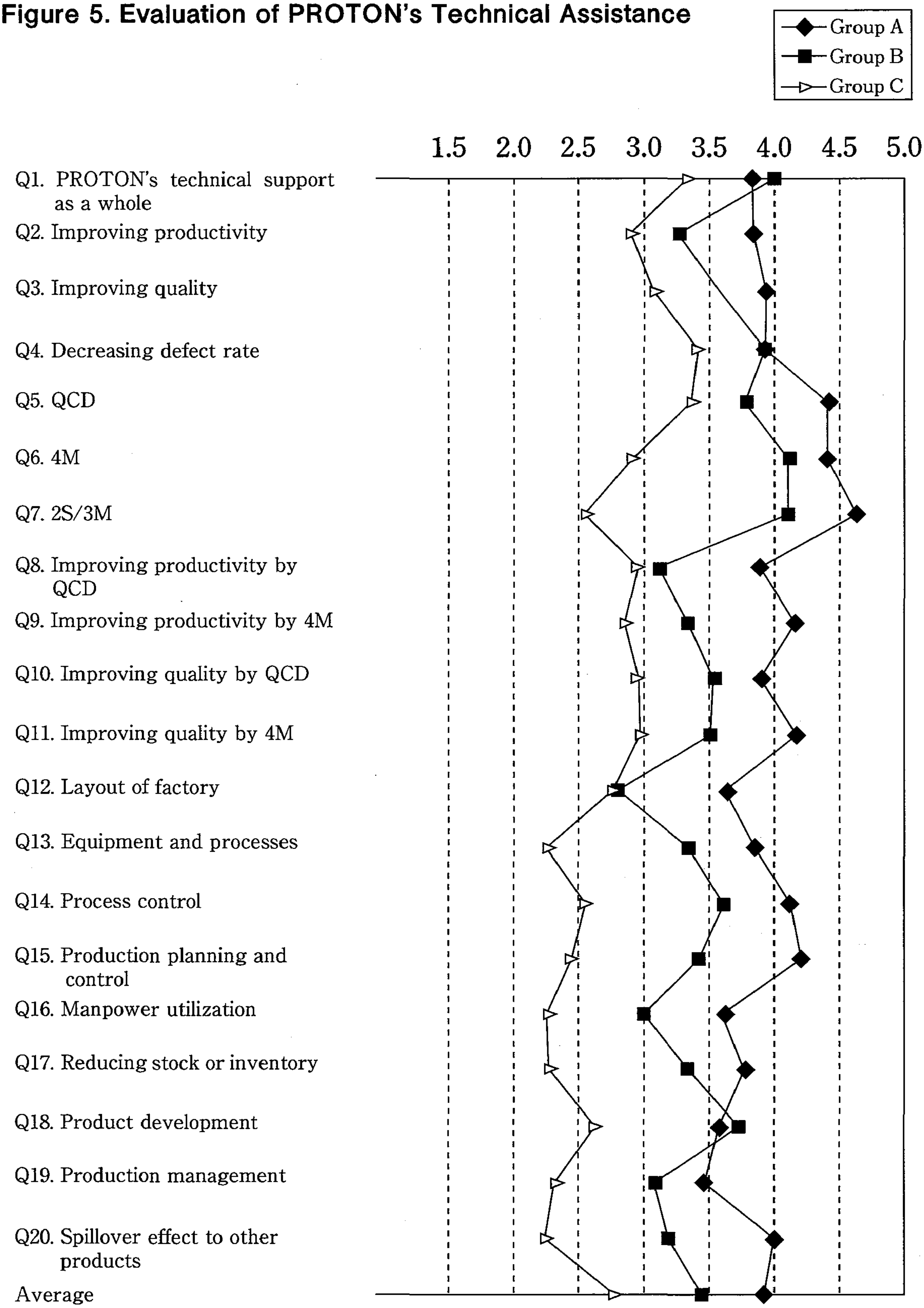
The result of a five point evaluation by each group is seen in Figure 5. Most of the questions asked were related to the transfer of process innovation technology. As was expected, those in Group A evaluated technical support by PROTON as most crucial. As is seen in the figure the average score for all the questions of Group A was 3.97, Group B was 3.46 and Group C was 2.73.

