The Spread of the "Japanese Type" Production System into Asia:

Evolutionary Theories and the Case of Thai Auto and Electrical Parts Industries

for the degree of Ph.D. in economics

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Abstract

In the past, technology efficiently assisted industrialised countries in their conquest of colonies. However, technology has not helped many less developed countries in their industrialisation. Although some literature contended that technology would inevitably spread to less developed countries, it has spread only partially to most less developed countries. The literature seems to have failed to present a clear picture of how a less developed country can acquire technology. Recently, East Asian economies and their peculiar nature became a focal point in Western literature. A key to understand their development path lies in Akamatsu's "flying-geese" pattern theory, which shows the mechanism of technology diffusion from more developed to less developed countries. Starting from Akamatsu's theory, this thesis argues that East Asian economies today are specifically set within a culture, where labour and management co-operate, and where large industry and small-medium industry co-operate. In this culture, technology spreads from more developed to less developed countries and facilitates faster industrialisation. Also, this thesis argues that technology is dynamic and complex. Learning technology is not an easy matter. Technology diffuses through human contact, and accumulates. Japanese expatriates try to teach technology to local workers, not to hide it as argued by the intelligentsia in ASEAN countries. This thesis measures the levels to which technology has been learnt, examining effective borrowing processes in the context of Thailand's auto parts and electrical parts industries. Thus, this thesis contributes to the study of technology transfer in the Third World countries, which has been affected so far by a narrow understanding of technology.

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Abbreviations and Glossary

Technical terms

3K: *kitsui* (exhaustive), *kiken* (dangerous) and *kitanai* (dirty), refer to disliked industries
5S: *seiri, seiton, seisou, seiketsu, shitsuke.* Five Japanese words all in a set mean to keep the factory clean and tidy, a step for *kaizen*
CAD: computer aided design
CAM: computer aided manufacturing
CNC machine: computer numeric control machine
EDM: electro discharge machining
FA: factory automation
FDI: foreign direct investment
FMC: flexible manufacturing cell
FMS: flexible manufacturing system
IC: integrated circuit
IE: industrial engineering
JIT: just in time, a Japanese production system for the synchronisation and the decrease of waste stocks
kaizen: continuous technological improvement by employees' participation in Japan
kanban: a Japanese production system to achieve the synchronisation of tasks, including suppliers
LDC: less-developed country
MC: machining centre
MD: managing director
MNCs: multinational corporations
NC machine: numeric control machine
OA: office automation
OJT: on the job training
PCB: printed circuit board
poka-yoke: fool-proof devices, aimed for ZD
QC: quality control
QCD: quality, cost and delivery time
QIB/TIB: quasi-internal borrowing/ true internal borrowing
R&D: research and development
SE/SME/ME/LE: small enterprise/ small-medium enterprise/ medium enterprise/ large enterprise
shitauke: a multi-tier Japanese subcontracting system
SI/SMI/MI/LI: small industry/ small-medium industry/ medium industry/ large industry
SMED: single minute exchange of dies
SS: suggestion system on the shop floor, a step for *kaizen*
TA: technical assistance
ten-pai-gyo: changing and abandoning of jobs, a Japanese industrial policy for restructuring
TPM: total productivity management
UPS: uninterrupted power supply
VA/VE: value analysis/ value engineering
VTR: video tape recorder
WC EDM: wire cut electro discharge machining
ZD: zero defect, a method of QC in Japan

Names of institutions

Thailand

BOI: Board of Investment
DIP: Department of Industrial Promotion
MIDI: Metalworking and Machinery Industries Development Institute
MOI: Ministry of Industry
TDRI: Thailand Development Research Institute
TPA: Technology Promotion Association

Japan

IDE: Institute of Developing Economies
JICA: Japan International Co-operation Agency
JODC: Japan Overseas Development Corporation
MITI: Ministry of International Trade and Industry
PFC: People's Finance Corporation
SBC: Small Business Corporation
SBFC: Small Business Finance Corporation
SCB: Shoko Chukin Bank
SCAP: Supreme Commander of the Allied Powers in Japan

Chapter 1: Introduction

1-1. Problems setting

In the past, technology assisted the industrialised countries in their rapid conquest and rule of colonies. Today, in contrast, technology assists the industrialisation of less developed countries. In recent years, technology has spread from Japan to Asia. Nevertheless, technology has not spread fully to less developed countries, the so-called Third World, especially those of low GNP per capita such as India, part of Latin America and most of Africa.

Although it is widely recognised that technology plays an important role in the development of economies, the way the East Asian countries have borrowed technology and are now borrowing it is not fully understood by Western economists, or indeed by the intelligentsia in developing countries. This thesis intends to shed light on the characteristic nature of borrowing technology in Japan and Thailand, with special reference to the development of the auto parts and electrical parts industries.

For a less developed country, borrowing technology begins with the importation of industrial goods. Then, the less developed country soon replaces the importation of goods with domestic production, and then export the products which the less developed country has learnt to manufacture. The replacement begins with simple technology products such as textile products, then moves to more complex technology. This whole process of technology diffusion to less developed countries was called a "wild-geese-flying" pattern by Akamatsu (1962, 17), and "flying-geese" pattern in this thesis.[1] It involves changes in the pattern of trade, changes in products and changes in the production sites from industrialised to less developed countries.

Assisted by technology carriers, a less developed country achieves industrialisation step-by-step in a flying-geese pattern characterised by co-operation between industrialised and less developed countries. Nevertheless, in Southeast Asia, it is frequently argued that Japanese firms and expatriates hide technology and do not teach it to local people. It is also argued that Japanese expatriates stay for decades and the local staff never have the chance to learn technology. Local staff with higher education prefer a Western style hierarchy and want to be promoted faster although they often do not know how to manage, nor how to manufacture. What they want is a paper contract, job descriptions and manuals. In contrast, Japanese management tends to train the people inside the firm from scratch, mainly through work experiences and learning from failure.

In the case of FDI by Japanese firms including small-medium industries, the management system is at a comparatively lower stage of development. In Japan, *small-medium industry* is defined as an industry with not more than three hundred employees and the management system is not an established hierarchical management structure of monopolistic firms of longer history as seen in the Western oil or pharmaceutical industries. In contrast, Japanese firms are investing in very competitive markets as latecomers. They are always adapting and changing their production systems in order to survive. Therefore, it is difficult for them to describe workers' tasks in clear job descriptions or manuals. If the local staff with high education insist that they need job descriptions, it means they do not understand the dynamism of today's businesses. It seems difficult to teach them about the dynamics of management and technology.

After WW2, in the 1950s and 1960s, most US investment in Thailand occurred in monopolistic markets. Then in the 1970s, it occurred in the assembling of electronics parts such as integrated circuits (ICs). In general, assembly processes are easy to teach and make profits easily. In contrast, Japanese investment in Thailand, involving the transfer of a whole engineering process, was more difficult and involved risks. Profit was not guaranteed. Nevertheless, Japanese firms are taking the risk as a "national desideratum" as will be explained (Ozawa, 1979: xx).

Because Japanese firms invest in competitive markets (Santikarn, 1981: 143-4), competition is hard and the local staff are not able to manage in the beginning. However, an enterprise needs to make a profit or at least break even. Today's manufacturing products and processes are continuously changing. It is not easy for local staff to learn this point because they are lacking experience.

It is argued in this thesis that Japanese firms are working harder than Western firms to teach more difficult jobs to local staff. Consequently, Japanese firms send more expatriates for longer periods than do Western firms.

In order to derive objective answers to the above questions on the acquisition of technology, this study will concentrate on the process of learning technology, and try to measure the "learning level (achievement level)" of Thai staff, and examine the effectiveness of technology transfer. The measuring method for the empirical survey is borrowed from the concepts of technology developed by a number of authors (Fransman, 1984: 10; Stewart, 1990: 309; Ogawa, 1990: 21-34; 1992: 21; Makido, 1990: 10) and also from recent surveys in Asia (Nikkeisangyo Shohi Kenkyusho, 1992: 10; Ajiakeizai Kenkyusho, 1992: 319-22, 345; TDRI, 1989: 3/28-3/32; Sumeth, 1992: 41-3; JICA/UNICO, 1994b: Annex I).

1-2. Basic concepts

Technology for industrial production is complex and dynamic and its meaning is broad. Basically, *technology* refers to knowledge (Freeman, 1982: 4), or sometimes a collection of *techniques*. Technology includes marketing and overall management of enterprises (Ahiakpor, 1990: 32). Also, management know-how, the higher level of organisational or management knowledge is called *technology* (Gomulka, 1990: 5). In the broadest sense, it encompasses all knowledge which contributes to production (Rosenberg, 1972: 7). Fransman describes technology as "knowledge relating to *the transformation of inputs into outputs*" (Fransman, 1986a: 7; 1984: 9). On the other hand, *technique* is the method of production and very often also refers to skill (Ahiakpor, 1990: 32).[2] *Technology* is thus complex, even confusing. It sometimes refers to a holistic body of knowledge (and methods) and, at the same time, it refers to partial knowledge (or method). Also, it is dynamic and keeps changing. In addition, if accumulated step-by-step, it develops.

The next concept concerns the *holders* or *embodiment* of technology. Technology is embodied in hardware, software, humans and organisations. Organisations include not only a firm but also an industrial sector and a country as a whole. For example, we can say that a US firm has superior technology to a Japanese firm, or the USA has superior technology to

Japan. In these cases, *technology* (of a firm or a country) means the same thing as a *system of production* (of a firm or a country). Especially when the word *technology* is combined with *borrowing* and *transfer*—such as borrowing of technology and technology transfer—*technology* means the same thing as a *system of production* of a firm or a country.

To sum up, technology is the knowledge of *production,* and technique is the method of *production.* Yet, technology normally covers both knowledge and the methods. The word technology covers both the technical aspect (product technology, process technology) and the production management aspect (quality control, production control, R&D planning) and the marketing or managerial know-how (Madu, 1992: 2; Meier, 1989: 268).[3]

A system of production is supported by technology. While Schumpeter used the term "production function", Veblen and Kuznets used the term "the system of production" (Veblen, 1939: 136; Kuznets, 1965: 83-4, 115).[4] Following them, this thesis will also use the term *system of production,* a broader concept more suitable to accommodating the concept of "a firm as an innovator" of Schumpeter or "the machine process" of Veblen (1914/1994a: 299). Kuznets argues that "one might define modern economic growth as the spread of a *system of production*, in the widest sense of the term, based upon the increased application of science, that is, an organised system of tested knowledge" (Kuznets, 1965: 83-4).

Landes uses a slightly different expression for a system of production. He says, "the heart of the 'Industrial Revolution' was an interrelated succession of technological change.... Concomitant with these changes in equipment and process went new forms of industrial organization" (Landes, 1969: 1-2). For him "the factory was more than just a larger work unit. It was a system of function, resting on a characteristic definition of the functions and responsibilities of the different participants [employer and workers] in the productive process" (Landes, 1969: 2).

As he says, the employer and the workers are the main components of a *system of functions and responsibilities.* In modern economics, a change of the production function is shown by a change in the coefficients or its mathematical form. In our understanding, a change manifests itself in the relationship between employer and workers. Theories of technical change and the "régulation" school also focus on the restructuring of the "productive system" (Freeman and Perez, 1988: 58, 65) or "productive organization" (Boyer, 1988: 70-71).

The concept of a *system of production* includes a whole set of equipment, human resources, training systems and management, which receives raw materials from outside and, by operating the system of production, processes raw materials into products. A *system of production* is equal to the "routines" of Nelson and Winter (1982: 14). A *system of production* could simply be stated as the *technology* of a firm. For Fransman:

> ... technology is defined broadly so as to encompass everything pertaining to the transforming of inputs into outputs. Technological change involves change, however minor, in the way in which inputs are transformed into outputs, including changes in the quality of the output. (Fransman, 1984: 9)

Some production technologies are simple and easy to learn, while others are complex and difficult to learn (Hufbauer, 1970: 189; Ogawa, 1986: 13). For example, the production of a handmade earthenware jar by the traditional way adopts a fairly simple technology. The people dig out clay from the earth, make the shape and then harden it by burning wood outdoors.[5] In contrast, production of automobiles or even some of auto parts needs fairly sophisticated technologies. Although the existence of sophistication in practice is apparent (Fransman, 1984: 10), measuring the degree of sophistication is not easy.

Ogawa classified the degree of sophistication into five categories—highly sophisticated, sophisticated, upper moderate, lower moderate and traditional [simple]:

> The developed countries have the broadest level of technology, ranging from highly sophisticated to sophisticated, moderate (both upper and lower), and down to traditional [simple]. The semi-developed countries lack the ability to deal with highly sophisticated technology but can manage the remaining four types. However, developing countries are not able to deal with highly sophisticated and sophisticated technologies and can only manage moderate and traditional [simple] technologies. (Ogawa, 1986: 13)

A practical way of measuring the degree of sophistication is the product's competitiveness in the market. For example, when a product can only be sold to local users in developing countries, it is not yet advanced, it is unsophisticated. On the other hand, a technology level good enough to sell to an international market competing with leading firms in industrialised countries is the most sophisticated (TDRI, 1989: (3)-31-2; Sumeth, 1992: 45).

In order to upgrade technological capability, technology has to be accumulated (Cantwell, 1989: 186; Pavitt, 1988: 130; Ogawa, 1984a: 38-41, 139-46). The greater the quantity and quality of the existing stock of capability are, the greater the increments to that stock are (Chantramonklasri, 1990: 56). The process of technological accumulation in the Third World has been analysed by a number of economists.[6] From the viewpoint of production management, Ogawa classified it into three strata. He argued that technologies are at first obtained as operational technologies. Then, improvement technologies will be obtained on the basis of the operational technologies. Further, development (creative) technologies may ultimately be obtained on the basis of the accumulated experience in operational and improvement technologies (Ogawa, 1992: 16-22; 1993a: 304-7; 1993b: 36-7).[7]

In addition, in the case of machine industries, technology basically develops in the following order (Makido, 1990: 10):

(i) assembling technology and its partial management technology,

(ii) metalworking technology and its partial management technology,

(iii) product technology and its partial management technology [product technology refers to the development of new products including designing technology],

(iv) total management technology of (i), (ii) and (iii).

Following the above order, transfer of technology will be achieved step-by-step in order to complete the whole set of technologies of (i), (ii), (iii) and (iv). However, the case of (iv) is applicable only to large industries such as car assemblers or set-makers of electrical appliances. It is not applicable to supporting industries; they are not supposed to acquire the total management technology (iv).

The above discussions can be summarised as follows. If technology is understood as a whole production system, not as a piece, technology acquisition will proceed as "an ongoing activity", not as "a once-and-for-all" event. Thus, technology will be accumulated step-by-step from unsophisticated to sophisticated, from partial technology to the whole set of technology. This thesis will focus on a *system of production* or a *production system,* where technology, or the man-machine system (Ogawa, 1976; 50; Tran, 1989: 80), becomes a focal point. Detailed definitions of a *system of production* for this thesis will be given in Chapter 6.

Based on the above concepts of technology and also on past surveys, the following chapters intend to clarify the concept of technology transfer and technological accumulation, and develop a measurement methodology in the context of Thai auto parts and electrical parts industries. Although the survey was restricted to Thailand, this thesis intends to show that technology develops hand in hand with culture. In that sense, this thesis also aims at helping the understanding of technology transfer in general, both in the Third World and industrialised countries.

Part I: Literature Survey

Chapter 2:
Theories on Borrowing and Technological Development: Historical views and Evolutionary Thinking

Introduction

As the understanding of technology is complex, this chapter intends to review the literature on borrowing and technological development. Firstly, the role of technology in the history of European industrialisation will be reviewed. History seems to tell us that technology was borrowed through direct human contact. As a result, it brought in not only technical change, but also changes in culture and institutional frameworks, i.e. in Veblen's words, a hybrid society was created. Secondly, theories on technological development will be surveyed. Those selected are the theory of technical change, the theory of appropriate technology, concepts of indigenous technology and post-Fordism. The theory of technical change, which treats technology as an endogenous factor, proposes that technology has to be brought into the centre of economic analysis. The focal point is the dynamism of production technology, which was presented as "innovation" by Schumpeter, "routines" by Nelson and Winter, and a "techno-economic paradigm" by Freeman and Perez. Indigenous technology has been another focal point among the Third World countries as they wanted to control everything foreign after their independence from colonisation. Post-Fordism is a recent topic in industrialised countries where workers dislike repetitive labour. In the West, Japan's factory automation under workers' leadership is considered a solution, though the dream is not easy to achieve.

2-1. Historical views on borrowing

The two phrases, borrowing of technology and international technology transfer, completely overlap; the difference lies in the viewpoints and the nuance. "Borrowing" seems to have the nuance of inequality, from more developed to less developed, while "transfer" suggests that it occurs between equal partners "all at once" (Rosenberg, 1982: 272). It is misleading if the phrase technology transfer had given the impression that technology would be automatically obtained like a commodity once the supplier had an intention to transfer. The recipient remains rather passive in the latter case. This attitude retards the practice of borrowing. The following sections will show that many economists doubt this point. The theory of borrowing is attributed to Veblen, Gerschenkron and Landes (Amsden, 1989: 5, 13, 21; Gomulka, 1990: 159).

2-1-1. Lessons from Europe

Thorstein Veblen, the founder of institutional economics, was considered an evolutionary economist (Griffin, 1992: 299), likened to Marx (Hunt, 1992: 123) and contrasted with Schumpeter (O'Donnell, 1992: 25-7). Two aspects, pointed out by Veblen were (1) *hybrid of populations* and (2) *borrowing of technology and culture*. Veblen first described how the European peoples were formed through a long history of interaction (Veblen, 1939). He distinguishes *nations* or *peoples* from *races*. He says:

> Like the populations of the neighboring countries, the German population, too, is thoroughly and universally hybrid; and the hybrid character is perhaps more compounded out of the same racial elements that enter into the composition of the European population at large. (Veblen, 1939: 7; 1994a: 15)

Thus, defining the boundary of Germany, he extends his analysis to the *borrowing* in his word, or the international technology transfer, in today's words. As is true in the case of England, Imperial Germany [Prussia] did not start borrowing abruptly at any specific date. It is obvious though that it began with the era of Napoleon (Veblen, 1939: 150).

For Veblen, borrowing is a holistic concept comprising borrowing-of-technology and borrowing-of-culture that usually occurs successfully when they proceed hand in hand. Technology and culture, thus interacting each other (Veblen, 1915/1994b: 255-8; Herbig and Palumbo, 1994: 145), and crossing over countries, will shape a new category of borrower through the process of borrowing, assimilation and combining. In the borrowing process, the borrower did not simply replace the existing elements with the borrowed, rather assimilated the borrowed ones and combined them with the existing ones (Veblen, 1939: 22). Furthermore, what he has found is that very often technology of "the borrower people" surpass that of their "originators". In other words, technological innovations and institutional arrangements, in many cases, achieve their maximum serviceability at the hands of the borrower nation. "Why are borrowed elements of culture more efficiently employed than home-grown innovations? or more so than the same elements at the hands of their originators?" (Veblen, 1939: 24) His own answer is:

> It would of course be quite bootless [useless] to claim that such is always or necessarily the case, but it is likewise not to be denied that, as **a matter of history**, technological innovations and creations of an institutional nature have in many cases reached their fullest serviceability only at the hands of other communities and other peoples than those to whom these cultural elements owed their origin and initial success. (Veblen, 1939: 24, emphasis added)

In the case of Britain, borrowing and assimilation started around Tudor times up to the Elizabethan era (Veblen, 1939: 93). The British did not take all available technologies and institutions. Limitations such as European handicraft systems or the petty trade system were not borrowed. The British, thus freed from limitations in the origin countries, proceeded into the industrial revolution gradually. In contrast to the British case of autonomous development, the German case is typified by heavy government intervention; they used a prohibitively high protective-tariff, constructed railways and built ships, in large part for the purpose of wars (Veblen, 1939: 179).

Borrowing, however, has never been easy. Borrowed technology and culture can bring about a "derangement" of traditional value systems and "discrepancy" between old and new. The borrowed elements conflict with the existing cultural values and interests. They will be brought in:

> ... only at the cost of some, more or less serious, derangement of the accustomed scheme of life and the accepted system of knowledge and belief.
>
> They are vehicles of cultural discrepancy, conduce to a bias of scepticism, and act, in their degree, to loosen the bonds of authenticity. Incidentally, the shift involved in such a move will have its distasteful side and carry its burden of disturbance and discomfort; but the new elements, it is presumed, will make their way, and the borrowing community will make its peace

> with them on such terms as may be had; that assumption being included in the premises. (Veblen, 1939: 39)

Borrowing is thus the process which leads to assimilation and creation, that is a matter of history. It is "a matter of history", in the sense that it is a hope for "the fullness of life", not in the sense that it is deterministic in the way Stalin described (Hunt, 1979/1992: 121).

David Landes has proposed a historical law of borrowing in the industrialisation of Europe (Landes, 1969). In western Europe, the learning process preceded the borrowing. Among the European governments and business societies, from 1750s to 1770s, study tours to Britain had become popular (Landes, 1969: Chapter 3). Nevertheless, at the early stage of the industrialisation many obstacles retarded its advancement in Europe. Decades had to be spent overcoming the social, cultural and economic handicaps that existed. As a result, it was not until around the time of Paris Peace Talks (1814-5) that industrialisation began in France. German industrialisation occurred decades later. However, when the time had come for reaping the benefits of borrowing, "Their very lateness now turned to their advantage" (Landes, 1969: 229-30).

For him, firstly, technology is the key point of industrialisation. In his words, "the heart of the Industrial Revolution was an interrelated succession of technological change" (Landes, 1969: 1), which brought in a "new system of production". A new system of production is constituted by labour and management. Landes observes the feature of labour in the economic relationship—the "wage nexus"—and the feature of management in "supervision and discipline". Here, a new breed of worker was "broken to the inexorable demands of the clock" (Landes, 1969: 2). Secondly, Landes observes technological change within a larger, more complex process of modernisation. In other words, he understood that technical change will occur only within a modernisation framework, which includes, "urbanization, a sharp reduction in both death rates and birth rates, ... the establishment of an effective, fairly centralized bureaucratic government, the creation of an educational system, ... the acquisition of the ability and means to use an up-to-date technology" (Landes, 1969: 6). Thirdly, he mentions the indispensability of technological maturity. It is necessary that technological maturity and industrialisation go together, "otherwise one has the trappings without the substance, the pretence without the reality" (Landes, 1969: 7). He says, "the West has provided them with some education—enough to know their dependence and to dream of freedom, but not enough to create and operate a modern economy", probably comparing India with Japan (Landes, 1969: 11-12, 39).

Two more lessons deserve notice. Firstly, the importance of step-by-step technology. Landes asserts that Central Europe had developed during 1800-1850 on obsolete equipment. Even during 1850-1900, labour-intensive production and obsolescence prevailed. Heavy industry in underdeveloped countries tends to be well below theoretical capacity. These countries lack a machine industry to maintain and modify the equipment (Landes, 1969: 543-4). Secondly, Landes emphasises the importance of technology carriers. He reports that by 1825 two thousand skilled British workers had come to Continental Europe despite Britain's prohibition on the emigration of British artisans until 1825, to preserve the technological edge of Britain. In addition, European governments and business societies invited numbers of technicians and entrepreneurs from Britain to learn technology. They later became leading businessmen in their host countries around 1850 (Landes, 1969: 148-9). Landes says:

> ... many placed a high premium on leisure—the more so since they were generally homesick, unhappy, and prone to drown their sorrows in alcohol. They had a keen sense of their indispensability, and this combined with national pride to make them arrogant and fractious. (Landes, 1969: 149)

At the end, "perhaps the greatest contribution of these immigrants was not what they did but what they taught. Employers or employees, they trained a generation of skilled workers, many of whom became entrepreneurs in their own right" (Landes, 1969: 150). Thus, the technological independence of European people was achieved "largely from man-to-man transmission of skills on the job" (Landes, 1969: 150). Although it is a story of the nineteenth century, the observation looks fresh and applicable to today's developing countries as will be discussed in Part II of this thesis.

2-1-2. Catching-up technology

For Alexander Gerschenkron, industrialisation in "backward" [less developed] countries was understood to occur (i) discontinuously as a sudden great spurt, (ii) under different industrial structures and different institutional instruments (iii) with different nationalistic spirit or ideology (Gerschenkron, 1962: 7; Oman and Wignaraja, 1991: 11). Strong government interventions and high growth rates are necessary for the backward countries' industrialisation. In his well-known words, "Industrialization always seemed the more promising the greater the backlog of technological innovations which the backward country could take over from the more advanced country" (Gerschenkron 1962: 8). Because the gap between industrialised and backward countries is so large, industrialisation has to be achieved by the emphasis on heavy industry with a sacrifice of consumer goods. He says,

> their efforts on introduction of the most modern and expensive technology, their emphasis on large-scale plant, and their interest in developing investment-goods industries need not necessarily be regarded as flowing mainly from a quest for prestige and from economic megalomania. (Gerschenkron, 1962: 26)

This point was questioned by Landes (1962: 548). Investment in heavy industry needs maintenance capability (Landes, 1969: 549-50). Pride and hope alone will not suffice. "Preference for industry rather than agriculture, for heavy rather than light industry, for monuments rather than utilitarian investments"—often the price for such a bias will "far surpass the compensating gain of stimulation received" (Landes, 1969: 550). It is truly regrettable that Gerschenkron missed a critical point which Veblen and Landes emphasised. He ignored the borrowing process by direct human contact between teachers and learners. The import of machines alone will not suffice.

Alice Amsden examined technology borrowing in Korea's post-war industrialisation (Amsden, 1989: 3). She emphasised the role of the government, as did Gerschenkron. However, for her, government interventions did not mean "over" protection. In the case of Korea, intervention was accompanied by discipline. Discipline imposed by government bureaucrats functioned well to achieve efficiency, which was different from some other countries (Fine, 1993: 114). She therefore did not agree with the "conventional" economic thinking of the market mechanism. Promotion of the steel industry in the early 1970s was a typical example of state intervention, towards which the World Bank was hostile (Amsden, 1989: 291).

The second point she emphasised is the investment in education and the role of foreign technical assistance. Korean educational indicators scored the highest among developing countries even higher than Singapore in 1978 (Amsden, 1989: 218). The Korean shipbuilding is a case in point. In order to ensue long term development of the shipbuilding, the government established departments of naval architecture at universities as early as 1946 (Seoul), 1950 (Pusan) and 1954 (Inhas). Graduates of these departments became engineers in the Korean shipbuilding industry. Examples of foreign technical assistance given by Amsden were a retired engineer from Mitsubishi at Hyundai Motors, a university professor in a shipyard and so on. The technology conveyed by them was advanced and state-of-the-art. "Access to such technical assistance placed Korea in an enviable position. Other late-industrializing countries further afield from Japan culturally and geographically have lacked such a resource to draw on" (Amsden, 1989: 234-5).

Amsden's case studies of three industrial sectors presented a clear picture of this point. In the case of the textile industry, two firms, both established during the colonial period—one a Kanebo subsidiary, the other a Toyo subsidiary—had been in the hands of the government when Japan left the country. The Korean government then entrusted or sold the plants to the present owners, trusting their experience obtained at Japanese plants in Manchuria and Korea. This shows that Korea utilised the technology which was obtained during the colonial period. The post-war development of the textile industry also involved borrowing from abroad, particularly from Japan.

The shipbuilding and the steel industry borrowed technology from Japan. After WW2, the government obtained and operated Korea Shipbuilding and Engineering Corporation (KSEC), then the largest shipyard in Korea, which had been founded by the Mitsubishi group in 1937. Added to KSEC was Hyundai Heavy Industry (HHI), which commenced shipbuilding in 1973 when HHI was separated from Hyundai Construction Company. In the case of the steel industry, the government established a state-run steel mill, Pohang Iron and Steel Company (POSCO) in 1968. These two industries borrowed technology from Japan. For example, HHI received technical assistance from Kawasaki Shipbuilding of Japan, and POSCO from Nippon Steel Corporation. POSCO was started firstly on a turnkey basis and actively borrowed not only equipment and process technology but also organisational structure and management systems from Nippon Steel Corporation (Amsden, 1989: 295).

Although Amsden emphasised government interventions and catching-up technology as did Gershenkron, she lucidly presented how Korea borrowed technology from Japan through human contact. She emphasised the importance of foreign technical assistance, not "nativeness" alone. Although Amsden does not explicitly refer to the borrowing of production management from Japan, her reference to QC circles, preventive maintenance of equipment (TPM) and zero defect (ZD) suggests that Korean firms have borrowed not only product technology but also production management from Japan.

Korea was colonised by Japan from 1910 to 1945 and Taiwan from 1895 to 1945. Since the colonial relationship is "one of the most sensitive and potentially explosive issues", it is clear that consensus on this issue is impossible (Landes, 1969: 35). Nevertheless, it is argued that Japan's colonisation advanced the industrialisation of these countries (Kim, 1988: 117-32; Ryu, 1975). The rapid post-war industrial development of Korea and Taiwan was based, at least partially, on technology and institutional frameworks introduced by Japan during the colonial period (Hart-Landsberg, 1993; 106-9, 139-40; Kohl, 1994; Leys, 1984: 181; Kuznets, 1994: 18; Song, 1990: 42). Being located in the best position to learn (Wade and Kim, 1977: 8; Song, 1990: 42), Korea did not hesitate to borrow from Japan (Kuznets, 1994: 12). The most important thing is the capacity, the will and efforts, to absorb technology. "Technologies can be transferred through imported machinery and workers' experience in **foreign-owned firms**. The availability of technology is not as critical a constraint to economic development as the capacity to absorb and utilize it effectively" (Kim and Lee, 1990: 95, emphasis added).

2-1-3. Catching-up in the Third World

Nathan Rosenberg believes that nothing can stop the spread of industrial technology. For him, it is apparent and inevitable that technology would spread as long as it exists:

> ... there was never any doubt that such new technologies would spread and be adopted elsewhere when the circumstances and surrounding conditions permitted (or were created).
> ... One central conclusion that may be drawn from this account is that the transfer of industrial technology to less developed countries is inevitable. (Rosenberg, 1982: 270)

At present, "improved techniques of communication and transportation" have enabled the acceleration of the diffusion of industrial technologies "from the center to the periphery". This tendency is powerfully assisted by foreign direct investments and licensing activities of the multinational firms (Rosenberg, 1982: 276). However, Rosenberg does not imply that technology transfer is an easy matter. On the contrary, it is difficult to understand and hold technology as a whole because technology transfer is not only the purchase of machines or manuals but also it depends on human skills, cultural and institutional infrastructure of the recipient nation (Pavitt, 1988: 130). "What matters is the institutional system" (Rosenberg and Birdzell, 1986: 145). The capacity to absorb technology is indispensable. Rosenberg argues:

> Typically, high levels of skill and technical competence are needed in the recipient country. ... Furthermore, technologies are more than bits of disembodied hardware. They function with societies where their usefulness is dependent upon managerial skills, upon organisational structures, and upon the operation of incentive systems (Rosenberg, 1982: 247-8).
> ... the transfer of technology must not be conceived of as a once-and-for-all affair. It is not something that happens at a single point in time. It is, rather, an **ongoing activity**. (Rosenberg, 1982: 272, emphasis added)

Last, but not least, to be noted is that developed technology could assist rapid technology diffusion but it could also harm the Third World countries. Rosenberg says, "the coin has two sides. ... Sophisticated, dynamic technology in the possession of such [advanced industrial] societies will generate innovations with very deleterious consequences to the less developed countries" (Rosenberg, 1982: 247). "Western imperialism and colonial capitalism retarded India's development" (Nafziger, 1995: 66). In the middle of the 19th century, new technology, e.g. iron-hulled steamships and machine guns, enabled the swift, thorough and cheap conquest of most colonies such as India. At the same time, new technology brought in the expansion of exports of tropical goods and imports of manufactured goods to colonies. Furthermore, new technology ruined local industries (Headrick, 1988: 3-9).

Technical change at first created large markets for primary products such as cotton, wool, rubber, vegetable oil and so on. However, in the 20th century, synthetic products substituted many of these primary products. The implication of this technical change was serious to the Third World countries without technology because these countries had been heavily dependent upon the export of primary products (Rosenberg, 1982: 247).

Studies on technology transfer were initiated in 1961 by a UN resolution proposed jointly by Brazil and Columbia (Komoda, 1986: 405-419). It should be remembered, however, that "the transfer of technology from one place to another is not just a recent phenomenon but existed throughout recorded history" (Rosenberg, 1982: 245). Since the 1960s the term *international technology transfer* has become popular instead of the term *borrowing of technology* from the political perspective. Not only the literature on technology transfer but also much of the present literature on multinational corporations (MNCs) and foreign direct investment (FDI) in fact discusses international technology transfer. In a sense, therefore, it can be said that the topics of MNCs and FDI in many cases analyse international technology transfer also (Ahiakpor, 1990: 13-5; Cantwell, 1991: 18). Therefore, these topics should be treated together. For example, a series of meetings were held under the auspices of the UN in 1969, and discussed problems relating to "the role of foreign direct investment and technology transfer from multinational corporations located in developed nations" (Driscoll and Wallender, 1974: 1). Here, the three topics, FDI, technology transfer and MNCs, were grouped together under one theme, which is quite usual.

In the 1960s and '70s, from the structuralist's viewpoint, considerable debate on MNCs and FDI emerged (Oman and Wignaraja, 1991: 26; Fikentscher, 1980). The first conference of UNCTAD was held in Geneva in 1964 and the second in New Delhi in 1968. The problem of international technology transfer was included on the agenda and the conference concluded with recommendations, which were later implemented by some developing countries. India particularly introduced very strict control on technology imports in 1968-9 (Yamazaki, 1990: 236-7). The conference's reports not only expressed the Third World thinking on technology transfer at the time, but also had significant influence upon the Third World thinking on technology transfer thereafter. The final report of the second conference in 1968 recommended:

> 1. Developing countries should: a) facilitate the transfer of patented and un-patented technology to developing countries on reasonable terms, b) not impose restrictions on the use of transferred technology that would curtail developing country exports or otherwise retard development of host country industry.
> 2. The UN specialized agencies should: a) help in setting up transfer centers, b) draw up model transfer agreements, c) help developing countries to acquire the latest technology.
> 3. Developing countries should: a) set up regional centers designed to facilitate the optimum use of technology, b) purchase technology outright so as to ensure its availability to their own enterprises, c) increase capacity of domestic scientists and technicians to absorb technology and modify it to suit indigenous conditions, d) exchange information on transfers with other developing countries. (Driscoll and Wallender, 1974: 23-24)

The report adopts the notion that technology is a type of commodity which is transferable, and that developing countries should be allowed to purchase and use it more easily. But technology is not only a commodity to purchase and use. Rather it should be understood as a *system of production* which needs to survive competition in today's economic system. Even though transplanted from an industrialised country, a system of production can not survive if the foreign investor has to bear heavy burdens. Investors may leave the country (Vernon, 1981: 54-5), and if they leave, the borrower country will lose its teachers to learn technology, which is expected to be the "key" to the progress of mankind (Fikentscher, 1980: 39; Casson, 1979: 103). Finally, it may adversely affect the economic growth at which UNCTAD aims (Vernon, 1977: 215-6; Marton, 1986: 293-4).

2-2. Theories on technological development

2-2-1. Evolutionary theory of technical change

This section intends to survey the literature on technical change. When technology is borrowed, technical change will occur. The main focus will be on the "firm's production system". Therefore, it is useful to outline the theories of "firm" and "production function" at the beginning. Here the "firm" includes the "multinational corporation".[8]

It is argued that neo-classical economics supposes that every firm behaves as a profit maximiser under the price mechanism of equilibrium (Nelson and Winter, 1982: 12-3). Coase contended that the price mechanism does not fit within a "firm" and focused on the role of an entrepreneur or a co-ordinating organisation (Coase, 1937: 387-9). But, he finally explained the choice of products and the size of the firm by the price mechanism (Coase, 1937: 402-3). As a result, for him, "[m]anagement proper merely reacts to price changes, rearranging the factors of production under its control" (Coase, 1937: 405), which is called "transaction cost (internalisation) theory". Williamson replaced "the concept of firm as production function" with "the concept of firm as governance structure" and, comparing US firms to Japanese firms, suggested an advantage of Japanese firms from the viewpoint of "transaction costs economizing" (Williamson, 1985: 123). Buckley and Casson also pointed out the American inefficient "low levels of trust" (Buckley and Casson, 1992: 36). The point is that transaction cost theory alone does not satisfactorily explain firms' behaviour (Williamson, 1986: 130; Casson, 1987: 31-2; Cantwell, 1989: 215-6). Schumpeter developed the theory of innovation with an emphasis on the role of risk taking entrepreneurs and enterprises (Schumpeter, 1939: 102-3). But, his positive views on the emergence of large firms in capitalism (1942: 96) were in contrast to the negative views of Veblen (O'Donnell, 1992: 26-7). Penrose defined the firm as a dynamic administrative organisation (1959/1972: 15). Chandler also focused on managerial organisations and characterised large US firms as managerial hierarchies. His contribution was that he distinguished difference between characteristics of US, British and German firms from the viewpoint of management organisation (Chandler, 1990).[9] The major characteristic of the above theories is that they all emphasised the role of managerial systems. On the contrary, Veblen, Landes and Rosenberg, as did Marx, all focused on the shop floor from the viewpoint of production process and technology. This thesis will also focus on the shop floor depending on Ogawa, Shingo and Suzuki as will be explained in Chapter 3.

Modern neo-classical economics basically neglects production (Nelson, 1981: 1031) and concentrates on utility. Thus, the production function is a mere copy of utility function

(Nishimura, 1986: 117-8). It principally neglects the importance of production (Roll, 1956: 368). The production function generally denotes $Q = F(x, y, ...)$, where Q *is* output (products) and $x, y, ...$ are inputs (production factors), normally capital and labour, and technology is not included. Here, a firm level, a sector level and a national level function take the same form by way of aggregation (Layard and Walters, 1987: 289). The production function regards capital and labour as factors, but only in terms of amount, not as a lively organisation or as a firm (Penrose, 1972: 12) or as a *system of production* in the sense that new forms of industrial organisation are generated by innovation (Nelson, 1981: 1038-40). Schumpeter could not reduce production function to a measurable quantitative relationship between input and output. Ruttan explains, "Schumpeter explicitly rejected the possibility of measuring the effect of innovation through changes in the production function. He argued that price changes and non-neutrality of innovation would effectively limit the possibilities of measurement" (Ruttan, 1971: 75). Finally, Schumpeter abandoned the construction of mathematical forms of production function (Heertje, 1977: 132-3). This meant that Schumpeter needed a new framework, other than production function, to place a *firm* as an innovator at the core of the model.

Schumpeter broke the price mechanism mould of modern economics. He set up a new economics of evolutionary thinking, a challenge to the orthodoxy. Schumpeter did not explain why a firm exists. For him, "like human beings", firms are born and die naturally and constantly (1939: 94-5). Firms are the blood of capitalism. "The fundamental impulse that sets and keeps the capitalist engine in motion comes from the new consumers' goods, the new methods of production or transportation, the new markets, the new forms of industrial organisation that capitalist enterprise creates" (Schumpeter, 1942: 82-3, quoted by Heertje, 1988: 79).

Here, firms (enterprises) are defined as innovators (creators of new goods and so on). For Schumpeter, capitalism cannot be explained without firms and their innovation, whereas, in orthodox economics, economic activity is completely explained by profit maximisation (Rosenberg, 1994a: 160). In orthodox production functions such as Cobb-Douglas function or Solow's model (Solow, 1971), capital and labour will suffice. For Schumpeter, firms challenge and innovate. "The firm" is the core. The concept of innovation was thus brought in and "technical change" was placed "at the heart of his system" where the entrepreneurs (firms) play a key role in the creative destruction of the economy (Nelson and Winter, 1982: 39; Heertje, 1988: 71; Freeman, 1988: 5). "Men of action", or "creative individuals", bring about a fundamental and discontinuous endogenous change in the economy (Heertje, 1988: 73) and "innovation continually upsets equilibrium" (Nelson and Winter, 1982: 41). Here, "innovation is an endogenous phenomenon because it is entirely a matter of business behaviour" (Heertje, 1988: 76).