We will describe the main results observed from Figure 5. Both firms in Group A and B evaluated technical support by PROTON as a whole as suffi-

---

Governance Mechanisms and Technical Changes in Malaysian Industrialisation, National University of Malaysia, on 15-16 August, 1995. Some firms overlapped two or three categories so that a new effort was made to simplify the classification itself.

Figure 5. Evaluation of PROTON's Technical Assistance

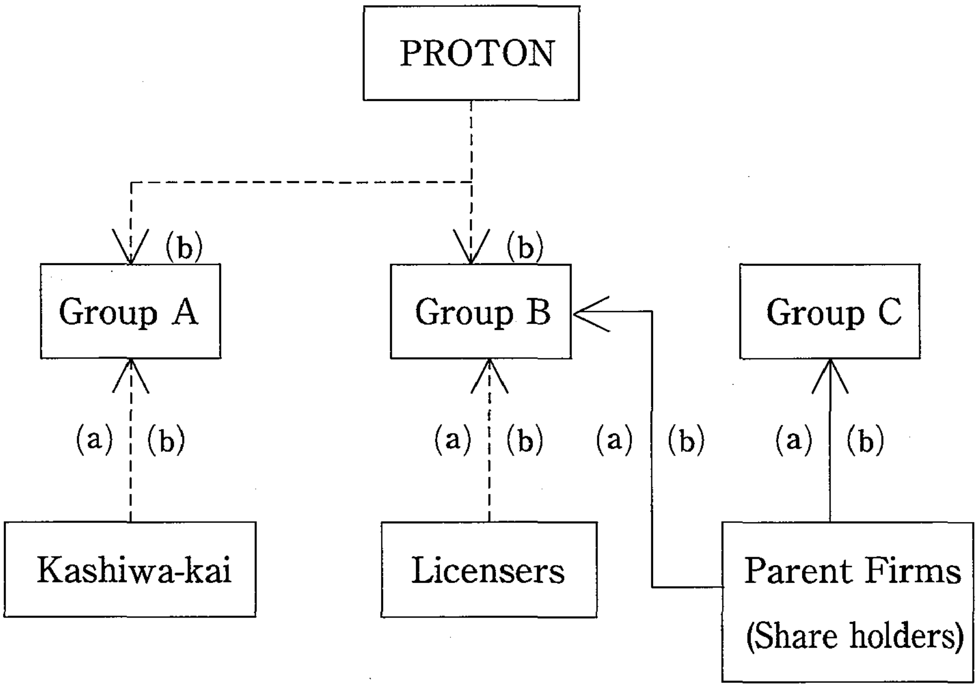


Note: Managers and engineers were required to choose one from five possible answers. They were very much (five point), fairly (four point), moderately (three point), not so much (two point), and not at all (one point).

cient (Q.1). Those in Group B on average recorded a slightly higher score than that of Group A. Group A estimated QCD (Q.4), 4M (Q.5) and 2S/3M (Q.6) as more valuable. Among them 2S/3M had the highest score. Firms in Group B also put a high value on them. On the other hand, firms in Group C did not recognize that they were very beneficial, in particular, 4M and 2S/3M. These facts typically indicated the different technological levels among these groups. From Q.12 to Q.20, more concrete elements of PROTON's technical assistance were evaluated. The scores of Group C were rather low again compared with those of Group A and B.

Group A firms with less management resources, particularly technology, needed more support from PROTON and they recognized upgrading process innovation technology through inter-firm technology transfer by PROTON contributed to improve their technical capability. The interviews with managers of vendors gave evidence that PROTON's technical support was more concentrated on the firms in Group A. Firms in Group B and C seemed more independent from PROTON with regard to the technology they utilize than those in Group A. The different evaluation between Group B and C, however, suggests that firms in Group B do not necessarily have sufficient channels through which process innovation technology will be transferred. These firms could receive technical assistance mainly by licensing through which more production technology would be transferred. Sufficient process innovation technology was not always transferred from the licensers and some part of it should be complemented by PROTON. Interviews with managers of Group B firms revealed the fact that product quality requirements by PROTON are stricter than other customers, encouragingtomake use of PROTON's technical support such as QCD and 4M to fulfill the requirements. Firms in Group C that have been maintaining a more advantageous position, could receive any technical assistance in the form of intra-

Figure 6. Main Channels of Technology Transfer



Note: ——: Intra-Firm Technology Transfer, (a) Production Technology
- - - -: Inter-Firm Technology Transfer, (b) Process Innovation Technology

firm technology transfer from their parent firms. Both production and process innovation technology would be transferred by them.