Then, what is "innovation" for Schumpeter? Schumpeter presented five cases of innovation as Nelson and Winter summarised:

> (1) the introduction of a new product [product technology]
> (2) the introduction of a new method of production [process technology]
> (3) the opening of a new market
> (4) the opening of a new source of supply
> (5) the carrying out of the new organization of any industry, like the creation of a monopoly position. (Nelson and Winter, 1982: 277)

Using the concept of the firm as an innovator, Schumpeter further explains the cycle of inventions, innovations and diffusions. Innovations occur in clusters and create a business cycle (1939: 134-5). Freeman emphasises this point. "For Schumpeter, as for us, technical innovation is not a separate phenomenon, but is on the contrary a crucial factor in the explanation of business cycles and the dynamics of economic growth generally" (Freeman, 1988: 1). Schumpeter described the cycle of innovation as follows:

> The new processes do not, and generally cannot, evolve out of the old firms, but place themselves side by side with them and attack them. Furthermore, for a firm of comparatively small size, which is no power on the money market and cannot afford scientific departments or experimental production and so on, innovation in commercial or technical practice is an extremely risky and difficult thing. (Schumpeter, 1928, printed in Rosenberg, 1971: 40)

Then, innovation spreads in leaps and bounds, and ends in catastrophes.

> But as soon as the success is before every one's eyes, everything is made very much easier by this very fact. It can now, with much-diminished difficulty, be copied, even improved upon, and a whole crowd invariably does copy it—which accounts for the leaps and bounds of progress as

> well as for setbacks, carrying in their wake not only the primary disturbance, inherent to the process, but a whole string of secondary ones and possibilities although no more than possibilities, of recurrent catastrophes or crises. (Schumpeter, 1928, printed in Rosenberg, 1971: 40)

Heertje points out some weaknesses in Schumpeter's theory if it were to be applied to a present day economy. First, the agent of innovation is not clearly defined. According to Heertje, the agent of innovation in Schumpeter shifted from an individual (in 1912) to a new firm (in 1926) and then to an existing firm. In 1939, Schumpeter explained innovation by the creation of a new production function. Later he discussed shifts in production functions. This presumed that innovation would be achieved by an existing firm, not by a new firm. Heertje argues that Schumpeter's concept of production function seems to cover both technical aspects (process innovation and product innovation) and management aspects. But Heertje thinks that the concept of production function is not supposed to include management aspects (Heertje, 1988: 83). Thirdly, Schumpeter did not consider incremental improvement. "The continuous stream of minor improvements in equipment and products, sometimes called continuous technical development is lacking" (Heertje, 1988: 87). Although Heertje's critique is accepted, Schumpeter's contribution cannot be dismissed. Nelson and Winter and other followers refined and developed Schumpeter's revolutionary economics as follows.

Nelson and Winter, reviewing the *orthodox* theory, proposed instead an *evolutionary* theory. They pronounced, "What we offer in this book is, we believe, a plausible promise that fundamental reconstruction along the lines we advocate would set the stage for a major advance in understanding of economic change" (Nelson and Winter, 1982: 5-6). First, they summarise orthodoxy: "In orthodox theory, firms are viewed as operating according to a set of decision rules" or the rules of maximising behaviour. "A maximization model of firm behavior usually contains three separable components". First, firms seek profit; second, firms have the properties of "production set"; third, firms' actions bring the result aimed by the firms (Nelson and Winter, 1982: 12). In addition, the above decision rules are executed under the concept of equilibrium (Nelson and Winter, 1982: 13).

When Nelson and Winter discuss the evolutionary model, they "dispense with all three components of the maximization model" (Nelson and Winter, 1982: 14). Instead, they bring in the term "routines"[10] to explain the pattern of the firm's behaviour. The term routine covers:

> from ... technical routines for producing things, through procedures for hiring and firing, ordering new inventory, or stepping up production of items in high demand, to policies regarding investment, research and development, or advertising, and business strategies about product diversification and overseas investment. (Nelson and Winter, 1982: 14)

In their evolutionary theory, "these routines play the role that genes play in biological evolutionary theory" (Nelson and Winter, 1982: 14). Then, they classify "routines" into three categories for convenience: (1) Routines of *operating characteristics* in the short run, which are done at any time, given its prevailing stock of plant, equipment, and other factors of production that are not readily augmented in the short run. (2) Routines concerning the *investment decision*, which determine the period-by-period augmentation or diminution of the firm's capital stock (those factors of production that are fixed in the short run). (3) Routines *to modify over time* various aspects of their operating characteristics (Nelson and Winter, 1982: 16-8). By the introduction of "routines" they further formulate models which demonstrate the selection mechanism of firms in which "profitable firms will grow and unprofitable ones will contract, and the operating characteristics of the more profitable firms therefore will account for a growing share of the industry's activity" (Nelson and Winter, 1982: 17).

Nelson and Winter suggest to us that a firm has the function of memory. In other words, a firm remembers the routines just as a person learns skills and accumulates knowledge. The memory of a firm is the technical and technological capability of the firm. Manuals cannot replace the memory of a firm (a routine), nor skills of a man. Nelson and Winter explain this as follows:

> The idea that organizations *remember* a routine largely exercising it is much like the idea that an individual remembers skills by exercising them. The point that remembering is achieved largely through exercise, and could not be assured totally through written records or other formal filing devices, does not deny that firms keep formal memories and that these formal memories play an important role. But there must be much more to organizational memory than formal records. (Nelson and Winter, 1982: 99)

It is obvious that innovation involves change in routine (Nelson and Winter, 1982: 128). What follows is an example of an innovation originated from routines:

> Consider the foreman of a work team responsible for a particular operation (set of routines) who observes that a machine is not working properly. He routinely calls in to the maintenance department, which in turn routinely sends out a machine repairman. The machine repairman has been trained to diagnose in a particular way the troubles that such a machine might have. He goes down a list of possible problems systematically, and finds one that fits the symptoms. He fixes the part so that the machine again may play its role in the overall work routine. He may also, however, report to the foreman that this particular kind of trouble has become very common since the supplier started using aluminium in making the part in question and that perhaps the machine should be operated in a different manner to avoid the difficulty. (Nelson and Winter, 1982: 129)

In conclusion, it is evident that *routines* of a firm are equal to the concept of *technology* or a *system of production* of a firm.

Nelson and Winter elaborated the concept of "routine." For them, a firm is the core of economic activity. Freeman and Perez interpreted the concept of innovation in a wider context and extended it to the idea of "techno-economic paradigm" which is supposed to lead to Schumpeter's long cycles and "creative gales of destruction" (Freeman and Perez, 1988: 47). In other words, they are more interested in macroeconomic and historical aspects of Schumpeter's innovation. In the introductory part of *Technical Change and Economic Theory,* Freeman stated:

> This book is an exploration of a new approach to economic theory, capable of incorporating technical and institutional change into the mainstream of economic analysis and policy-making, rather than treating it as part of the rag-bag of 'residual' or 'exogenous' factors. This leads us not just to a critique of mainstream economic theory, but also to an attempt at an alternative formulation of some of the main issues. It is not more than a first attempt but the somewhat ambitious aim is to analyse in depth **the role of technological change** in relation to microeconomic behaviour, adjustment processes and macroeconomic patterns of transformation of the economic system. (Freeman, 1988: 1-2, emphasis added)

And then, to sum up his critique of the neo-classical approach, Freeman quotes from Nelson:

> It is reminiscent of the story told by Nelson [1981: 1059] of the drunkard who looked for his key under the street lamp because it was the only clear spot although he knew he had lost it somewhere else. Despite its logical elegance and the extreme sophistication of many contemporary developments, its failure to address some of the crucial problems of technical and institutional change and its lack of historical perspective weaken its claims to represent a satisfactory theory of economic growth. (Freeman, 1988: 5)

As well as Schumpeter and Nelson and Winter, Freeman and Perez attribute a very central place to innovation. Freeman and Perez categorised the concept of innovation into four groups according to the scale of impact and the range of spread, from the minor one of the firm level to a massive one of the national or international scale as below:

(i) *Incremental innovations*: They may often occur as the result of learning-by-doing and learning-by-using. The scaling-up of plant and equipment or quality improvements to products and services are included.

(ii) *Radical innovations*: Such as from rayon to nylon. They are normally the results of R&D in enterprises and/or in universities and government laboratories.

(iii) *Changes of technology system*: Such as occurred in synthetic materials, petro-chemicals, injection moulding and extrusion. The changes occur in clusters.

(iv) *Changes in techno-economic paradigm* (or technological revolutions): The changes that are so far-reaching as to influence the behaviour of the entire economy (Freeman and Perez, 1988: 45-7).

The fourth category, (iv) "techno-economic paradigm" is much wider than (iii) "technology systems". The former refers to "a combination of interrelated product and process, technical, organisational and managerial innovations, embodying a quantum jump in potential productivity for all or most of the economy and opening up an unusually wide range of investment and profit opportunities" (Freeman and Perez, 1988: 47). According to Freeman and Perez, we are now in the "information technology paradigm" supported by low-cost chips in the fifth Kondratiev wave. The third Kondratiev wave was supported by low-cost steel and the fourth Kondratiev by low-cost oil (Freeman and Perez, 1988: 48-9). The emergence of a new "techno-economic paradigm" goes far beyond technical change. It brings in a restructuring of the whole productive system (Freeman and Perez, 1988: 58). It not only leads to the emergence of a new range of products, services, systems and industries in its own right; but also affects directly or indirectly almost every other branch of the economy. From this viewpoint Schumpeter's long cycles and "creative gales of destruction" are a succession of "techno-economic paradigm" associated with the institutional framework.

2-2-2. Appropriate Technology

As we have already seen in the preceding sections, borrowed technology will bring in technical change into the system of production. Then, what type of technology should be brought in? An answer to this question is the so-called appropriate technology (AT).

In the 1950s and '60s, large-scale projects of modern high technology rather than small-scale industry received more interest from policy makers. However, these large projects, both of MNCs' FDI and uni-national corporation's investment (Ahiakpor, 1990: 10) were criticised because they had been unable to help the poor and had not even created many jobs in the modern sector. Hence, a strong cause emerged for small-scale industry promotion (Vepa, 1971: 4-8; Schumacher, 1973). This was the origin of AT theory, advocated by Vepa and Schumacher. Vepa proposed appropriate technology (AT) for the poor people quoting Japan's small-medium industry (SMI) policy (Vepa, 1971: 6). His main concern lies in mass participation with a limited volume of capital available. Vepa's thinking is obviously influenced by Gandhi's ideas. According to Vepa, Gandhi, contending that "machines [are] made for men, and not men for machines", proposed hand-spun and hand-woven *Khadi* for poor people (Vepa, 1971: 9, 16). Schumacher also expressed sympathy for the poor, saying that "the poor are getting poorer while the rich are getting richer" (Schumacher, 1973: 159). Although Schumacher admitted the importance of large-scale projects, he at the same time, quoting the success of the small-scale labour-using system of Japan, proposed intermediate technology (IT) which would bridge the gap with modern high technology in the long run (Schumacher, 1973: 163, 167).

The AT concept was first materialised as the Intermediate Technology Development Group (Smillie, 1991: 82) in 1964 in London, and has spread world-wide.[11] According to Kaplinsky, from the early 1980s, the OECD Development Centre identified 277 of the most active AT institutions (Kaplinsky, 1990: 16). However, most of the AT projects were reported as failures (Marshall, 1983; Stewart, 1987; Stewart and Ranis, 1990: 3-42; Kaplinsky, 1990). For example, the Ambar Charkha project of the hand-spinning-wheel, a national project in the Indian Five Year Plans, was also reported as a typical failure of AT projects (Sen, 1975: 106-110).

Admitting the failures of AT in the past, Stewart *et al* (1990: vii) proposed "a more systematic approach", i.e. policies supported by, and consistent with, macroeconomic policies. They admit that:

> experience indicated that the characteristics of appropriate technology are not the same for all cases and may change over time; moreover appropriate technologies are not necessarily small-scale or labour-intensive. To determine if a technology is appropriate, the question—appropriate to what conditions—must first be answered. (Stewart and Ranis, 1990: 39)

In spite of the past failures, Kaplinsky still believes in AT. One of his reasons for supporting AT is the success of Japan and NICs. For Kaplinsky, the tradition of small-scale production and the success of economic growth in these economies seem to prove the relevance of AT (Kaplinsky, 1990: 3). Kaplinsky thus advises developing countries to emulate Japanese production systems (Kaplinsky, 1994a, 1994b).

Despite much effort, the promotion of the small-scale industry has not improved the life of the poor. Technical assistance and training given were very often so outmoded that the technologies learnt were useless and did not allow real business to enter new markets. Markets, domestic and international, wanted products of higher technologies and quality, not "appropriate technologies" producing low quality products. This correlation between appropriateness and no-technical-change is well illustrated by Madu (1992: 156).

A more powerful attack on AT came from Emmanuel. According to him, "appropriate technology" is not a technology specially designed for poor countries, but an impoverished technology. It does no more than increase their lagging behind the developed countries and their dependence upon them. For Emmanuel, what is important is the amount of goods produced and not the number of jobs created to produce these goods. The volume of production defines the level of social welfare, as well as the economic and political independence of the country. Emmanuel argues that "the most modern and capital-intensive technologies are more productive than the old or appropriate technologies, which are more labour-intensive" (Ghertman, 1982: 1). Emmanuel criticises AT, saying: "A technology appropriate to the underdeveloped countries would be an underdeveloped technology; that is to say, one which freezes and perpetuates underdevelopment. This is exactly what should be avoided" (Ghertman, 1982: 3).

Emmanuel then shows his solution for economic development and possible paths for technology transfer. Technology transfer could take two forms for LDCs. One is to buy factories on a turnkey basis, together with information concerning the ways and means of running them, and of training technicians for repair and maintenance. The second way is indirect: calling upon multinational companies to invest locally, transferring technology to their own subsidiaries (Emmanuel, 1982: 35-8). International subcontracting will be another way to transfer technology (Yamanaka, 1973: 15)

In sum, although the basic concept of AT was reasonable, its application has not worked in market economies.

2-2-3 Development of indigenous technological capability

Every nation wishes to indigenise. "Indigenousness" is difficult to define from the historical viewpoint of Veblen who understands human history as the product of hybrids. Today, it is understood in many developing countries that FDI may bring in employment, technology and economic growth. The point is that technology brought in by FDI is expected to facilitate the development of indigenous technological capability. How then is indigenous technological capability defined?

From the viewpoint of a recipient country, Santikarn reviewed the concept of technology transfer and then offered her own definition from the viewpoint of localisation, namely "indigenousness". Four categories of technology transfer are distinguished by Santikarn as below (Santikarn, 1981: 6-7).

(1) *Geographical* transfer of technology

Technology transfer is realised when a new technology is used effectively in a new environment. "No attention is paid to the origin of inputs of production. As long as new technology is employed efficiently, for example, even if the whole factory is run by foreigners, technology is considered transferred."

(2) The transfer of technology into the *local work force*

"Technology transfer occurs when local workers have acquired the skill to operate machines correctly, to keep to a meticulous maintenance schedule, to fix and repair machines; and local managers are able to prepare input-output schedules, marketing plans, and so on."

(3) Technology transmission or *diffusion*

"Technology transfer occurs when technology spreads to other local productive units in the recipient economy."

(4)Technology adaptation and *development*

Technological adaptation and *development* will be realised (i) when technology is fully understood by local workers, and (ii) these workers begin to adapt the technology to the specific need of the local environment, or (iii) to modify it for the various purposes. (iv) Development of new techniques by local workers and (v) the reverse engineering are also included.

Santikarn excluded "geographical transfer" from technology transfer because the local work force does not participate in this case. The other three categories are understood to facilitate development of the indigenous technological capability. Headrick also distinguished geographical transfer from diffusion and recognised the importance of diffusion (Headrick, 1988: 3-9).

In sum, "indigenousness" does not mean total isolation. Thailand is in fact a typical example of a hybrid society as will be seen in Chapter 4.

Indigenousness is a sensitive topic in many countries due to their historical background, particularly in the case of post-colonial countries (Landes, 1969: 35). This is related to nationalism and pride. However, it should be noted that if a country chooses not to borrow technology, technical change will not occur (Casson, 1979: 103), unless it is created indigenously. Each nation has choices, to borrow or not to borrow, to be dependent or independent. In a conference on MNCs at Singapore, Raymond Vernon stated the following:

> Governments still have options. Albania and Burma exercised that option. They simply cut themselves off. Japan exercised an option; it simply did not allow multinational enterprises in but took on the costs of reaching out itself for the technologies and knowledge about foreign markets. India is using a different approach. The Brazilians are now moving to quite another approach. (Vernon, 1981: 54)

In the following a rough sketch of indigenous development of the automobile industry in India and Brazil will be provided.

In India, Ford and GM came back to start assembly plants after WW2. The Indian government decided in 1953 to limit production to those companies with approved programmes to make engines, transmissions, axles and other components. As a result, Ford and GM withdrew from India in 1957. Three Indian automobile firms succeeded in raising the local content to 95 per cent or more with technical assistance from foreign firms (Maxcy, 1981: 97, 127-8). In 1968-9, the government adopted very strict controls on joint ventures (JVs) and technology agreements (Yamazaki, 1990: 236-7). As far as the passenger car sector is concerned, very outdated, poor quality products were manufactured with 100 per cent local content at hopelessly uneconomic volumes. Models of the passenger cars were not changed for 25 or 30 years. In 1979 eight assemblers produced 101,277 cars in India (Maxcy, 1981: 264-6).

However, a joint venture with Japan, MUL,[12] changed the Indian car industry in the 1980s. The production of passenger cars started to grow. From 1982-83 to 1993-94, the production of passenger cars increased 380 per cent. The 92 per cent of the increase was achieved solely by MUL due to the following factors:

> MUL was able to introduce an egalitarian system in India, where the system of division of labour based on caste is still widespread.
> MUL has improved its network of dealers, systematically trained repairmen, and arranged a national network for the swift supply of components. (Takahashi, 1995: 35)

In Latin America, until the mid-1950s all automobiles were imported either as completely built-up (CBU) or completely knock-down kits (CKD) to be assembled locally (Maxcy, 1981: 119). In 1956, selecting two local assemblers and nine foreign assemblers, the Brazilian government chose a free competition policy for the development of the Brazilian automobile industry (Maxcy, 1981: 258-260). By 1962 almost 100 per cent local content was achieved by all firms (Dahlman, 1984: 319-20). In 1980 Brazil produced 1,165,000 cars, becoming the world's tenth largest automobile manufacturer. The automobile development policy seems to have succeeded if we consider that Brazil produced only 113,000 cars in 1960 (Shapiro, 1993: 194). Brazil is now a manufacturer and exporter of automobiles and auto parts; no longer an importer of CBU or CKD parts.

In sum, India is an extreme case of indigenisation without the technological development of the local work force until the 1970s, whereas Brazil and Thailand show compromise cases. It is clear that the technological capability of the local work force is far more important than the *indigenousness* of the car brand or the *ownership* without technological capability. The issue of ownership will be discussed again in Part II of this thesis.

2-2-4. An evolution from Fordism to post-Fordism

According to the advancement of human living standards, a once-welcomed economic model turns out to be a disappointment, and then the disappointment produces a new model. Machine technologies and mass production system in the USA supplied Americans with low cost industrial goods (Rosenberg, 1972: 50, 54). Ford's completion of the moving assembly line, in 1914, reduced labour time for a car from 12.5 hours to 1.5 hours. The price of Model T dropped, yet workers were paid the highest wages (Chandler, 1990: 205). The automatic machine was "the ideal mechanical contrivance" (Veblen, 1914/1994a: 307). "The machine is the new messiah" (Nye, 1979: 129). *Fordism* was definitely a human dream:

> Increasingly, the production worker is becoming a skilled technician. Brain, rather than brawn, is becoming the most important factor in modern industry. ... Automatic machines and automated production lines have eliminated much, and in some cases, all of the fatiguing manual efforts which was formerly associated with factory work. (*The Encyclopaedia Americana,* Vol. 18, 1963: 399f)

But, in the 1970s and '80s workers' dissatisfaction with Fordist mass production became apparent (Yamada, 1991: 105-16; Piore and Sabel, 1984: 116-7). According to Boyer, after the war until the 1960s the reproduction system ('régulation') functioned quite well under Fordism. Both "capital" and "labour" benefited from economic and technological progress. Since the 1970s, however, Fordism has become counter-productive. "Blue-collar workers revolt against Taylorist and Fordist methods through turnover, absenteeism, and a slackening of work intensity" (Boyer, 1988: 86). In addition, the international competition broke into the national economy to upset the peaceful compromise between labour and capital and the mark-up relationships between firms. Simultaneously, the erosion of US economic hegemony introduced many destabilizing factors including the "struggles between Japan and the United States" (Boyer, 1988: 88).

As a result, alternatives to Fordism appeared. These include *flexible specialisation* (Piore and Sabel, 1984), *lean production* (Womack, Jones and Roos, 1990), *beyond mass production* (Kenney and Florida, 1993) or *post-Fordism* (Coriat, 1992; Boyer, 1988; Yamada, 1991: 142-6). These new models sought an ideal model in Japanese production system, so-called Toyotism.

The Japanese model or Toyotism, however, was not free from criticism. Many people claim that the Japanese production system is based on low paid, intensified, exhaustive and repetitive labour (Nakamura, 1983: 412-3; Kamata, 1981; Saruta, 1995: 46-51; Higuchi, 1985: 126). They contend that it is nothing more than an Asian version of Fordism.

The third dream, *Volvoism*, was advocated as an alternative to the inhuman Japanese production system (Yamada: 1991: 142-6). Regarding Toyotism, Berggren also says that the character of the work itself has not changed, the rhythm and pace of the work on the assembly line is more inexorable under the Japanese management system than it ever was before (Berggren, 1992: 5). According to him, in Volvo, the orthodox line assembly was replaced by parallel dock assembly, in which small teams of skilled workers built complete cars or trucks. And the traditional shop floor hierarchy was replaced by group work, which enables autonomous decision making and reduces the vertical division of labour (Berggren, 1992: 7, 92-3). At the Uddevalla plant, it was expected that the workers' dream would be finally achieved as a *anthropocentric* and *transcendent* production system, in which workers could be freed from Taylorised fragmentation and have a sense of meaningful participation

(Berggren, 1992: 13, 175). Nevertheless, the third dream, Volvoism, has not yet been realised. Contrary to people's expectations, Volvo continued to lose money and closed the Uddevalla plant in 1993 (Nikkan Jidosha Shimbunsha, 1995: 206; Sandberg, 1993: 83).

Mass production under Fordism and Taylorism once provided people with high wages and low price automobiles to US citizens. Toyotism also did the same thing to people other than the US citizens who had been too poor to have their own cars. Nevertheless, both Fordism and Toyotism are being criticised. It should be noted that critiques are seeking improvement, not rejecting industrial production itself. Volvoism and factory automation (FA) should be understood from this viewpoint.

Critics claim that Japan's technology is imitation, not innovation (Nakamura, 1979: 75-79). It is true that Japan only borrowed, and the USA guided Japanese industrialisation (Rosenberg, 1994b: 138; Chandler, 1990: 616-7), especially after the outbreak of the Korean War (Nakamura, 1979: 52-3, 68-74). Secondly, it is argued that Japan's industries are competitive because workers are forced to work hard for less pay (Kato and Steven, 1990: 231) or it is questioned whether it makes people happy (Buckley, 1989: 221). Especially, the specific dual structure enables large firms to exploit low paid workers and small industries (Sei, Omori and Nakajima, 1975, 1976; Nakamura, 1983: 412-3; Kageyama, 1980: 170-1; Nagao, 1995: 190).

Regarding the first issue (imitation), it is true that Japan borrowed technology in all aspects—products, processes, machines, organisations, management and marketing—from the West. Even now Japan is more a borrower than a lender of technology as the figures on technology trade show; Japan received 431 billion yen and paid 798 billion yen in her technology trade in 1993 (Kagaku Gijutsu Cho, 1994: 592-3). In addition to machines and technologies, management methods (QC, IE, VA, etc.) were also imported mainly from the USA. Ohno Taiichi of Toyota once said that Toyota's production system was a combination of Ford's flow production and Taylor's scientific management (Saruta, 1995: 11-2). Nevertheless, this does not contradict the fact that the Japanese added incremental improvement and engaged in creative development of borrowed technology. Management methods were also adapted to the Japanese environment (Noda, 1969, 1988; Shingo, 1981, 1986). For example, Japanese firms established many research centres after the war (Table 2-1). As a result, Japan's technology trade began showing surpluses at least in the steel and iron industry from 1974 and the automobile industry from 1987 (Kagaku Gijutsu Cho, 1994: 594-5). In conclusion, there is no shame in imitation; it is a starting point for improvement and the development of technology.

Table 2-1 Establishment of research centres in Japan

	before the war	1946-55	1956-60	1961-65	1966-68	total
general machines	2	2	2	12	2	20
electric machines	3	4	3	11	2	23
transport machines	0	2	5	5	1	13
precision machines	1	0	0	3	1	5
total	6	8	10	31	6	61

Source: *Nihon no Jidosha Kogyo,* quoted in Nihon Kikaikogyo Rengokai, 1982: 204

The second issue, low wages and the dual structure of industries to force hard work, may be accepted as a problem inside Japan (Piore and Sabel, 1984: 128). However, if this is raised as an international issue, it seems difficult to contend that Japanese people are oppressed low paid workers (Kenney and Florida, 1989). Today's problems for Japanese firms are labour shortages and high wages. This is the reason for the Japanese *type* of foreign investment (Kojima, 1977; Ozawa, 1979; Buckley, 1989; 191; Pavitt, 1988: 128), and "the investment development cycle" (Dunning, 1982: 89-91), and "the *push* due to the exhaustion of resources in established settlements and the *pull* of new opportunities on the territorial frontier" (Casson, 1987: 260-1). It should be admitted that, without low wages and hard work, Japan's catching-up could not have been achieved. This applies also to developing countries (Kikaishinko Kyokai, 1991: 36-7) and Eastern Europe (Jürgens, 1995: 42, 46-7). If living standards were high, people would no longer work hard physically (with their brawn), but would want to work with their brains (Berggren, 1992: 92-3). Japan and Taiwan now face labour shortages in manufacturing industries in labour-intensive works of 3K. 3K refers to *kitsui* (exhausting), *kiken* (dangerous) and *kitanai* (dirty). This attitude of young people urges Japanese industries to implement factory automation (FA) or to move offshore (Kikaishinko

Kyokai, 1991: 37-40; Kokumin Kin-yukoko, 1995). On the other hand, people in developing countries need jobs even at low wages (Deutschman, 1995: 58-60). As a result, industries are moving from Japan and Taiwan to ASEAN and to China. If people do not want to work hard for low wages, it means that labour-intensive industries have difficulty in surviving (Shoko Chukin Bank, 1995: 260-90).

Table 2-2 Yearly sales per employee (Japan, Taiwan, Thailand)

holding company in Japan			subsidiary in LDCs			sales per employee in 100 million yen		ratio between e/f	products
firm	sales a	emp b	firm in	sales c	emp d	holding co. a/b = e	subsidiary c/d = f		
No. 1	130	534	Taiwan	14	110	0.243	0.127	0.523	transformers
No. 2	31	110	Taiwan	9	65	0.282	0.138	0.491	valves
No. 3	140	480	Taiwan	66	540	0.292	0.122	0.419	PCB
No. 4	140	410	Singapore	40	300	0.341	0.133	0.390	micro motors
No. 5	50	240	Malaysia	14	250	0.208	0.056	0.269	electrical press parts
No. 6	170	600	Thailand	170	3800	0.283	0.045	0.158	components
No. 7	300	972	Thailand	20	500	0.309	0.040	0.130	camera shatters
No. 8	64	250	Malaysia	13	400	0.256	0.033	0.127	metal parts for hoses
No. 9	37	92	Thailand	2	40	0.402	0.050	0.124	clutches
No. 10	40	55	Thailand	3	75	0.727	0.040	0.055	auto seats

Source: Shokosogo Kenkyusho, 1995: 260-290.
sales = yearly sales in 100 million yen; employees = number of employees; ratio between e/f = ratio of sales/employee between subsidiary and holding company.

If the "yearly sales per employee" (Table 2-2) is compared among Japan, Taiwan and Thailand, Japan is the largest and Thailand the lowest. According to the survey, the "yearly sales per employee" of Taiwanese firms is 40-50 per cent of that of Japanese firms. The "yearly sales per employee" of Thai firms is between 5.5 and 15.8 per cent of that of Japanese firms. This gap explains two things. Firstly, more capital-intensive production systems are adopted in Japan and Taiwan than in Thailand. Secondly, employee productivity is very low in Thailand. However, because the wage level is lower and people work hard in Thailand, Japanese firms are investing there. On the contrary, in Japan and Taiwan, the wage level is high and it is difficult to make profits in Japan and Taiwan. That is the cause of relocation and de-industrialisation in Japan and Taiwan.

As a consequence, firms in Japan and Taiwan have two alternatives, (i) to move to less developed countries where people work hard for lower wages, or (ii) to increase productivity, for example by replacing workers by machines, i.e. automation. The first issue is a cause of FDI and forms the engine for the "flying-geese" pattern of development. The second issue advances technological development. Production systems continuously seek higher productivity and try to improve products, processes and working conditions.

These issues will be discussed further in the following chapters in the context of Japan's and Thailand's experience.

Chapter 3:
The Japanese Production System: from Borrowing to Exporting Technology

Introduction

This chapter will begin with Japan's technological borrowing in the mid-nineteenth century. After the opening of the country in 1854, Japan rushed to catch-up with the West. "Civilisation, Wealth and Armament (*bunmei-kaika, fukoku, kyohei*)" became the national slogan of the new (Meiji) government. Assisted by the world atmosphere of the Victorian free trade policy, borrowing from the West had been smooth. Export from small industries supported the large industries' import of capital goods and technology.

After Britain's abandonment of a century's free trade policy in 1932, borrowing from Britain became difficult which led to Japan's reliance on US technology. After the outbreak of the war with China in 1937,[13] the USA became hostile to Japan and controlled her machinery exports to Japan. Thus, Japan's import of capital goods and raw materials from the West became more difficult. Japan had to increase its efforts to develop an indigenous machine industry. The Japanese government moved to strengthen the machine industry, requesting co-operation between large industries and small-medium industries. This resulted in the formation of a specific industrial system called *shitauke*, a multi-tier subcontracting system.[14]

Based on Japan's borrowing experience, Japanese thinkers have developed the theory of technology spread. The Japanese thinkers, both in the government and the private sector, positively consider that technology spread will benefit both Japan and recipient countries.[15] Under this theory, Japanese expatriates, i.e. technology carriers, are thus cheered up and encouraged to devote themselves to transplanting technology. This theory was schematised as the "flying-geese" pattern of development by Akamatsu, which will be reviewed in the second section.

In the final three sections, the evolution of the Japanese production system after WW2 will be surveyed. Supported by Western co-operation, especially after the breakout of the Korean War, Japan rushed to emulate the US mass production system. In the process of the building up of the Japanese production system, however, Japan did not simply replace her systems with the US ones. Firstly, the Japanese production system was constructed as a manager-worker co-operation system. Secondly, it involved the fostering of the Japanese subcontracting system. In this, large industries (LIs) and small-medium industries (SMIs) were supposed to co-operate for the building up of the Japanese production system.

In the 1970s, it was thought that the Japanese production system almost caught up with that of the West. Moreover, many were arguing that the Japanese production system was becoming more advanced than the Western one. This last section intends to explain the specific structure of the Japanese production system by introducing a model of a multi-tier subcontracting system. The model shows how the Japanese production system is being relocated domestically and then internationally. In practice, the recent relocation of large industries is affecting Japanese small-medium industries in the subcontracting system.

3-1. Japan's borrowing process

3-1-1. The early stage of industrialisation

When Japan was opened to the West in 1854, "the sharp discontinuity in the industrial technology of traditional Japan and the modern industrial countries of the West" became apparent (Nakagawa, 1989: 1). Recognising the gap and formulating a new government for Meiji Restoration, people from the samurai class (*shi*)[16] actively took the initiative in the borrowing process with the assistance of merchants (*sho*). Few craftsmen (*ko*) grew up to be prominent businessmen in the early stage of Japan's industrialisation, which was different from the British experience (Nakagawa, 1989: 20). In order to fill this wide gap, a variety of methods were deployed.

Firstly, Dutch Studies scholars and their students learnt technology from books, mostly in Dutch and some in French and English. "Almost a half century of 'book learning' preceded the start of the real industrial revolution" and these scholars played a large role in the earliest stage of the industrial revolution (Nakagawa, 1989:1). For example, in the 1840s, Western style iron furnaces were constructed by Dutch Studies scholars by reading a Dutch text book in order to make cannons. Western style boats and steam engines were also made by knowledge from books (Uchida, 1990: 263).

Secondly, students were sent abroad to learn technologies, mainly to Britain, some to France and the USA (Nakagawa, 1989: 1). After the Meiji restoration, from 1862 to the 1880s, the (Meiji) government sent at least 80 students abroad to study industrial science and technology (Uchida, 1990: 274). If students in all subjects from both the government, local governments and the private sector are counted, the number totalled nearly 6,000 during the period of 1868-81. The study mission of high ranking officials to the USA and Europe for about two years (Iwakura mission, 1871-73) should also be noted (Yasuba, 1981; Yasuba and Dhiravegin, 1985).

Thirdly, institutions for the higher learning of science and technology were established in Japan. In 1855 Nagasaki Kaigun Denshu-jo (naval training school) was established. Following this, some state-owned factories opened training institutions. Technical universities and high schools were also established in the 1870s and '80s (Uchida, 1990: 273-80).

Lastly, teachers, engineers and technicians were invited from the West. The number of employed foreigners totalled 527 in 1875, of whom nearly 40 per cent were employed under the Ministry of Industry which was in charge of state-owned industrial plants. Later, the number declined to 155 in 1886, and to 79 in 1895 (Yasuba, 1981: 45-6; Yasuba and Dhiravegin, 1985: 26).

The above process has been called the "learning habit" by some economists (Ozawa, 1985: 224; Lynn, 1985: 256-7; McMillan, 1985: 325), but it was in fact a reaction against the threat by the West (Landes, 1969: 39). For Japan, learning foreign ways was a matter of survival as a whole nation whereas in the case of Thailand, the Kingdom sent only a few members of the royal family to the West until the 1890s (Yasuba and Dhiravegin, 1985: 26) even though both countries opened almost simultaneously. It is a common understanding in today's Japan that her success in industrialisation depended upon her institutional arrangements for education in technology (Uchida, 1990: 276). At the same time, it is important to note that the contribution of foreign teachers was so crucial, even though they had been sent to expand their markets for their own benefits. Technology could be borrowed properly and faster only with direct human contact as was proved by the unsuccessful case of the Dutch Studies scholars.

As stated, Japan diligently borrowed modern technology from the West. However, this does not mean that modern technology totally replaced the Japanese technology then in existence. Odaka's model will explain this (Table 3-1). (M) is the borrowed modern technology which had been lacking in Japan. Japan imported this category of technology as mentioned. On the other hand, (I) represents many traditional industries which survived as they were, or were developed by partial adoption of modern technology. (I) played a significant role in the industrialisation of Japan as Yamanaka has argued and is discussed in the following section. (I*) represents examples of the combination of traditional technology and large size production system such as shipbuilding and brewing. They depended relatively on traditional technology although they developed to be large industries by borrowing foreign technology. (M*) is the case of small industries which borrowed foreign technology, such as small size printing shops or machine shops (Odaka, 1990: 335-9). Japanese small size weaving industries also belong to this category. Traditional textile machines were improved step-by-step taking the idea from Western technology at the time.

Table 3-1 Odaka's model of borrowing patterns in Japan

	small size industry	large size industry
Traditional technology	I	I*
Western new technology	M*	M

Source: Odaka, 1990: 335-9.
I = traditional technology, M = modern technology, * = adaptation

3-1-2. Borrowing in the machine industry

The development of the machine industry is recognised as important. Some have argued that state subsidies may be effective for this goal (Fransman, 1986b: 35; Amsden and Kim, 1986: 112-3; Amsden, 1989). However, it is not always necessary to promote the machine industry at the early stages of industrialisation. A country does not always become more independent by making its own equipment. "Knowledge is important in the *selection* of technology" (Little, 1982: 248-9). For example, in the case of India, protection for capital goods fostered inefficiency (Lall, 1984: 240-1). In Britain, industrialisation began with the textile industry which in turn stimulated the development of the machine industry. In Japan, however, industrialisation was initiated intentionally both in the machine and the textile industries at the same time.

In 1855 the education of sailors and engineers by Dutch engineers was initiated by the government, using a gunboat donated by the King of Holland, which was the beginning of *Nagasaki Kaigun Denshu-jo* (naval training school). In 1857 iron works (*Nagasaki Seitetsu-sho*) were attached to the Nagasaki naval training school. The government then established another shipyard at Yokosuka in 1866 with the assistance of French engineers (Yokosuka Seitetsu-sho). The above two shipyards were the first institutes to study Western machine technology directly from foreigners (Uchida, 1990: 264-5; Nakagawa, 1989: 7-11). In total, Japan imported 166 gunboats in the decade of 1860-70 (Uchida, 1990: 264). As mentioned, in the 1840s some Japanese local governments tried to construct Western style boats and steam engines depending on knowledge from Dutch books, but the results were unsuccessful. That is why Japan had to rely on imports. Maintenance docks had to be constructed with foreign assistance. In 1872, all the government shipyards were consolidated by the newly organised Navy Department. In the mean time, Japanese engineers became able to operate by themselves. As a result, foreign experts lost their role and left Japanese shipyards gradually (Fujihara, 1936: 20). In addition, the Meiji government constructed Osaka Arsenal for cannons and guns, and Tokyo Arsenal for rifles (Chokki, 1986: 125). No doubt, most of the equipment and machine tools had to be imported, although some were made in Japan (Chokki, 1986: 126; Sawai, 1990: 222-6).

The development of the machine industry in Japan had been slow in comparison with the textile industry because imported products were better and cheaper (Fujihara, 1936: 49). Before and during the Sino- and Russo-Japanese wars (1890-1905), military workshops such as arsenals, munitions works or shipyards composed the largest part of the machine industry. Following the Russo-Japanese war, these military works decreased the number of workers in tens of thousands, who then constituted a large number of small-size machine industries (Sawai, 1990, 239-42), or were employed in large industries as engineers (Sawai, 1989: 207). Skilled workers trained in large industries were considered to be a main source of knowledge for small size machine industries in Japan, which were later formed into the subcontracting system (Toyoda, 1941: 174). Although the reliance on imports continued until the 1920s, the import of machines became difficult or impossible during the First and Second World Wars. Consequently, domestic production was stimulated.

In summary, Japan's machine industry proceeded in the following steps; starting from imports, domestic production expanded during the Sino-Japanese and Russo-Japanese wars, and after that imports coexisted with domestic production. After WW2 the machine industry, including the machine tool industry, became competitive enough to be a major exporting industry of Japan (Chokki, 1986, 150-51). This type of development from imports to exports in general is named the "flying-geese" pattern development by Akamatsu (1962).

3-1-3. SMI's role in borrowing

The development process of a national economy does not necessarily follow the "general principles" of the classical economics based on Britain's experience, "each people and each age has its own peculiar economy" (Haney, 1921: 488). In the case of Japan's national economy, two specific elements were recognised. One is the co-existence of large industry (LI) and small-medium industry (SMI)[17] both in export and import substitution (Yamanaka, 1948: 79). In Japan, SMI produced exportables and contributed to the industrialisation by earning foreign currencies. LI did not kill SMI by competition, as was the case in Britain

(Yamanaka, 1948: 44-5; Clapham, 1926: 555-6; Veblen, 1939: 100-1). The other is the complementary role of SMI in the manufacturing sector because of the need for rapid industrialisation after the 1930s, which resulted in the generation of the subcontracting system (*shitauke*), another type of LI-SMI co-operation (Yamanaka, 1948: 62-3).