Upper half of Figure 6 shows inter-firm technology transfer patterns from PROTON to its vendors. As was already explained, process innovation technology would be transferred from PROTON to mainly Group A and B vendors. We would like to emphasize that upgrading of process innovation technology through QCD and 4M has been the main technical support provided by PROTON. Particularly, the strict quality requirements by PROTON made vendors pay more attention to quality.

4. The Other Forms of Technology Transfer

We have already investigated intra and inter-firm technology transfer of

PROTON so the remaining channels of technology transfer will be examined in this section. They are inter-firm technology transfer through the technical assistance arrangement by PROTON under match making scheme, inter-firm technology transfer under other licensing and intra-firm technology transfer among foreign owned firms (see Figure 6). The other possible way of technology transfer would be found in the training courses organized by public and private institutes.

Together with sending engineers to vendors, match making provides a way to improve vendors' technical capability. PROTON introduced match making in order to transfer technology that PROTON itself can not provide. PROTON mainly transferred process innovation technology to vendors, especially to those firms in Groups A and B. Production technology, however, would not be transferred sufficiently by PROTON alone and sometimes it was impossible for PROTON and even MMC to transfer it. In that case, PROTON required those vendors to arrange technical assistance agreements with suitable firms. Introduction of the licensers by PROTON reduced the cost for vendors to search for them by themselves. It also minimized possible conflicts with regard to the contracts generally found between licensers and licensees. More often, MMC's vendors (Kashiwa-kai members) in Japan were chosen as their collaborators. Technology transfer through match making scheme would be categorized in the inter-firm technology transfer from foreign to Malaysian firms under the contracts. Introduction of production technology is most crucial, however, continuous training will help to upgrade it.

PROTON, as a car assembler, does not necessarily have production technology that is crucial to produce particular parts and components and neither does MMC. Being purchasers of parts and components, car assemblers can partly recognize technology used by their suppliers. Some production processes of parts and components are still black boxes for assemblers. As was examined in the second section, MMC relies this kind of technology on its vendors and it is not transferred sufficiently to PROTON and therefore not to PROTON vendors.

As of September 1995, 40 technical assistance agreements were concluded under match making scheme, which also recognizes joint ventures and purchase agreements as a part of the scheme. Table 4 shows the allocation of source countries and as was expected Japanese firms were the main sources of the agreements and joint ventures.

Table 4. Match Making Companies

Source Country	Joint Venture	Technical Assistance	Purchase Agreement
Japan	16	35	4
Germany	3	–	–
Taiwan	5	1	–
Korea	6	–	–
Australia	2	1	–
Others	3	3	–
Total	35	40	4

Source: PROTON Corporate Profile

The most typical inter-firm technology transfer under the technical assistance agreements can be described as follows. The licensers in Japan send their engineers to PROTON vendors to investigate their technical level and help to introduce new technology sometimes even by giving suggestions as to what kind of machinery and equipment should be purchased. They also instruct them how to operate these machines. If the vendors already have the necessary facilities, engineers from licensers pay more attention to improve productivity and quality of products. Japanese engineers stay in Malaysia for a certain period, but not that long since all the costs are paid by the vendors.

It seems that technology transfer under the agreements generally concentrated more on transferring production technology and it was beneficial for vendors to acquire it. It was also expected that some process innovation technology would be transferred together with production technology. Nonetheless, technical assistance agreements did not seem sufficient enough to transfer process innovation technology to vendors mainly because of the limited time and communication gap among the engineers from both sides.

Out of 70 firms surveyed about match making and other technical assistance agreements, 15 firms in Group A, four in Group B, and none in Group C arranged technical assistance agreements under match making scheme. Technical support was mainly directed towards vendors in Group A, particularly Bumiputera SMIs. Interviews with managers of those vendors emphasized the contribution of match making scheme to improve technology levels.