Japan's industrial revolution was not the result of the "natural" or autonomous development of the economy. It was rather the result of the change in specific international conditions which had defined the position of Japan's economy in the world (Yamanaka, 1948: 74-5). As a result, Japan's economy had become a "dual" economy of imported large industries (LI) and traditional small industries (SMI; handicraft industries or *shu-kogyo* and household industries or *kanai-kogyo*). Examples of SMIs are silk threads, silk weaving, porcelain, lacquer ware, tea, straw-mat, cotton, indigo dye, vegetable oil, and Japanese nails, some of which soon moved into exporting. The most important thing to be noted is that LI had to import capital goods, technologies and foreign experts. In other words, Japan as a whole needed foreign currencies to industrialise. This task was achieved by SMI's exports:

> The specific nature of the structure of Japan's national economy during the time of her industrial revolution is the fact that the circulation of Japan's national economy had been supported by its two-tier system; a tier of circulation involved in the international economy and a tier of circulation within a closed subsistence economy which had been maintained despite the opening of the country. One could exist only because the other did exist. This dual structure has to be regarded as important in the sense that it formed the basis of the Japanese industrial revolution. (Yamanaka, 1948: 79, translation by the author)

Because the government had recognised the importance of SMI as mentioned above, the policy recommendations for SMI's export promotion appeared as early as in 1884 (*Kogyo Iken,*[18] quoted in Yamanaka, 1948: 92-5).

It was in the 1930s, about half a century after the recognition of SMI's export promotion, that the conception of the subcontracting system emerged (Yamanaka, 1948: 158-9, 160-3; Toyoda, 1941: 175). Although Japan had completed her industrial revolution in light industries around the time of the First World War, machine industries were still in a weak position (Yamanaka, 1948: 171; Allen, 1946: 116-8). Japan needed the development of her indigenous machine industries (Yamanaka, 1948: 173). Especially after the Marco Polo

Bridge Incident in 1937 which led to trade restrictions against Japan, the indigenous machine industry became indispensable to Japan (Yamanaka, 1948: 185). At that very moment, Japan needed the same environment as Britain had enjoyed in the middle of the nineteenth century (Allen, 1946: 153). However, the world situation proved unfavourable for Japan (Gregg, 1965: 427; Howe, 1996: 429-30):

> Her economic interest required a world in which there were liberal trading arrangements so that she might be able to exchange on good terms her manufactured goods for the raw materials she needed in increasing quantities. But these conditions were disappearing from international trade. (Allen, 1946: 153)

With the start of Japan's war-time autarchic economy (1932-45), Japan's SMI was thrown into a new environment which pushed Japan's SMI to suffer from the industrial policy of "changing and abandoning of jobs (*ten-pai-gyo*)". This means, firstly to be guided to change jobs, and, if unsuccessful, to self-denial of its own existence (Yamanaka, 1948: 175). For this purpose (*ten-pai-gyo*), the government laid down policy measures such as the opening of consultation service centres, loan schemes by Japan Industrial Development Bank (*Kogin*) and Shoko Chukin Bank, strengthening of the industrial co-operatives, and relocation of SMIs to Manchuria[19] (Yamanaka, 1948: 199-200). However, the most urgent task was to make munitions and to strengthen machine industries. This necessitated the co-operation of LI and SMI as already mentioned. In order to foster indigenous automobile industries, in compliance with the Automobile Industry Law in 1936, the government announced "the Ordinance of Promotion of Shitauke" in 1937 (Minato, 1987: 102; Toyoda, 1941: 176-7). In the following year, 1938, the Ordinance for Good Auto Parts Certificates was issued and 136 suppliers were given certificates (Amagai, 1982: 68-9). In 1940, the Machines and Steel Iron Products Rationalisation Ordinance (*Kikai Tekkohin Kogyo Seibi Yoko*) was introduced to control SMIs further (Yamanaka, 1948: 206; Toyoda, 1941, 219-24). According to this Ordinance, SMI was classified into:

> (i) (A class); independent parts suppliers,
> (ii) (B class); lower level subcontractors,
> (iii) (C class); workshops of consumer products and exporting products, miscellaneous and repairing workshops, firms to abandon jobs [*Ten-pai gyo*]. (Amagai, 1982: 68-9, translation)

Meanwhile, military procurement from the private machine industries rapidly expanded, from 0.364 billion yen in 1932 to 3.283 billion yen in 1937, nine fold in five years (Minato, 1987: 99). The capacity of LI, however, was not enough to supply the demand, thus a large amount of orders remained unfilled. LI in consequence needed the assistance of SMI although the technology level of SMI was low and the linkage between the two was fragile at the beginning (Komiyama, 1941; Tasugi, 1941/1987). For example, in 1932, the ratio of subcontracting in the machine industry was as low as 11.2 % on average. The corresponding ratio in large scale industries of employees over 1,000 persons was 8.3% (Minato, 1987: 93). These figures show very low ratios of subcontracting at that time as compared to today's ratio which is considered as high as 70 per cent (Ohashi, 1987: 9; JICA/UNICO, 1994b: 1-3-6).[20] The shortage of capacity at LI and the rapid growth in the government procurement urged the fostering of subcontractors and technology transfer from LI to SMI. Thus, the linkage between LI and SMI was constructed although the level of achievement was not so satisfactory (Ueda, 1992; 1993). This was the origin of Japan's subcontracting system (Minato, 1987: 95; Mitsui, 1991: 147; 1993: 31) which constitutes a specific nature of Japan's industrial system (Berry and Mazumdar, 1991: 40-41).

3-2. From technology borrowing to spread

3-2-1. Akamatsu's "flying-geese" pattern

The overall development process of trade and industry was well analysed in the theory of the "flying-geese" pattern development by Akamatsu Kaname. According to Yamazawa, Akamatsu made the theory of the "flying-geese" pattern public in 1941 (Yamazawa, 1981: 194), twenty five years before the product cycle theory of Vernon, to which Akamatsu's theory is comparable. The implication of Akamatsu's theory is that trade and industry inevitably spread as a natural law. His theory of sequential development of trade and industry is observed from three different aspects as follows:

1. Shift from import to domestic production and to export (market and production site change).

Due to the interaction with the West, firstly, import of consumer goods from the West occurs (see the Table 3-2; 1st stage, Asia (1)), and then, competing with the imported goods, domestic production occurs (2nd stage, Asia (3)), later export of the goods occurs (3rd stage, Asia (5)).

2. Shift from simple products to sophisticated products (product change).

Major products shift from native Asian products to modern consumer products and then to capital good products.

3. Shift from the West to Japan and to less-developed countries (diffusion among countries).

First, the West will export consumer goods to Asia (1st stage, West (5)), then the latecomer (Japan) exercises domestic production and exports the same consumer goods (3rd stage, Asia (5)). At a later stage, less-developed countries replace Japan in the production of the goods and start the export of the goods instead (4th stage, less-developed (5)).

The implication of this theory is that mutual interactions will inevitably transfer industries through trade to less-developed countries, as Josiah Tucker wrote in 1758:

> It has been a Notion universally received, That Trade and Manufactures, if left at full Liberty, will always descend from a richer to a poorer State; somewhat in the same Manner as a Stream of Water falls from higher to lower grounds; ... It is likewise inferred, very consistently with this first Principle, that when the poor Country, in Process of Time, and by this Influx of Trade and Manufactures, is become relatively richer, the Course of Traffic will turn again....(Josiah Tucker, quoted in Hufbauer, 1970: 184)

In fact, the notion of spread of technology (e.g., Kuznets, Rosenberg) was already reviewed in Chapter 2. Akamatsu has recognised a law similar to Josiah's in which the less-developed will catch-up with the industrialised. Akamatsu's contribution is that he presented a stylised model of the catching-up process for less developed countries (Tran, 1989: 83). Kojima called this the *catching-up product cycle* (Kojima, 1979: 66). Dunning also explained FDI from the viewpoint of economic development stages of a country and called it "the investment development cycle", a type of relocation model (Dunning, 1982: 91).

Table 3-2 The flying-geese pattern development by Akamatsu

stage	West	Asia (Japan)	less-developed
1st	(5)Export of consumer goods to Asia and less-developed	(1)*Import of consumer goods.* (2)Export of native Asian products and fall of native handicraft industries	(1)Import of consumer goods. (2)Export of native Asian products and fall of native handicraft industries
2nd	(c)Out-going FDI in consumer goods (8)Export of capital goods to Asia	(a)In-coming FDI in consumer goods for domestic market (3)*Domestic production of consumer goods to replace import.* (4)Import of capital goods for domestic consumer goods industry	(1)Import of consumer goods. (2)Export of native Asian products and fall of native handicraft industries
3rd	(c)Out-going FDI in consumer goods (8)Export of capital goods to less-developed	(b)In-coming FDI in consumer goods for export (5)*Export of consumer goods* (6)Domestic production of capital goods	(a)In-coming FDI in consumer goods for domestic market (3)Domestic production of consumer goods to replace the import. (4)Import of capital goods for domestic consumer goods industry
4th	(c)Out-going FDI in consumer goods	(7)Decline of export of consumer goods. (c)Out-going FDI in consumer goods (8)Export of capital goods (9)Import of consumer goods from less-developed countries	(b)In-coming FDI in consumer goods for export (5)Export of consumer goods

Source: Akamatsu, 1962. The table is made by the author with modifications.

Yamazawa, and others supporting Akamatsu's theory as applicable to less developed countries, tested Akamatsu's theory for Taiwan, Thailand and Korea (Yamazawa, 1981; Yamazawa and Watanabe, 1988; Tran, 1989: Murakami, 1990). Yamazawa (1981) and Yamazawa and Watanabe (1988), following Kojima's suggestion, called the sequence the catch-up product cycle (CPC). They covered both the product cycle of a specific item and the long run shift of an industrial structure, but not the international sequence. However, in his later book, Yamazawa distinguished CPC and the flying-geese pattern development (Yamazawa, 1993: 98-104). There, he summed up Akamatsu's sequence into five stages; introduction, import substitution, export, maturity and reverse import (from less developed). He added the role of FDI and technology transfer in the empirical analysis of Japan's economic development because Akamatsu did not explicitly refer to the role of FDI. Yamazawa maintains that the flying-geese pattern development theory is a good tool to analyse the development process of developing countries. Tran Van Tho, relying on the theory of Akamatsu (the flying-geese pattern) and Ogawa's framework for technology transfer, emphasised the importance of "the role of foreign technology and management know-how" (Tran, 1988; 1989).

Murakami refined Akamatsu's theory and classified the development process into ten stages by the combination of the industrial sector and the market (Table 3-3).

Table 3-3 A model of development stages by Murakami

		Domestic market	Export market
Primary industry	food, raw materials	I	II
Secondary industry (Manufacturing)	light industry (textile, sundries)	III	IV
	heavy and chemical industry (iron and steel, shipbuilding, automobile, petrochemical)	V	VI
	high-technology (Micro Electronics, bio-technology, new materials)	VII	VIII
Tertiary industry	service industry	IX	X

Source: Murakami, 1990: 5

Stage I is a predominantly agricultural economy, such as Japan up until the Tokugawa era. Stage III is the import substitution of textiles and sundries that was completed in the 1880s in Japan (Murakami, 1990: 6). Stage V of the heavy and chemical industry follows, which started in the 1890s in Japan (Allen, 1946). Rosenberg pointed out the importance of this stage (V) in the case of the USA. "[A]n important aspect of industrialization may be illuminated by examining the changing historical role of the capital goods industries, and more particularly that growing portion of them which is devoted to the production of producers' durable goods" (Rosenberg, 1976: 10).

It should be noted, however, Yamanaka stated that the above stages usually overlap. The export of primary industry and light industry goods occur at the same time, and will support the furtherance of industrialisation as seen in Japan. The process of technological development cannot skip from the bottom to the top. History shows that it developed step-by-step, at least in Asian countries.

Vernon's product cycle and Akamatsu's theory bear some resemblance to one another (see Figure 1 in Vernon, 1966). Nevertheless, they are different in their emphases and focuses. Vernon's theory explains the behaviour of MNCs, while Akamatsu explains how a latecomer catches up in industrialisation and then hands over the acquired technology to the less-developed. This difference was pointed out by Kojima (1979: 61-7) and Yamazawa and Watanabe (1988: 217-8). Yamazawa and Watanabe stated:

> R. Vernon formulated in his Product Cycle (PC) Theory how American-based MNCs transferred new technology to developing countries once the technology had been standardized. The MNCs took advantage of cheaper labor costs to supply the American market. Vernon's theory explains the transfer of an assembly-operation or simple processing of a new product of an industry with a constant flow of new product innovation. But the theory does not explain the transfer of the whole industry generating the innovation flow itself. The transplanting of modern industry to the NICs and ASEAN is better explained by a combination of the CPC and PC theories. (Yamazawa and Watanabe, 1988: 217-8)

Vernon's product life cycle theory would be well applied to a specific consumer product, while the flying-geese pattern development is applied to the development stages of a national economy. Ozawa called this an "industry-cycle" approach to differentiate it from the product-cycle approach (Ozawa, 1979: 54). Therefore, the two concepts are not the same (Kojima, 1979: 61-7). Both PC and CPC focus on a product, whereas Akamatsu focuses on the mechanism of industrialisation. Kojima, Yamazawa and other followers' contribution to Akamatsu's theory lies in the explicit addition of FDI, which Akamatsu did not mention clearly.

Lastly, Howe's interpretation of Akamatsu's theory deserves notice. He explains the flying-geese pattern development as follows:

> This of course could be accomplished only by the expulsion of the western powers, who naturally wished to avoid the painful readjustments that Asian economic success would entail and therefore sought to impede the development of a Japan-centred Asia and impose the trade and industrialisation patterns that suited them. (Howe, 1996: 409)

Although Howe's historical perspective was limited to the Pacific War period, he clearly highlighted the specific nature of Japanese capitalism as it differed from Western capitalism.

3-2-2. The notion of technology spread

In the flying-geese development model (catch-up model), not only large-scale industries but also small-scale industries (craftsmen) seek business opportunities abroad and play the role of technology carriers. In Europe, "[d]uring the eighteenth century perhaps a million people left Britain to seek a living overseas. ... Among them were ... a number of artisans who defied the law by carrying their technical knowledge and skill to Europe" (Ashton, 1964: 4). Early in the 1970s, Japanese economists and leaders in SME[21] began to study and promote SME's overseas investment,[22] focusing upon developing countries. For example, the yearly published SME White Paper[23] by MITI started the report on FDI by Japanese SMEs in Asia from 1970.

In addition, the No. 118 Sub-Committee on SME of Nippon Research and Art Promotion Association (*Nippon Gakujutsu Shinko Kyokai*) published two books, *The Developing Economies and SME* (Fujita and Fujii, 1973) and *The Internationalisation of Economy and SME* (Fujita and Fujii, 1976). Furthermore, a government bank for SME (*Shoko Chukin Bank*), sending survey missions regularly to Asia from 1969, published a series of investment guidebooks. At first, *Investment Guide for South-east Asia* was published in 1970, followed by twenty volumes until 1994. The last one was *Investment Guide for Vietnam* (1994). Japanese thinking on the internationalisation of SME is observable in all these volumes. To quote Fujita:

> As Japan lacks natural resources, it is a destiny for Japanese people to build the state in a good balance of materials and human spirits through peaceful education and promotion of science for human benefits. Consequently, Japan's international economic policy has to be based on co-operation and mutual assistance for the welfare of other nations and states, especially developing countries. Otherwise, Japan's international activities may be futile. As Japan is the world number two country in the electric industry, there is no other way for Japan's SME than to co-operate with developing countries, including Taiwan, as well as with industrialised countries. Japan need to utilise SME's advanced technologies, should not exploit cheap labour of other countries but improve the level of labour and technology although that may bring about hardship to Japan's

> economy. In that sense, *Japan's SME Basic Law* has to be reconsidered. (Fujita, 1973: 149-50; translation by the author)

The SME Basic Law (1963) laid down principles for SMEs to modernise their production systems—to install modern machines and expand production capacity—and, by so doing, to create international competitiveness and to achieve surpluses in the international balance of payments. Fujita says that because Japan's economy has, as a whole, already constructed the international competitiveness and has become a comparatively strong economy, principles aimed at the formulation of the export capacity in SME by the SME Basic Law should be reconsidered. Yamanaka argues:

> Japan has achieved a high economic growth under this international environment. Meanwhile, it was as if she had repeated a bird-like action, first, staying in the nest, carefully observing the outer world, and then went out to catch the game and brought it back to the nest—the same as whaling vessels far in the off-shore which came back home with the catch. Nevertheless, towards the 1970s, Japan's economic development, which was achieved within the nest, has reached the point that Japan is not allowed to take the advantage of the outer world as given, but is requested to take responsibility in the outer world as well. Essentially, the outer world still functions as given conditions, however, Japan has grown up to the point that she has to pay attention and be responsible for the reproduction of the given conditions of the outer world as well as that in the inner world of the nest.... It is necessary to abandon the past attitude towards the outer world to regard it only as given. Japan must co-operate with the outer world in order to maintain her reproduction process even if her economic growth rates may become zero. (Yamanaka, 1976: 18-9, translation by the author)

Fujita's and Yamanaka's views have been confirmed by other economists. For example, it was contended that the separation between LE and SME became irrelevant, on the ground that Japan's economy had become a strong economy. SMEs did not need promotion any longer (Tatsumi, 1992; Kawakami, 1992). It is thus widely admitted that the Japanese SME should positively assist in the promotion of SMEs in developing countries and NICs. It is, furthermore, suggested that some of the Japanese government agencies specialising in the SME promotion and consultancy be transferred to developing countries (Abe, 1990: 81-2). In fact, the government agencies for SME under MITI began sending advisors to Hong Kong, Malaysia, Thailand, Shanghai and Dalian to assist Japanese investment by SMEs in the late 1980s.[24]

For Japanese enterprises, including SMEs, 1985 marked a turning point for overseas investments. Pushed by the surge in the yen, the number and amount of FDI increased after

1985. Facing strong pressures in the G-7 conference (Ishigaki *et al*, 1990: 300-1), the Committee on the Economic Structural Adjustment chaired by Maekawa submitted the so-called Maekawa Report to the Japanese government in April 1986. The Report, in brief, said:

> During the post-war period of 40 years, the Japanese economy has achieved high growth rates and gained the status to play a great role in the world economy. Her current account generated surplus each year in the 1980s. Especially in 1985 the surplus reached as much as 3.5% of GNP, sufficient to intensify international trade friction. Considering this internal and international economic situation, it is the time for Japan to exercise a historical change in the radical direction of economic policies and the people's life style. It is completely evident that without the change, Japan has no more development in the future. Therefore, it is necessary to keep the current account balanced, to shift the economic structures from export-led to domestic-based economy and make hard efforts to maintain her national economy consistent with the international economy. (a summary of Maekawa Report by Ikeda, 1992: 119-121, translation by the author)

The Maekawa Report presented the following policy recommendations (Ikeda, 1992: 121).

(1) The expansion of domestic demand.

(2) The change of industrial structures to harmonise the Japanese economy with the international economy through:

(i) Aggressive policies to restructure industries.

(ii) Promotion of **foreign direct investment**

(iii) Restructuring of agriculture.

(iv) Opening of domestic market to follow the new round of GATT.

(3) Improvement in the market structures and promotion of imports.

(4) Stabilisation of currencies and liberalisation of money markets.

(5) International co-operation and contribution to the world economy.

In addition to the above mentioned information service by the government agencies, the government policies for promotion of SME's FDI, still in effect in 1994, includes financial supports initiated in 1987. They were loan schemes and credit guarantee schemes by the five government agencies; Export and Import Bank, Shoko Chukin Bank, Small Business Finance Corporation, Japan Overseas Development Corporation and Small Business Credit Guarantee Associations.[25]

3-3. Borrowing and spread after the war

3-3-1. Borrowing and catching-up in technology

Nissan, Toyota and Isuzu luckily escaped great war damage. In September 1945 they resumed production under the permission of the Supreme Commander of the Allied Powers (SCAP) to manufacture up to 1,500 trucks per month (Nakamura, 1983: 205). However, machines were old and not well-maintained, parts and raw materials were scarce, and suppliers were disorganised due to heavy war damage. Moreover, inflation affected production activity. As a result, not more than 500 trucks per month were produced until 1947. After the tight money policy called the Dodge Line (1949), the automobile industry faced a survival crisis. In May 1950, President Ichimada of the Bank of Japan said that Japan had better import passenger cars from the USA rather than manufacture them domestically (Nakamura, 1983: 216-7).