Our research revealed other channels through which technology was transferred. Technical assistance agreements not under match making scheme were also found among the vendors in all the Groups, seven firms in Group A, ten in Group B and 12 in Group C. Within the seven firms in Group A, four firms concluded agreements with foreign partners who owned minority equity. Another seven firms in Group B also arranged agreements with foreign minority shareholders. Only three firms in Group A and three in Group B had their own foreign licensers. Firms in Group C, without exception, concluded agreements with their parent firms. Technical support from parent firms not under contract terms were also observed in the other firms in Group C.

Inter-firm technology transfer through match making has been very substantial for firms with limited management resources in Group A in transferring production technology. In the case of firms in Group B, there were two main channels through which technology was transferred. One is inter-firm technology transfer under the technical assistance agreements irrespective of intervention by PROTON. The other technology transfer channel would be that of intra-firm from foreign minority shareholders. Production technology would be transferred through these channels. As in the case of Group A firms, as far as technology transferred under contract basis, sometimes transfer of process innovation technology is not sufficient. The analysis in previous section revealed that firms in Group B put a rather high value on PROTON's technical support, through which mainly process innovation technology was transferred. This would be partly attributable to the fact that inter-firm technology transfer under contract basis was not always sufficient to transfer process innovation technology. Technology transfer from foreign minority shareholders can be categorized as an intra-firm, however, in nature, it is almost identical to the inter-firm technology transfer, if they did not control the management and only production technology was transferred. Different from the cases in Group C firms, generally, foreign engineers were sent to Malaysia for a short term period on a contract basis.

Group C firms depended mostly on parent firms technologically. They are the most independent of PROTON's technical support because through intra-firm channels both production and process innovation technology was transferred. Being subsidiaries of foreign firms, most of the management resources including technology were transferred from parent firms abroad. They can easily access their parent firms' management resources sometimes without paying any costs. Foreign managers and engineers were found in these firms and technology was transferred daily on the shop floors by them. If necessary, more foreign engineers would be sent to Malaysia to assist their production or training of the local staff. Local engineers were also sent to their parent firms for training. The exchanges of engineers helped to minimize the communication gap and contributed to smoother transfer of both production and process innovation technology.

The training courses organized by public and private institutes are the other important channels of technology transfer or diffusion. Both production and process innovation technology would be transferred based on the needs of the firms. This kind of technology transfer complements that found among private firms and promotes enlarging industrial bases of the country.

PROTON prepared training courses for vendors with the cooperation of Standards and Industrial Research Institute of Malaysia (SIRIM).[18] It organized not only general courses but also tailor made courses for specific customers. The other public institutes such as National Productivity Centre (NPC) (National Productivity Corporation since 1991) and the Centre for Instructor and Advanced Skill Training (CIAST) also prepare courses for firms which need to train their staff. Even PROTON sent its engineers to the seminars organized by CIAST. Other private or semi-government organizations such as Federation of Malaysian Manufactures (FMM) and Penang Skills Development Centre (PSDC) organize seminars mainly for the members. In the case of PSDC, it has its own facilities for training donated by member companies, most of which are MNCs. The courses are also open to the public and non-members can make use of the facilities.[19]

---

[18]Abdul Aziz Abdul Rahman, "Nurturing of Bumiputera SMIs Through PROTON's Vendor Scheme: A Case Study of Tracoma," in Hara Fujio ed., *The Development of Bumiputera Enterprises and Sino-Malay Economic Cooperation in Malaysia*, Institute of Developing Economics, Tokyo, 1994, p.31.

[19]PSDC prepared 654 training courses in 1994 and about 10,000 employees took theses courses.

5. Other Support by PROTON

Technology transfer would be more effective when other related support was made to reinforce it. The roles of PCS, single sourcing, PPP and ex-PROTON staff are examined.

PROTON Component Scheme (PCS)

The special vendor development was launched in December 1988 with the introduction of the PCS which assisted selected SMIs in gaining access to the PROTON car component market by securing purchase orders from PROTON. This was the first case of the vendor development program (VDP),[20] the objective of which was to enable Malaysian SMIs to become suppliers of parts and components used by large-scale industries and MNCs. To qualify for this assistance package, which includes financial support, the potential SMI vendors are required to have relevant business experience, a shareholder's fund of not less than 20,000 ringgit with a minimum Bumipureta equity of 70% and a total Bumiputera work force of not less than 55%. The PROTON Bumiputera vendor scheme constitutes a part of the PCS.[21] Under the scheme, Bumiputera SMI vendors were qualified to apply for the technical assistance arrangement and were also available for a maximum one million ringgit Government grant for financing new equipment. At the end of 1993, 19 SMI vendors were receiving this grant.