The outbreak of the Korean War in June 1950 changed the automobile market. Financial credit to the automobile industry was resumed. The automobile industry introduced US style mass production. In June 1952 the government laid down a principal policy for the import of foreign capital and technologies for passenger cars as follows (Nihon Kikaikogyo Rengokai, 1982: 97):

1 For domestic brand passenger cars, approvals will be given to projects helpful for the development of domestic passenger car industries.

2 For foreign brand cars, approvals will be given to the following projects:

(1)The production license has to be given to the domestic side and at least 90% of the main parts have to be produced domestically within 5 years after the conclusion of the agreement.

(2)The Japanese side has to present trustworthy data to promise the achievement of the above conditions.

Following the above regulations, four projects were approved between the end of 1952 and September 1953 (Amagai, 1982: 121-7; Nihon Kikaikogyo Rengokai, 1982: 98-103; Nakamura, 1983: 231). They were:

- Nissan, passenger cars, Austin A 40 (from Austin Motors, UK).
- Hino Diesel, Renault 4CV (from Renault, France).
- Isuzu, Hilman Minx (from Rootes Motors,[26] UK).
- Mitsubishi, jeeps (from Willes Overland Export Corporation, USA)

They all completed localisation in 3-5 years.

Meanwhile, Toyota failed to reach an agreement with Ford. Nevertheless, Ford showed its US plants to Toyota (Nakamura, 1983: 230-3). Toyota, according to its five-year (1951-6) investment plan, modernised and expanded its plants with US and European machines and technologies (Amagai, 1982: 127-9).

In the 1950s German and American machine tool industries wanted Japan as their market, thus they would not sell their advanced production technologies to Japan. Consequently, Japan bought technologies from France, Switzerland and Italy (Nihon Kikaikogyo Rengokai, 1982: 187-90):

- Production technology of high speed cutting tools for nuts and bolts from France in 1952.
- Technology of high speed lathes from Switzerland in 1953.
- Technology of super high speed lathes from France in 1953.
- Technology of vertical lathes from France in 1955.
- Technology of grinding machines from France in 1955.
- Technology of a special purpose cutting tools from France in 1957.

In the 1960s Japan succeeded in the import of advanced technologies from Germany and the USA. Imported technologies were concerned with automation, high speeds and precision all of which Japan had been lacking. By the middle of the 1960s, assisted by these borrowed technologies, the technological level of Japanese machine tools industries reached that of Western countries, both in price and performance (Nihon Kikaikogyo Rengokai, 1982: 187-90).

The policy environment that made this possible began when Ministry of Commerce and Industry was reorganised into the Ministry of International Trade and Industry (MITI) in 1949. The newly established MITI made a principal development plan for the *machine industry* (May 1949). The main contents of the development plan were (Nihon Kikaikogyo Rengokai, 1982: 29-30):

1 Upgrading of technology to an international level, production of machines by local firms.

2 Policies for upgrading production technologies.

3 Policies for the improvement of management technologies.

4 Special policies for the export promotion of machine industries.

5 The import of foreign capital and technologies.

6 Policies for small-medium industries.

In order to develop the *machine industry* as a whole, it was recognised that upgrading of *parts suppliers* was important. In 1956, the Machine Industries Promotion Extraordinary Law (*Kikaikogyo Shinko Rinji Sochi-ho* or *Kishin-ho*) was enacted. This law described principle methods to provide promotional measures, such as financing and tax reductions, to designated industries. The government laid down five-year development plans for 19 designated industries shown below.

1. casting of hard steel irons,
2. die-casting,
3. nuts and bolts,
4. bearings,
5. gears,
6. machine tools,
7. arc welding and resister welding machines,
8. electrical tools,
9. cutting tools,
10. super hard and diamond tools,
11. moulds and dies,
12. hydraulic pumps,
13. sewing machine parts,
14. measuring apparatus,
15. testing apparatus,
16. parts and components for clocks,
17. mirrors and lens for binoculars,
18. resistors and capacitors,
19. auto parts

(Nihon Kikaikogyo Rengokai, 1982: 125, 146).

The parts suppliers were mostly composed of small-medium enterprises (SMEs) and the Law was considered as a measure for SMEs. Prior to the above law, in 1948 the SME Agency was established, and in the 1950s the gap between large enterprises and SMEs became a controversial issue, not only for themselves, but also for the national economy. The rescue of

SMEs and upgrading of their technological level were considered indispensable for the development of machine industries, including auto parts and electrical parts industries.

Parts suppliers imported machines and technologies from the West. From 1949 to 1959, the number of license agreements totalled 1,029 and nearly half were in machine industries.[27] Process technologies accounted for the largest number. Every year 20-30 per cent of the investment in equipment was investment to introduce new technologies under these license agreements (Nihon Kikaikogyo Rengokai, 1982: 89). For example, auto parts suppliers made license agreements with the US and German firms for fuel pumps, automobile engines, spark plugs, air brakes, air clutches, air springs, tachometers, rubber springs, engine valves, bearings, connecting rods, universal joints, etc. (Nakamura, 1983: 253). Ductile iron casting[28] was taught by Canadian Nickel, USA, to about 20 Japanese firms; *meehanite* iron casting[29] to about 20 Japanese firms; and shell mould technologies by a German company to about 200 firms. Shell mould technologies are good for mass production of thin precision casting parts. Other related technologies such as sand slingers (filling sands into moulds), shot blasts (cleaning of the surface), moulding machines, and a flow production method in pouring molten iron, were also transferred to Japanese firms (Nihon Kikaikogyo Rengokai, 1982: 186-7).

The import of the mass production (flow production) system from the USA became possible due to the change in the US policy to foster Japanese industries after the outbreak of the Cold War. The US firms showed and exported their advanced production systems to Japan. The US mass production system was based on continuous, synchronised production lines[30] with scheduled delivery time, the forerunner of Japan's JIT. "The continuous, synchronised movement of parts and assemblers to points on the final line where they are incorporated into the automobile is the outstanding feature of the assembly plant" ('mass production' in *The Encyclopaedia Americana*, Vol. 8, 1963: 399).

Supported by the industrial rationalisation policy, machines, technologies and the management and labour system of the mass production were imported from the West (Johnson, 1982: 112-4, 215-6). In the 1950s, mass production technologies and management methods gradually spread to automobile industries, electrical appliances industries, cameras and clocks industries (Nihon Kikaikogyo Rengokai, 1982: 193-5). Conveyer systems were introduced in assembly lines. Special purpose machines, automatic machines, continuous lines and partial transfer machines were introduced. In 1953 the first *transfer machine* in Japan was developed in-house at the Kyoto plant of Shin Mitsubishi for the production of small-size agricultural electrical generators (Nihon Kikaikogyo Rengokai, 1982: 193). *Transfer machine* (or *transfer line*) refers to a system of automation in which several machines are connected to conduct continuous processing. As a result, the ratio of automatic and continuous machines to all machines employed gradually increased (Table 3-4), labour productivity rose and production capacity expanded.

Table 3-4 The ratio of automatic and continuous machines

	1955	1959
The electrical home appliances industry	18.5	29.0
The automobiles industry	11.1	26.4
The machine industries as a whole	8.3	16.5

Source: Kikai Keizai Kenkyusho, *Wagakuni Kikaikogyo-no Otomeshon* (1960), quoted in Nihon Kikaikogyo Rengokai (1982: 194)

Concerning the organisational system (Freeman and Perez, 1988: 46), jobs of lower level workers were divided into extremely simplified tasks. These workers were called single task workers (*tan-noko*). Meanwhile, upper level workers were trained to become skilled workers (*ta-noko*) through OJT and job rotations. The synchronisation of tasks, automatic belt conveyers and the shop floor organisations enabled workers to achieve the highest productivity. The shop floor organisations of Japan developed differently from those in the USA (Koike, 1984: 48; Cole and Yakushiji, 1984: 173-4; Kenney and Florida, 1993: 28-9). From the workers' point of view, however, the flow production system was considered an inhumane production system (Kamata, 1981) which forced workers to become machines (Yamamoto, 1994: 314). Toyotism was criticised as a system to force workers into intense and irregular labour conditions with low pay and long hours (Saruta, 1995: 50-51).

In 1959, Toyota started the operation of the Motomachi plant, the first mass production automobile plant in Japan, fully equipped with new machines. Nissan completed the Oppama plant in 1962, followed by Isuzu and others. As a result, the production of automobiles increased and reached a million cars in 1962 and ten million in 1980 (Table 3-5).

Table 3-5 Introduction of mass production in the automobile industry (Japan)

	1930	1940	1950	1955	1960	1965	1970	1980	1990	1993
passenger cars		2	2	20	165	696	3,179	7,101	9,989	8,201
trucks	0.4	42	26	44	308	1,160	2,064	3,974	3,562	2,603
busses		2	4	5	8	19	46	101	41	47
total	0.4	46	32	69	482	1,876	5,289	11,176	13,592	10,851

Source: Nihon Jidosha Kogyokai (1994); *Jidosha Tokei Nenpo,* each year. (unit: number of cars in thousand)

3-3-2. Development of a new production system in Japan (1970-present)

In the 1970s and '80s, the Japanese machine industry began shifting to *automation*. This is different from the *flow production* in mass production which had spread in Japan since the 1960s. The *flow production* system imported from the USA was also called automation but it was a partial mechanical automation although it had been once "the most developed form of production by machinery" in Marx's term (Marx, 1990: 503).[31] Today's automation in Japan, developed after the 1970s, is numerical controlled (NC) and computer controlled (Yamamoto, 1994: 38). In more detail, today's automation is characterised by NC machines, NC robots (Freeman and Perez, 1988: 60-1), computerised automatic assembling lines, automatic material handling system, automated guided vehicles (AGV), automated storage and retrieval system (AS; AR), automated warehouse and central controlling units.

Yamamoto classifies today's automation into two categories, *line automation* and *flexible automation* (Yamamoto, 1994: 37). *Line automation* is the principal pattern of factory automation (FA). It is an advanced pattern of *product type workshop* before the war and *flow production* after the war (Table 3-6). The *line automation* seeks the highest productivity in mass-production for general markets (*sho-hinshu tairyo-seisan*). In this case, simple tasks may be replaced by machines and robots depending on the economic conditions, i.e. profitability. On the other hand, *flexible automation* is the production for ordered products (not for general markets, but for segmented markets), and aims to produce a variety of products by NC machines or MCs. Both flexible manufacturing system (FMS) and flexible manufacturing cell (FMC) are classified as *flexible automation* (Table 3-7).

The nature of today's automation is different from mass production of the 1960s in the sense that it employs micro-electronic technology. However, this does not mean that full automation is already achieved. It presented the "technological possibility to replace" workers' tedious, exhaustive labour with automation (Yamamoto, 1994: 35). For example, in the case of automobile production, spot welding is fully automated, whereas the body assembly is less than 20 per cent automated (Yamamoto, 1994: 38).

As Yamamoto says, automation will be introduced only to reduce costs. It will not be introduced to lighten "the day's toil of any human beings" (Marx, 1990: 492). If machines and robots are more costly than human labour, automation will not be advanced. For example, a survey in 1994 shows the existence of gaps in the use of automation among assemblers and subcontractors as follows (Tomita, 1995: 128):

(i) final assembly makers use large size transfer presses and large size press machines with robots,

(ii) first tier subcontractors use medium size transfer presses,

(iii) second tier subcontractors use progressive dies (*junso puresu*) and small size press machines with robots, and

(iv) third tier subcontractors use single press machines with manual operation.

It should be noted that even today a whole production system to manufacture automobiles by automation needs the support of multi-tier subcontractors in Japan. At the lower levels, subcontractors use manually operated single machines or only their eyes and hands.[32]

Table 3-6 Development of Japanese production systems (Yamamoto's model)

production system	examples
(1) manufacture	shipbuilding at the end of Tokugawa
(2) all-round machine workshop	shipbuilding in the middle of Meiji, machine tools making in Meiji
(3) *machine type* classification workshop	shipbuilding after Taisho/Showa, heavy electrical machine industry after Taisho/Showa
(4) *product type* classification workshop	automobile industry before and during the war, aeroplane industry during and after the war
(5) flow production system	automobile and light electrical machine industry during the high growth period (1960s and '70s).
(6) automation (a new production system)	assembly lines of servo motors, PCB, automobile units in the 1980s, welding lines of automobiles in the 1980s

Source: Yamamoto, 1994: 13-14; Amstead *et al*, 1987, 414-6. Summarised by the author.
The original table by Yamamoto contains descriptions of major equipment (seisan shudan), labour force and management system. (1) *Manufacture* was a production (and management) system which was managed by foreign experts or Dutch studies scholars, where craftsmen (shipwrights) were employed by subcontracting. Shipbuilding of wood-made boats by hand tools is an example (Yamamoto, 1994: 14; Marx, 1990: 455). (2) *All-round machine workshop* was a workshop to manufacture, e.g., boilers, steam boats, power transmissions, etc., by all round lathes. An all round lathe-man used an all round lathe to process every kind of machining from boring, cutting screws to shaping, finishing, etc. Precision was low, productivity was also low, but a variety of products were manufactured by all round skilled craftsmen. Machine tools making and shipbuilding in the Meiji era are the examples of this type (Yamamoto, 1994: 14). (5) *Flow production* was perfected for grain milling in the late eighteenth century in the USA (Rosenberg, 1972: 108).

Table 3-7 Today's automation and economies of scale

type	suitable machines	lot size(pieces)	product items
the line automation	Special purpose transfer lines	2,000 or more	1 - 2
	NC transfer lines	1,000 - 15,000	2 - 8
the flexible automation	Flexible manufacturing system (FMS)	20 - 2,000	5 - 100
	Flexible manufacturing cell (FMC)	25 - 500	10 - 800
(all-round machine workshop)	NC machine	25 or less	200 or more

Source: Yamamoto, 1994: 36-7; Inoue and Taniguchi, 1992. Summarised by the author.

Earlier, Piore and Sabel pointed out the difference between the two production systems "mass production" and "the craft sector" and called the latter *flexible specialisation* (1984: 26-7). It seems, however, that flexible specialisation only focuses on Yamamoto's flexible automation. As Yamamoto noted, in the case of the machine industry the core of automation is *line automation,* an extension of mass production, not flexible automation.

Flexible automation or more labour-intensive manual tasks are still widely found in the second and third tier subcontractors. Most of these tasks are called 3K (*kitsui* (exhaustive), *kiken* (dangerous) and *kitanai* (dirty)) industries and disliked. This is one reason for relocation of industries.

Table 3-8 Technology trade of major countries (100 million yen)

	Japan			USA			UK		
	export	import	ratio	export	import	ratio	export	import	ratio
1971	213	1638	0.13	8890	842	10.56	1002	938	1.07
1980	803	3011	0.27	16062	1641	9.79	2163	1867	1.16
1990	3590	8744	0.41	24086	4539	5.31	3003	3969	0.76
1992							3627	3025	1.20
1993	4311	7981	0.54	22683	5382	4.21			

Source: Kagaku Gijutsu Cho, 1994: 592-3; 1995: 436-7. ratio = amount of export / amount of import
Original source: Japan = Bank of Japan, USA = *Survey of Current Business,* UK = Department of Trade and Industry, overseas earnings from royalties. Data are collected and summarised by Bank of Japan. Statistics of "technology trade" of Japan was based on the official reports to the Bank of Japan. The sample covers not only manufacturing industry but also other industries such as wholesales and retails, restaurants, service industries, financing and insurance, etc., which are not included in the statistics by industry below

Table 3-9 Japan's technology trade by industry (billion yen)

	1974		1983		1987		1992		1993	
	export	import	export	import	export	import	export	import	export	import
All industries	57	159	240	279	215	283	377	413	400	372
Manufacturing industries	53	154	209	272	200	280	372	410	**394**	369
Textile industry			2	5	4	3	3	6	5	6
Steel and iron industry	**8**	6	40	17	9	8	8	3	13	3
General machine industry			10	28	8	21	21	27	18	25
Electric machine industry			35	91	61	109	106	178	127	159
Transport machine industry	4	26	28	46	**49**	48	126	53	127	40
Precision machine industry			4	4	2	6	5	22	4	22

Source: Kagaku Gijutsu Cho, 1994: 594-5; 1995: 438-9. ratio = amount of export / amount of import
Survey on "technology trade by *industry*" was conducted by Statistics Bureau of Management and Co-ordination Agency (Somu cho, Tokei kyoku). Data was collected by mail and the sample does not include wholesales and retails, restaurants, service industries, financing and insurance, etc.

As a result of the continuous borrowing, Japan has become a technology exporter in "technology trade" in some field, which is measured by the amount of payment for royalties and other technology fees. Until recently, however, Japan's technology trade has recorded large deficits (Table 3-8). The export/import ratio was 0.13 in 1970 and 0.54 in 1993. On the other hand, that of the USA was 10.41 in 1970 and 4.30 in 1993. The USA has been the world's largest exporter of technology.

By industrial type, Japan's automobile industry has shown surpluses since 1987 (Table 3-9). Other industries still showed trade deficits until 1992, except the steel and iron industry since 1974. It should be noted that at least until 1993 Japan was the largest borrower of technology in the world although the deficit ratios are getting smaller year by year. Borrowing technology is not wrong. It saves time and energy. It facilitates catching-up.

It is true that some technology imports represent patents and royalties without technologies as will be discussed in Chapter 5. Examples are Parker pens, pharmaceuticals, toiletries. These industries are established as monopolistic ones as Hymer stated and may possibly perpetuate dependence (Chapter 5). Nevertheless, most other industries such as textile industries and machine industries inevitably diffuse technology to less developed countries. Borrowing is necessary and not wrong.

3-3-3. Adaptation of US managerial systems in Japan

After WW2 the Japan-US relationship became close. American industrial engineering (IE), quality control (QC) and production management were actively studied among Japanese business societies. Production management aims to achieve the highest productivity of a firm covering all aspects of the firm's activity from the top to the shop floor, while IE focuses on the improvement of the shop floor. "Inventory management, reduction of waste, QC circles, robots, and automated factories" are examples of IE in Japan. McMillan admits that "their practice is more advanced in Japan than anywhere, even the US" (McMillan, 1985: 204). In practice, American IE has been modified into a new Japanese management concept which, it is said, has the following features (Suzuki, 1995: 84-5): shop floor workers' responsibility, suggestion system (SS), QC circles, multiple machine and process operation, *kaizen*,[33] zero defect (ZD), single minute exchange of die (Shingo, 1985; 1986: 272-3), 5 S (keeping the shop floor clean and tidy, see Glossary), just in time (JIT) and total productive maintenance (TPM).[34] Above all, it should be understood that "the most distinguished feature of Japan's management system is its quick adaptability to environmental changes" (Weiermair, 1991: 59), or, in short, "disciplined flexibility" (Weiermair, 1991: 75).

Production management is simply the management of production. A Japanese textbook defines production management as follows: "[T]he purpose of production *management* is, *for a firm*, to achieve the highest level of total productivity in the production of goods by co-ordinating holistically the various productive functions" (Seisan Kanri Benran Henshu I-inkai, 1962/1991: 6, translation by the author). This definition illustrates three things. First, production management refers to the firm-level technology. Second, it aims to achieve the highest level of total productivity. Third, it covers all productive functions and aims to co-ordinate them. As the objective of the modern firm is not only productivity but also quality, delivery, service and so on, this definition equals the contents of "technology" or "routines" of firms. The difference between "production management" and "routines" or "technology" is that the former implies great effort (management), whereas the latter does not imply any effort or targets. It simply refers to the knowledge and methods of production in existence as they are, even if unsophisticated and undeveloped. On the other hand, IE is the method to achieve production management. The efforts are placed on the activity on the shop floor. The typical IE starts from "work study" at production lines (Seisan Kanri Benran Henshu I-inkai, 1962/1991: 6-7).