Single Sourcing

PROTON had a basic policy of procuring one specific product from a

[20]PCS was the first case of the vendor development programme introduced by MITI. Under a dual arrangement, vendors of PROTON, Sapura, Sharp Roxy could make use of Government grants. In 1993, a tripartite arrangement without Government grant was introduced. Ministry of Entrepreneurial Development is in charge of VDP since it took over the MITI SMI division's role in 1995. In August 1995, we found 43 anchor companies.

[21]Abdul Aziz Abdul Rahman, *op.cit.*, p.28.

particular vendor except some parts such as seat belts and shock absorbers. This policy was called single sourcing. Because of the narrow domestic market, even PROTON, the giant in the passenger car market, can not enjoy enough scale merit. The situation is almost the same for the vendors. If PROTON employed a plural sourcing policy, vendors' production volumes would be too small to enjoy minimum scale merit and it would push up the production cost for PROTON. Under the single sourcing policy, vendors can supply several items to PROTON so that they can enjoy an economy of scope as well.

The single sourcing policy may cause a bilateral monopoly situation. The oligopolistic situation in the passenger car market, in which PROTON holds the majority share of roughly 70%, however, gives PROTON more bargaining power against vendors. Further more, PROTON is always monitoring the material costs for production in each vendor and one vendor may replace another vendor's position. For instance, it is possible for one plastic manufacturer to produce other parts produced by its competitor. Existing potential competitors among vendors makes the competition harder and encourages them to improve their technological level and to reduce production costs. This situation might be called "competition by visible hand".[22] Recently, however, PROTON has changed its single sourcing policy to a plural sourcing policy to encourage competition among the vendors.

PPP (Persatuan Pembekal PROTON, PROTON Vendors' Association)

PPP was established in July 1992 initiated by PROTON, which tried to organize a vendors association similar to MMC's vendors association called

[22] Itami Hiroyuki, " Mieru-te niyoru kyousou: Buhin kyoukyu taisei no kouritusei," (Competiton by Visible Hand: Efficiency of Parts Supply System), Itami Hiroyuki, Kagono Tadao et al eds., *Kyousou to Kakusin- Jidousha Sangyou no Kigyou Seichou*, (Competition and Innovation- Company Development in the Automobile Industry), Touyoukeizai Shinpou- sha, 1988.

Kashiwa-kai. The objectives of establishing PPP are summarized as follows; (1) to foster closer relationships amongst members, and between members and PROTON; (2) to organize seminars and workshops to upgrade members on aspects like quality improvement, productivity improvement, product development, management, etc.; (3) to organize educational tours, local and overseas, to further enhance members' capabilities; (4) to promote organized export programs and channels of request for technical assistance agreements with overseas manufacturers; (5) to promote good relationships within the auto component industry and the government agencies; and (6) to organize any functional activities that are considered beneficial to members and PROTON.[23]

PPP organizes monthly vendors briefings in which production schedule and other information is announced by PROTON. It also organizes seminars for members with the assistance of SIRIM, CIAST and the like, charging lower fees. At the PPP annual dinner, vendors with good performance are given PROTON awards. These awards contributed to encourage vendors to improve productivity and the quality of their products.

The most important economic function of PPP was information sharing among vendors. With the assistance of PROTON, new business chances would be brought about among vendors, which facilitate enhancing business networks and diversifying customers of vendors.

Ex-PROTON Staff

Previous analysis proved that sending engineers was a very effective way of transferring technology to vendors. Technology possessed by PROTON engineers was transferred through communication with vendors. Among the managers and engineers of vendors we interviewed, many ex-

[23]Cited from PPP Directory.

PROTON staff, those who had been working for PROTON before, were found. Though it was not the direct support by PROTON, transfer of staff from PROTON to vendors helped to upgrade vendor's technological capability by introducing technology through them. They could replace the PROTON engineers' roles of transferring technology to vendors. They also act as boundary personnel who promote smoother communication between PROTON and its vendors.