Concepts of production management were borrowed from the West, however, it is said that Japanese production management is shop floor oriented whereas the American one is IE engineer oriented (Suzuki, 1995). As defined, production management is the management of a production system and requires co-ordination of various factors. The aim is a balance between respect for human beings and cost reduction (Ogawa, 1982: 176-90). Suppose that there is a work station with four workers, but the work volume assigned for the month can be handled by three persons, and one person becomes redundant: "Who should leave the work station in this case?" (Ogawa, 1982: 183-6; 1984b: 113) Ogawa says that the least competent worker should never be selected. If the person is really pushed out as redundant, the work station becomes a merciless place. The most important thing to do is, coupled with the best use of surplus equipment, for workers to help each other, not to push each other away:

> The standing practice is for the most competent one to leave this work station, enabling him to learn what goes on in other work stations to prepare himself for promotion to the status of foreman. The person who leaves the work station, joins the task force before being assigned to a new job. People in the task force help departments that are short of hands or assist stations in improving their work. (Ogawa, 1984b: 113)

As regards the harmony between machines and human beings, Ogawa brings in the term, *energy*, to measure the productivity, the relationship between input and output:

> Both input and output can be expressed in terms of energy units. There is material energy which represents raw materials and equipment and mental energy representing brainwork. Productivity improves when waste is either decreased or eliminated, materially or mentally, so that a larger percentage of energy input is obtained as output. (Ogawa, 1984b: 11)

What he intends to say is that the measurement of input by man-hour, or money, blurs the critical role of human efforts and effective use of machinery. This is why he used the word *energy* which expresses both human efforts and the role of machines such as numerical control (NC) machines, machining centers (MC) and factory automation (FA) (Ogawa, 1982: 26). He emphasises the role of field workers' autonomous activities in production management: "In the Japanese manufacturing plant, upgrading of the production goal is initiated by field workers who then make a concerted effort to realise such a goal. In other words, production management is field worker oriented or autonomous" (Ogawa, 1984b: 11).

It may sound strange when Ogawa concludes that "upgrading of the production goal is initiated by *field workers*" and "production management is *field worker oriented* or autonomous". The following section will elucidate this point.

IE in the USA originally meant work-study to analyse worker's activity to improve productivity. In Japan, however, IE activity was expanded to cover the whole shop floor improvement by all parties concerned. In that sense, the concept of IE in Japan became equal to the concept of production management as shown in Table 3-10.

Table 3-10 The US-Japan gap in management concepts by Suzuki

the concept of:	in US (the way Japanese understand)	in Japan (the way Japanese adapted)
1. production management (management of production system as a whole)	management of production excluding pre-production, top down method	improvement of both production and pre-production, field worker oriented or autonomous
2. IE (management of human work)	human work study by the IE engineer	shop floor improvement by all people concerned

Source: Suzuki, 1995: 9; Ogawa, 1984b: 11. Summarised by the author

Suzuki explains the nature of Western IE, characterising it as the method to determine standards for incentive systems. Consequently, the industrial engineers' study must be precise and reliable enough to persuade labour unions. Suzuki says:

> It is very important to understand that IE is utilized in three different ways. Up until now, nobody has clearly discussed this point. People often discuss different things using the same term "IE". There are no definite terms to express these three different IEs, the author calls these 1) Basic IE, 2) Traditional (Western) IE, and 3) Japanese IE. Basic IE is the original type of IE, which is used for problem finding and problem solving by industrial engineers. Traditional IE is the way that IE is utilized in many Western companies, in which IE is utilized for determining standards (norms and quotas) for incentive systems and not for problem finding and solving. In contrast, Japanese IE is the way that IE is utilized in good Japanese companies for problem finding and solving in a simplified and modified manner by all people concerned, including middle management, engineering staff, supervisors and, even line workers. (Suzuki, 1995: 9)

Japan's production system is very often represented by Toyotism. However, this does not mean that other Japanese firms have not improved their production systems nor that they have totally different production systems. Continuous improvement of production systems has been exercised by many Japanese firms including SMIs. For example, lectures on production improvement and QC were broadcast by NHK on radio from 1956 and on TV from 1957 to 1962. It is said that NHK sold more than one hundred thousand textbooks to accompany the broadcasts (Noda, 1988: 545-54).

From 1950 Juran and Deming came from the USA to teach statistical quality control (SQC) in Japan. At first students were mainly top management and division heads. Gradually the study of SQC changed direction in Japan as Shingo explains:

> QC leaders in Japan insisted, however, that the people who actually generate product quality are shop foremen, group leaders, and workers; by 1961, the focus of education and training began to shift to these people. In 1962, the QC circle idea was born when Professors Tetsui Asaka and Kaoru Ishikawa, among others, pointed out that if people of the shop floor are really the ones who generate quality, then those people should participate through circle activities. (Shingo, 1986: 269-70)

Business societies in Japan thus put emphasis on the autonomous activity by field workers (Ogawa, 1984b: 11), egalitarian job rotation and mobility (Koike, 1984: 61-65) and the QC circles by workers, not by top management (Shingo, 1986: 269-70).

Shingo, a technical school graduate before the war, learnt the US-made SQC after the war and developed this SQC to zero defects (ZD). In Shingo's understanding, SQC is a science of inductive statistics which adopts sampling inspections, standard deviations and control charts in the plant management. But the problem of SQC is that it adopts afterward-inspection. What Shingo wanted was inspections before production processes. He says he came across the idea in Germany. In 1971 at Wotan, a moulding machine manufacturer at Düsseldorf, a Japanese businessman asked if this factory carries QC and why there is no control charts in this factory. The representative at Wotan answered to visitors from Japan: "The basic idea behind our approach to quality control is to prevent defects from occurring in the first place." (Shingo, 1986: 51)

Back in Japan, Shingo made great efforts to find methods which excluded defects entirely. Approaches experimented with were successive-checks, self-checks and source-inspections. In 1977, the Shizuoka plant of Matushita Electric's Washing Machine Division achieved a continuous zero defects over months in a drain-pipe assembly line operation, involving 23 workers, handling 30,000 units each month. After observing this achievement, he completed the theory of ZD as following:

1. Use source inspections, i.e. inspections for preventing defects, to eliminate defects entirely. This does not mean dealing with the results of defect generation, it means applying control functions at the stage where defects originate.
2. Always use 100 percent inspections rather than sampling inspections.
3. Minimize the time it takes to carry out corrective action when abnormalities appear.
4. Human workers are not infallible. Recognize that people are human and set up effective poka-yoke (fool-proof) devices accordingly. (Shingo, 1986: 54)

Fool-proof (*poka-yoke*) devices were first invented by Toyota and soon became popular in the industrial society of Japan (Shingo, 1986: 45; Monden, 1994: 227-32).[35] Thus ZD quality control as theorised by Shingo has become a main pillar of Japan's industrial management. Shingo points out the shortcomings of mathematical techniques of SQC which is only good for theory-oriented technicians. He argues that such SQC promotions very often "ended up alienating shop technicians and front-line supervisors, especially shop foremen, group leaders, and team leaders, who have to bear the responsibility for quality control" (Shingo, 1986: 66).

A typical feature of Taylorism[36] is the maximised division of labour depending on each worker's specialisation in a single machine. Today's Japanese mass production systems adopt multiple machine and process operations dependent on multiple skilled workers. The separation of machines from workers enabled the emergence of multiple skilled workers and multiple machine and process operations (Shingo, 1981: 81). This became possible because machines had become reliable, already depreciated and many machines had been available at that time (Shingo, 1981: 81-2). At the beginning of the 1950s in Toyota: "3,500 sets of machines were equipped in the machine plant and only 700 workers were in charge of them. Namely, one man operates on an average 5 machines" (Shingo, 1981: 82). The layout was changed to make multiple machine and process operations easy from a linear line to L line and then to U line (Monden, 1994: 159-166). Multiple machine and process operations and the improved machine layout enabled small lot production and the decrease of transportation/stocks (Shingo, 1981: 36-8, 51-4; Monden, 1994: 109-116). Multiple machine and process operations have become possible through job rotation of workers (Monden, 1994: 166-75).

The theory of shortening set-up time is attributed to Shingo (Shingo, 1985). Shingo says that he came across the idea of shortening set-up time first in 1950 at Toyo Kogyo's Mazda plant in Hiroshima when he had conducted an efficiency improvement survey, where the efficiency was raised by about 50% by distinguishing the internal set-up (IED) and external set-up (OED).

In 1969 Shingo started working with plant staff to shorten the set-up time for a 1,000 ton press at Toyota Motor Company's main plant, which then required four hours for each set-up change. By taking special pains to distinguish IED and OED, they worked to improve each separately. After six months they succeeded in cutting set-up time to 90 minutes (Shingo, 1985: 21-6; Monden, 1994: 121; Hammett *et al*, 1995: 254) and later it was shortened to a single minute (Table 3-11) and named single minute exchange of dies (SMED). The SMED plays a great role in reducing stock (Shingo, 1986: 15-6) and enables small-lot production with JIT systems (Ogawa, 1984b: 64-6, 120-22). Kaplinsky in 1994 showed how SMED was effective in shortening set-up time and decreasing lot sizes (Table 3-11). In fact, SMED, small lot, one piece flow, multiple machine and process operation, etc. are all interdependent and influence productivity improvement as a whole. This is the Japanese IE and QC approach.

Table 3-11 Shortening of set-up time and reduction of lot-size in Toyota

Division			1970	1975	1980
Stamping	Set-up time	minutes	40-150	20-30	5-15
	Lot size	no. of items	5,000	1,500	500
Forging	Set-up time	minutes	100-200	20-50	10
Casting	Set-up time	minutes	60	20	4

Source: Kaplinsky, 1994a: 25

3-4. Development of the subcontracting system

3-4-1. The formation of the subcontracting system

In the last stage of the war, parts suppliers were deployed in military production, yet they suffered shortages of labour and raw materials, received heavy air attacks, and by the end of the war their houses and workshops were mostly destroyed. After the Second World War, auto parts suppliers resumed the production of spare parts mainly depending on the procurement by the Supreme Commander of the Allied Powers (SCAP). Scattered suppliers gathered and reorganised the National Auto Parts Co-operative in 1946, which was later changed to the Association in 1948. Following the similar methods to that adopted during the war, the government issued certificates for 593 products, 102 items and 297 factories (Amagai, 1982: 108-9). From 1950 to 1952, "SME counterpart funds loans" by US Aid Counterpart Funds was advanced to SMEs (Shoko Chukin Bank, 1987: 184). From 1953 onwards the Japanese government introduced special arrangements to allow SMEs to purchase machinery obtained by the "reparations program".[37] The general system of industrial promotion was the continuation of the war time promotion (Johnson, 1982: 112-4, 215-8).

After the Korean War, due to the rapid increase in demand and the shortage in capacity, each LI began organising suppliers under its umbrella and provided technical assistance and raw materials, arranged necessary machines and assisted them in finance (Chusho Kigyo Chosakai, 1960: 253-91). The Machine Industry Promotion Extraordinary Law (Kikai Kogyo Shinko Rinji Sochi-ho) in 1956 facilitated suppliers' investment,[38] which aimed to rationalise equipment of small-medium size parts suppliers in order to promote competitive machine industries including the auto parts industries (Nihon Kikaikogyo Rengokai, 1982: 125).

It was thought that if trade and capital inflows were liberalised, Japanese manufacturing industries might not be able to survive the competition with the US industries (Nakamura, 1983: 256-8). In order to compete with them, Japanese industries had to be rationalised by the introduction of Fordism and Taylorism to prepare for the liberalisation of trade and capital inflow (Sei *et al*, 1976: 34-5). In 1960, the government laid down the principal policy for the liberalisation of trade. Following this policy, the import of passenger cars was liberalised in 1965 and the capital transactions were liberalised in 1971 (Amagai, 1982: 180-1; Sei *et al*, 1976: 34-5).

Until the middle of the 1950s, auto parts suppliers had no confidence in the future constant orders from assemblers. Neither had they been organised yet under specific assemblers although they were provided raw materials and technological advice from assemblers (Nagao, 1995: 154). Towards the end of the 1950s, however, organising of parts suppliers (subcontractors) advanced (Nagao, 1995: 154; Sei *et al*, 1976: 34-6). They were thus organised into subcontractors' circles so-called *kai* (Womack *et al*, 1990: 60-1). Assemblers' dependence on specified parts suppliers increased (Takeda, 1995: 227) and subcontractors were dissolved into multi-tier strata (Takeda, 1995: 227-233).

For example, members of Toyota's Kyoho *kai* were divided into four sub-circles; (i) firms of casting, forging, and machining, (ii) press shops, (iii) special parts suppliers, and (iv) body parts suppliers. In addition, Toyota's Kyoho *kai* had nine study groups (*i-inkai*) such as "management group", "technology group", and "process control group". In 1954, Nissan also organised its subcontractors' circle, the Takara *kai* (Amagai, 1982: 215-7; Nagao, 1995: 154). Members of the Takara *kai* were grouped into five sub-circles (*bukai*); (i) complete parts suppliers, (ii) machining parts suppliers, (iii) press parts suppliers, (iv) body shops, and (v) dies and jigs suppliers. Furthermore, the Takara *kai* had five study groups (*i-inkai*); mass production, basic training, transportation, value analysis, and international trade liberalisation (*boeki jiyuka*). In the case of Mitsubishi at Mizushima, subcontractors organised a subcontractors' co-operative in 1962. In 1966, they moved into an industrial estate developed by the government.[39] Subcontractors of Hitachi and Toshiba also organised subcontractors' co-operatives. Examples of subcontractors' co-operatives are quite numerous (Nagao, 1995: 179; Nakano, 1978: 257).[40]

When the automobile promotion began after the Second World War, neither the price nor quality of Japanese auto parts was competitive. In 1955 the price level of parts was 60 per cent higher than on the international market and the target was set to lower this to 40 per cent higher by 1960 (Amagai, 1982: 162; Takeda, 1995: 229-30). In the period 1956-60, the cost of purchased parts and subcontracting (for assemblers) occupied 40 per cent of the chassis cost; and the ratio of the cost of purchased parts and subcontracting (for parts suppliers) occupied 24-27 per cent of the total cost (Amagai, 1982: 162; Takeda, 1995: 230). This meant that without cost reduction and quality improvement of parts and subcontracting, the international competitiveness of automobile industries would not be achieved.

In order to achieve cost reductions among subcontractors, Western machines and technologies in casting, welding, bearings, hydraulics, auto parts, etc. were introduced to the major machine industries (Nihon Kikaikogyo Rengokai, 1982: 186-7; Amagai, 1982: 164-7; Sei *et al*, 1976: 41-2). Government legislation, such as the Machine Industries Promotion Extraordinary Law, and financial support, such as preferential allocation of funds with low interest rates, helped to construct competitive auto parts subcontractors (Amagai, 1982 ; 159-64; Takeda, 1995: 229; Nihon Kikaikogyo Rengokai, 1982: 125).

As a result of the import of machines and technologies, the subcontractors' technology was upgraded (Amagai, 1982: 301-2). For example, in 1954-59 some parts suppliers grew to become large industries and their shares increased; in 1962-63, the market shares of the top three producers exceeded 90 per cent in seven items—i.e. piston rings, spark plugs, handles, etc. (Takeda, 1995: 232). Thus, upon the formation of the multi-tier strata of the subcontracting system, Japanese mass production system was completed. In the 1960s, many Japanese manufacturing industries became the world's top level firms (Nihon Kikaikogyo Rengokai, 1982: 202; Nakamura, 1983: 384-6).

3-4-2. Second and third tier subcontractors

Mass production requires the synchronisation of tasks not only within the assembler's plant but also with external agents, i.e. the subcontractors (*shitauke*).[41] The assemblers requested parts to be delivered to designated places "just in time" (JIT). In the process of the synchronisation, the first tier subcontractors assumed the responsibility to organise lower level subcontractors. In other words, some parts suppliers, i.e. the first tier suppliers, grew to become large industries, while many others, excluded from the first tier, were demoted down in the production hierarchy and became second and third tier subcontractors (Sei *et al*, 1975: 74-80; 1976: 60-78).

Roughly speaking, the dividing line between the upper level (first tier) and the lower level (second and third tier) subcontractors largely settled down at an employment size of 300 persons (Sei *et al*, 1976: 41). The upper level subcontractors introduced mass production systems and grew to be large profitable firms, whereas the lower level firms were forced to pick up small lot jobs, metalworking or moulding processes (Sei *et al*, 1976: 60-63). For example, when Prince Kogyo Co. was annexed to Nissan in 1966, among 103 members of the Prince Kogyo's *kai*, only 13 firms were chosen to be members of Nissan's *kai*. Others were excluded from the first tier subcontractors. Another example was the case that Nissan decreased its first tier subcontractors from 150 firms to 30 firms by the synchronisation of its production lines (Sei *et al*, 1976: 60-63).

Just as Toyota and Nissan had organised their subcontractors, the major first tier subcontractors also made their own circles (*kai*) and organised the second tier and the third tier subcontractors into their *kai* (Sei *et al*, 1976: 65-7; Womack *et al*, 1990: 60-1). In order to organise the second and third tier subcontractors, the first tier subcontractors cemented relations or human relations with the second and third tier subcontractors, and improved business relations with them by providing raw materials, moulds, dies, jigs and fixtures (Sei *et al*, 1976: 64).

It was said that lower wages of workers at subcontractors and the competition among lower level subcontractors made further cost-cutting possible (Sei *et al*, 1976: 67-8). Assemblers regularly checked and supervised production lines of first and second tier subcontractors. In some cases, assemblers even went to check third tier subcontractors' plants to assure the quality and synchronisation of the final products (Sei *et al*, 68-9).

First and second tier subcontractors gave subcontracting-orders not only to the existing subcontractors, but they also gave orders to new subcontractors. They even suggested their employees become independent subcontractors, or their family members work at home or at factory (Sei *et al*, 1976: 71). Subcontractors working at factories were called in-house subcontracting (*shanai shitauke*) (Sei *et al*, 1976: 71). In the following we will see some examples of second and third tier subcontractors.

Yokogawa Electric, Nakajima Aeroplane, Nihon Musen, etc. were the first large scale machine factories established in Mitaka, a former agricultural area on the edge of Tokyo. They were established in the 1930s and became military plants in the 1940s. Around these large scale factories gathered small workshops initiated by spin-off engineers, workers or former craftsmen. After the war, the large scale military plants were closed down by SCAP and people with technological backgrounds lost their jobs. When large-scale companies were permitted to resume productive activities and increase their production, they utilised small workshops as subcontractors. Furthermore, they even helped their employees to become independent subcontractors, which were mostly household workshops. In these cases, subcontractors were provided parts, raw materials, or sometimes machines (Nakano, 1956/1978: 237-52).

In Ibaragi in 1961, T Press, a first tier subcontractor of Hitachi, moved from Hitachi city to Suifu-mura which was then an agricultural village near Hitachi city. Twelve years later in 1973, there were 20 Hitachi's subcontractors in Suifu-mura; three first tier and 17 second tier subcontractors. The employment size of the first tier subcontractors ranged from 20 persons to 63 persons, and that of the second tier subcontractors was less than 20, ten persons on average. Among the 17 second tier subcontractors at Suifu-mura, nine firms were initiated by employees of T Press, two firms by employees of Hitachi Co., and four firms by farmers. First and second tier subcontractors were equipped with assembly lines, NC machines, and automatic lathes. First and second tier subcontractors subcontracted some of their jobs to the third tier which was composed of household workshops or household workers each numbering less than 10 workers. The third tier household workshops were engaged in painting, tapping, press works or milling machines. Meantime, household workers engaged in unskilled, labour-intensive manual works such as the winding of coils, soldering of lead lines, removing of burrs and caulking of cracks. When the volume of orders decreased in a depression, the first step was to cut the jobs of the third tier subcontractors, including that of household workers, and secondly to cut the number of employees at first and second tier subcontractors (Nagayama and Aono, 1976: 159-60).