An organization has its own terminology which can be completely understood by the members within the organization, in this sense, this exclusive terminology might cause a communication gap between two organizations. Such communication gaps would be minimized through frequent communication between boundary personnel from both sides. Face to face communication between PROTON engineers and engineers in vendors would contribute to minimizing the communication gap. Understanding PROTON's firm specific terminology is not enough for vendors to be better business partners. It is more important for vendors to understand the business principle of PROTON. Ex-PROTON staff were expected not only to be translators of PROTON's terminology but also agents to introduce PROTON's business principle. Most of the ex-PROTON staff were found in firms in Group A, which needed more support from PROTON.

6. Concluding Remarks

Figure 3 and 6 show channels both production and process innovation technology would be transferred through them. They help to understand how technology was transferred and diffused in the automobile industry. Classification of technology and technology transfer channels deepened our understanding. Grouping of the vendors by their nature contributed to examine which group needed more support from PROTON.

Main purposes of establishing PROTON were developing supporting industries and encouraging Bumiputera participation in the automobile industry. PROTON's support was directed mostly towards firms with limited management resources, especially technology. Firms in Group A in our classification enjoyed PROTON's technical support most. Not only firms in Group A, but other vendors were also able to enjoy PROTON's support. For the vendors, PROTON's technology and other management resources were identified as club goods which they could use without paying for it by being vendors. Technology sometimes embodied by the engineers was transferred by ex-PROTON engineers who were found in vendors, more frequently among firms in Group A. It was PROTON that supplied human resources to vendors and they contributed to upgrade venders' technical levels as a whole.

PROTON has a dualistic feature in a sense that technology has been being transferred from MMC and, on the other hand, technology has been transferred from PROTON to its subsidiaries and vendors. However, technology transfer from PROTON was encouraged after 1988 for reasons such as the appreciation of yen, fulfilling GSP criteria among other reasons. The five year period after establishment in 1983 had been a learning period for PROTON. It was after five years that enough management resources (technology) were accumulated in PROTON, making it possible for PROTON to launch into supporting vendors. PROTON's vendor development and other support exceeded the general effort by private firms and it should be recognized as an exceptional case. Being a national project enabled this kind of support by PROTON.

The arguments on technology transfer from foreign firms have been often biased towards the perspective of the suppliers. The capability of the receivers should be investigated for further analysis of technology transfer.

Self-sufficient efforts made by the recipients would be a necessary condition for further technology transfer in every stage.

The role of public and some private institutes or organizations should be emphasized more for the further development of technological capabilities of Malaysian firms. Both production and process innovation technology would be learned in the courses prepared by them. The tailor made courses will help to upgrade production technology of the participants.

Appendix

Correlation Matrix

	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
(a)	1.0000							
(b)	0.2190	1.0000						
(c)	0.3662	0.6892	1.0000					
(d)	-0.2746	-0.1867	-0.1652	1.0000				
(e)	0.2746	-0.1297	-0.0819	-0.6620	1.0000			
(f)	0.0312	0.3866	0.3033	-0.5044	-0.3133	1.0000		
(g)	0.4977	-0.0605	0.0709	-0.1799	0.3334	-0.1568	1.0000	
(h)	-0.4486	-0.1406	-0.2393	0.6041	-0.5201	-0.1661	-0.2144	1.0000

Eigenvalue Table	Eigenvalue	Contribution	Cumulative Contribution
Principal No.1	2.829433	0.353679	0.353679
Principal No.2	2.009381	0.2511173	0.604852

Principal Loading	Principal No.1	Principal No.2
(a)	-0.68112	-0.10160
(b)	-0.43837	0.71796
(c)	-0.52433	0.61551
(d)	0.80053	0.09322
(e)	-0.57990	-0.67059
(f)	-0.34599	0.65471
(g)	-0.43746	-0.42881
(h)	0.78117	0.18394

Note: (a) Business experience, (b) Paid-up capital, (c) Employees, (d) Equity share by Bumiputeras, (e) Equity share by other Malaysians, (f) Equity share by foreigners, (g) Business experience with PROTON, (h) Sales dependence on PROTON