Mitsubishi relocated to Kumamoto, an unindustrialised agricultural prefecture in the southern part of Japan, because it offered cheap land and labour. As such it marked the first step or the first goose in the industrialisation of the area. In 1967 Mitsubishi established an IC plant followed by NEC's IC plant (Kyushu NEC) in 1970. Subcontractors were created gradually in the late 1970s and '80s. At the end of the 1980s, Mitsubishi had six subcontractors and Kyushu NEC nine in Kumamoto. They engaged in assembly works, electroplating, production of raw materials and photo masks, etc. It was understood to be economical to use subcontractors because they save set makers' investment funds, function as shock absorbers in times of economic depression and take orders at lower costs (Ito, 1992: 154-9).

In the same token, farmers' stables in Sakaki, a village in Nagano prefecture, were converted to about 50 small-size machine workshops by installing NC machines, which Peter Drucker praised as a good example of the Japanese subcontracting system. The owners of these household workshops were mostly spin-off workers. In Northern Kyoto, a suburban area, there were 1,283 machine factories, among them only 68 firms had over 50 employees and only two firms over 300. The majority were household workshops which normally function as the lowest level subcontractors (Morino, 1995: 162-5).

As shown above, the shift of second and third tier subcontractors from the industrialised centres to local areas occurred in the 1970s and '80s (Morino, 1995: 168). However, in 1994 when Morino surveyed the above two new industrial districts, Sakaki and Northern Kyoto, they were found to be suffering from a sharp decrease of orders. This reveals the fact that the Japanese multi-tier subcontracting system functions as a shock absorber in depressions (Morino, 1995: 167-8). They are always at the brink of losing jobs. While first tier subcontractors converted to mass production systems by investing in machines, the lower level subcontractors chose to utilise low wage household workshops and household workers (Sei *et al*, 1976: 71-2). Both upper and lower level subcontractors were necessary as a whole for the automobile industry and other machine industries. The existence of the abundant lower level subcontractors, their low wages and the hard-working habits, and their endless competition, is the characteristic of the multi-tier Japanese subcontracting system (Nagao, 1995: 190; Nakamura, 1983: 412-3).

3-5. The machine industry, today and tomorrow

3-5-1. Restructuring of SMIs in the machine industry

As Yamanaka pointed out, the subcontracting system was first formulated at a specific development stage of Japan's national economy, i.e. the autarchic economy. Since then, after experiencing war-time destruction and post-war reform, it has reached the present day's subcontracting system.

The specific nature of the subcontracting system lies, as Minato says, in its parent-subcontractor relationship constructed upon mutual trust. In the USA or the UK, in contrast, business relationships in procurement stand on contracts, preferably with contingent claims (Minato, 1988, 1994: 7; Ikeda, 1991: 328). In Japan, a parent enterprise expects its subcontractors to follow after it when it adopts new policies whatever they may be. Typical examples are expansion of production capacity (volume), VA (cost), QC (quality) and JIT (delivery). Also, FDI is a significant test of the subcontractor's risk taking spirit. Thus, the parent-subcontractor relationship has never been permanent and is always changing. Request for change and challenge never ends.

Nevertheless, many low level subcontractors have become unable to follow their parent enterprises' requests. The termination of parent-subcontractor relations is caused not only by parent enterprises but also by subcontractors (Kikaishinko Kyokai, 1991: 30, 36).

The role of subcontractors differs according to their positions in the hierarchy. In most cases, first tier subcontractors are large firms, second tiers are medium size, and third tiers are household size. In a survey of automobile subcontractors in Kanagawa prefecture in 1992 (Fujimoto, *et al*, 1994),[42] the average number of employees in the first tier was 1,200 persons, the second tier 70, and the third tier 10. In another survey in Aichi prefecture in 1993 (Yoshijima, 1994), first tiers are mostly of large size and manufacture "system units", whereas second tiers are of medium size (of less than 500 employees) and manufacture "sub-units" or parts for the first tiers' "system units". According to the Kanagawa survey, 60 per cent of the first tiers were capable of developing their components or parts in-house. Many of the first tiers were no longer dependent on one parent. They had developed into specialised firms in specific items and had many customers, whereas most second tiers still relied heavily, in many cases, 100 per cent, on one firm.

In contrast, in the case of third-or-more tier subcontractors, the lot of orders are small and unstable. They have to rely fully on part-time workers, mostly women workers, and more than 30 per cent of them employ foreign workers. In the case of the third tiers in Kanagawa, the average age of workers was 46 years old and 25 per cent of firms were considering the "changing of jobs (*tengyo*)" and 10 per cent "abandoning of jobs (*haigyo*)" (Fujimoto *et al*, 1994). Employees are ageing, orders are decreasing. The declining trend of the third-tiers was therefore apparent in the 1990s (Morino, 1995: 162-8; Ikeda, 1995: 21-22).

The sacrifice of declining industries is not new in Japan. It is a Japanese tradition to accept a partial sacrifice for the greater good. The SME Basic Law in 1963 will show this point. A government publication at that time stated the principle of SME policy as follows.

> SME today has entered a new stage of the national economy. Japan now faces international pressure to liberalise trade,[43] rapid changes in technologies, and needs to achieve changes of the supply-demand structure suitable to the upgraded national income level. On the other hand, the high growth of the national economy has incurred a serious issue of labour shortage. This means that the role of SMEs is going to be undermined. In order to adjust to this situation, SME has to up-grade itself, has to construct international competitiveness and has to contribute to the achievement of a well balanced national economy. The government policy has to be formulated according to the **potential** of each SME's industrial sector. (Chushokigyo Pii Aaru Senta, 1963, emphasis added).

Then, what is the *potential* of each SME? The Committee on SME Policy, set up at MITI and chaired by Yamanaka Tokutaro, proposed a method to examine SME's potential which comprised material-based productivity (*butteki seisansei*) and value-realisation (*kachi jitsugensei*). Here, material-based productivity means the productivity measured by materials —numbers, units, pieces, weight, etc. And value-realisation potential refers to the possibility of realising sales. If a product is continuously sold in the market at price levels sufficient to continue production, it is said that value is realised or value realisation is achieved. From the viewpoint of material-based productivity, SME is classified into five groups from V to Z:

V: Demand is going to shrink, material-base-productivity should not be supported, the "changing and abandoning of jobs (*ten-pai-gyo*)" is recommended (77 sectors).

W: Because of the growth of LE, SME has little chance to grow, two choices are possible, to let LE grow and SME do the "changing and abandoning of jobs (*ten-pai-gyo*)" or regulate LE and let SME modernise (22 sectors).

X: Demand will grow but technical changes to improve material-base-productivity are not probable (56 sectors).

Y: Demand will grow and material-base-productivity will be improved if new technologies are invented (180 sectors).

Z: Demand will grow and the chances are apparent to improve material-base-productivity (26 sectors).

From the viewpoint of value-realisation potential, SME is classified into four groups.

A: Competition with LE does not exist. The problem lies in over-competition among SME (125 sectors).

B: Competition between LE and SME exists. Problems depend on each industry, more analysis is needed (93 sectors).

C: Subcontracting under trading capital (75 sectors).

D: Subcontracting under manufacturing capital (68 sectors).

(Chushokigyo Pii Aaru Senta, 1963: 16-8)

In conclusion, the Committee classified the 361 industrial sectors of SME into 5×4=20 cells which is the multiplication of V-Z and A-D. Sectors in each cell were not disclosed. Following the framework of the above mentioned classification, five-year-modernisation programmes were initiated by the SME Modernisation Promotion Law (1963). Since 1963 up until 1975, programmes were applied to 181 industrial sectors in total. At the same time policy measures for the "changing and abandoning of jobs (*ten-pai-gyo*)" were introduced. It is noted that the method is exactly the same as that adopted in the case of "changing and abandoning of jobs (*ten-pai-gyo*)" during the war time in the sense that important industries are promoted and unimportant are urged to change or abandon jobs (Yamanaka, 1948: 175).

The selective restructuring of SME was strengthened when the two oil shocks hit Japan's economy in the 1970s. Cost reduction and small lot production became a must for survival. Education of production management was extended to upper level subcontractors. For example, Aoyama, a subcontractor of Toyota, started the *kanban* system in 1976.[44] Mitsubishi Mizushima started subcontractors' education in 1979 (Ikari, 1988: 126). Many upper level subcontractors became independent. They accumulated technological capability enough to start R&D activity by themselves. For example, a survey showed that 45 per cent of the small-medium machine industry firms had design and R&D capability in 1994 (Shoko

Chukin Bank, 1995: 55-7; Shoko Sogo Kenkyu sho, 1995). In order to adjust to the labour shortage and the need for quality improvement, the introduction of automation and factory automation (FA) diffused considerably from 1988 to 1994 among the small-medium machine industries. As a result, in 1994 many small-medium machine industries were equipped with NC machines (70.2%), MCs (47.2%), industrial robots (39.7%), CAD (59.3%), CAM (22.2%), etc. (Shoko Chukin Bank, 1995: 56-60).

On the other hand, some of the lower level subcontractors could not catch-up with the new technologies and faded out in the 1980s (Koseki, 1994: 192-4). In order to adjust to the labour shortage and to adapt to small lot and precision works, the introduction of NC machines, MCs and EDMs became popular among machine industries in general.[45] Even for SMI, utilisation of NC machines gradually became necessary. According to the introduction of NC machines and computerised transfer machines, most traditional type of skilled workers became redundant in these factories (Koseki, 1994: 192-4). For example, in Ota-ku, Tokyo, an industrial complex of high technology household machine shops, 284 firms were closed resulting in the loss of 2,383 employees in the last three years (Morino, 1995: 168). However, this does not mean that all lower level subcontractors had to introduce NC machines or transfer machines. The traditional type of skilled worker still exists and they still use old general purpose machines such as single press machines (Tomita, 1995: 128-9). Many would not want to use NC machines even if they were installed.[46] They can not adapt to the new environment even if their future is not bright.

The newest policy to mitigate SMI's shocks from the economic changes was "the Shitauke SMEs' Adjustment Loan Scheme" started in 1987 (see 3-2-2). Qualified borrowers under this scheme were (i) subcontractors belonging to the designated 163 industrial sectors, and (ii) subcontractors which recorded at least 10 per cent decrease in sales amount due to declining orders from parent enterprises or expected at least 15 per cent decrease of sales due to the cut in domestic production at the parent enterprises (Kikaishinko Kyokai, 1987: 105-14).

3-5-2. A relocation model for the machine industry

As mentioned, Japan's subcontracting system constructs a multi-tier structure, comprising first tier, second tier and third tier, etc., above these are the parent enterprise or LI. In the Japanese language LI on the top is called *setto meh-kah* (set maker) or *assem-burah* (assembler). Examples are Toyota and Hitachi (producers of end-consumer-products) and Nippon Denso and Koito (producers of complete parts).

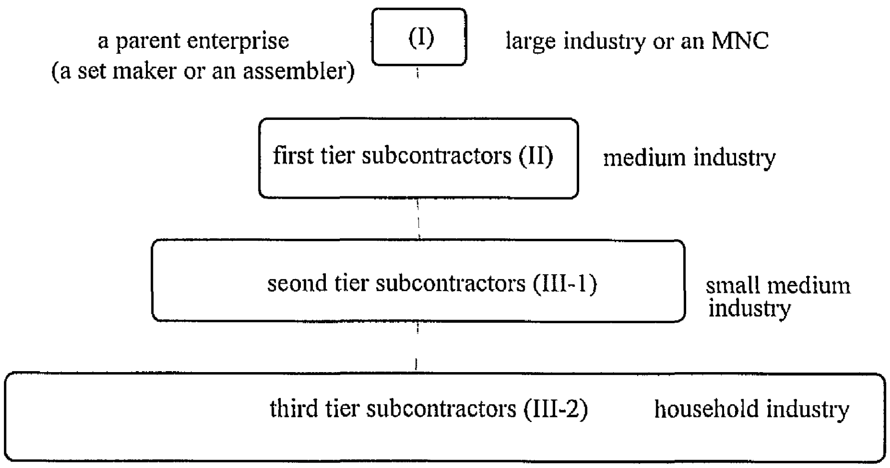
In the case of Toyota, the number of subcontractors working for Toyota is said to be 40,000 or 50,000. However, Toyota's direct contact with suppliers is exercised only with about 1,100 firms.[47] In contrast, GM is said to have direct transactions with over 10,000 manufacturing firms (Kikaishinko Kyokai, 1993: 1-3). The gap demonstrates the difference in the production systems of two countries. In Japan, a set maker's (or an assembler's) plant—such as a plant for TVs, automobiles, etc.—makes the core of a cluster of machine industries. In Kanto, Osaka and Aichi, many such clusters are found, which are called castle towns (*johka-machi*). The product item which the parent enterprise manufactures influences the content of the cluster of the each district.

It is natural that the technology required for subcontractors depends on the assembled product at the castle. Cassette radios and automobiles, as a matter of course, require different types of technologies and tasks. What product is to be assembled, or not to be assembled, at the castle? If a product is decided not to be assembled there, then where should the assembly plant be moved, to Hokkaido, Kyushu or Thailand? The decision made on the question inevitably determines a subcontractors' existence. The parent enterprise decides, and subcontractors follow or are excluded. This is the structure of Japan's machine industry, i.e. the relationship between the parent enterprises and subcontractors (Kikaishinko Kyokai, 1993: 7-11).

In Figure 3-1a, a model of Japan's machine industry, "the castle town model", is introduced (Kikaishinko Kyokai, 1993: 2). It comprises three levels of technologies;

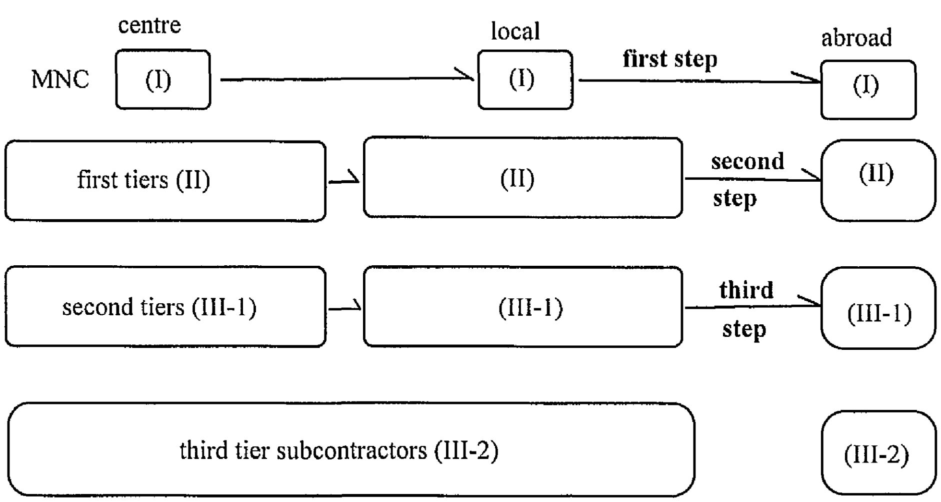
(I) is "product specific high technology for manufacturing and final assembly" (a parent enterprise).

Figure 3-1a The model of a "castle town (industrial cluster)"



Source: Kikaishinko Kyokai, 1993: 2 (modified)

Figure 3-1b The model of relocation



Source: Kikaishinko Kyokai, 1993: 14-24 (modified)

(II) is "product specific applied technology for unit production" (a first tier subcontractor). (III) is "all-round basic technology for process and assembling" (a second and third tier subcontractor).

(I) is undertaken by large industries (LI), or so-called MNCs; (II) by medium sized industries (MI); (III) by SMI. (III) is further divided into (III-1), capitalistic firms with employed workers, and (III-2), household firms of about ten persons composed of family members, female part timers or foreigners. (I) and (II) undertake product-specific works, whereas (III) is in most cases in charge of specific processes, such as welding, stamping, machining, or assembling. These jobs flow, in principle, downwards step-by-step from upstream (I) to the bottom tier (III-2). However, in practice, the flow is entangled. Not only downward flows but also horizontal or upward flows can be observed (Fujimoto *et al*, 1994: 15). In any case, a parent maker's change of products and production sites affects subcontractors.

The Figure 3-1b is a model of relocation of the machine industry (Kikaishinko Kyokai, 1993: 14-24). From the viewpoint of parent enterprises, the expansion of the production capacity was undertaken firstly at the original plant sites, normally in densely inhabited big cities. Later, as the original sites became crowded as residential districts, and, consequently, the cost of land and labour increased, the parent enterprises were urged to find new plant sites in the local areas, first in the Northern Kanto, later deep into the Northeast, the Japan Sea coastal areas or Kyushu.

Relocation was planned not only within Japan but also to foreign countries. What follows is the case of relocation to Thailand. First in the 1960s, urged by the import substitution policy, the relocation of a small number occurred (first step in Figure 3-1b). From the 1970s to the early '80s, further relocation occurred partly due to land-labour shortages in Japan and partly because of the local content regulations in Thailand, but still on a small scale (second step). After 1985, a large scale relocation occurred (third step), triggered by the high value of the yen.

Every relocation of LI, entry or departure, so far affected subcontractors of each district. Entry of a parent enterprise to a new district requires formation of a new production system of (I), (II) and (III). If relocation is conducted domestically, the thin density of (I), (II) and (III) will be supplemented by the supply from the old castle town although it may be costly because of the distance. Little by little, the formation of the (I), (II) and (III) firms at the new district under the new castle will take place. The departure of a large plant of assemblers or set makers has many effects. From the centre in megalopolis, many items have already transferred to local areas or abroad. Consequently, the function of LI's plants (I) in the centre of Japan (Figure 3-1a) was changed from that of low-end mass-production to the R&D activities or R&D related small-lot trial productions. This naturally accompanied technological changes in the down stream subcontractors (II, III) at the centre in megalopolis. Their technology also shifted from low-end mass-production technologies to R&D related high technologies. Although (III) in the centre are equipped with similar equipment to that of the local areas, technological levels in the centre are higher. They are capable of undertaking the most difficult processes for a variety of items, each in a small lot size, which need in-house manufacturing and the improvement capability of jigs, tools and equipment. Their technological levels are, both in creativity and sophistication, very high (Kikaishinko Kyokai, 1993: 6-7). Otherwise, they could not survive the competition with the local and foreign subcontractors (Yukawa, 1994: 181-4; Koseki, 1994: 192-3; Seki, 1990: 96-7).

Japan's subcontracting system as a whole, at least until 1990, was supported by the continued increase in the total demand in the market, including export markets. Neither relocation nor technological changes seems to have deprived subcontractors of the jobs. Decreases in the absolute number of firms and workers in the machine industry seem to have started only after 1990 (Table 3-12, Table 3-13). According to Shoko Chukin's calculations, the total number of SMI's employment in all machine industries increased by over 20 percent from 1980 to 1985 and over 4 percent from 1985 to 1990, whereas, in LI (over 1000 persons), the number employed increased by only 11.5 per cent from 1980 to 1985, and decreased 0.3 percent from 1985 to 1990 (Shoko Chukin Bank, 1993: 87). Calculations show that employment in LIs decreased slightly after 1970 and further after 1985. These figures correspond to LI's policy of decreasing the number of employees and shifting to overseas production.

The Maekawa Report in 1986 prescribed guide lines for Japanese firms to relocate. Set makers and assemblers have already changed the policy lines from domestic productions to overseas productions (Table 3-14). The basic policy is to shut down the plants of exporting products gradually (Kikaishinko Kyokai, 1993: 9), to increase imports not only from LI's own subsidiaries or subcontractors but also from local subcontractors (Kikaishinko Kyokai, 1993: 30-31) and to relocate not only low-end product items but also high technology products and R&D operations from Japan to foreign countries (Kikaishinko Kyokai, 1993: 19-21). As push factors, not only labour shortage in Japan but also trade friction and the high yen (Kikaishinko Kyokai, 1993: 14-17) has had an effect on LI's decision.

The next section will further examine the Japanese firms' shift to overseas production. As for LI's FDI, MITI's survey will be quoted. The analysis of SMEs' relocation and subcontracting to overseas firms uses surveys by Shoko Chukin Bank (SCB) and Peoples Finance Corporation (PFC).

MITI has surveyed Japanese firms' overseas business since 1970 (Tsusansho, 1994a; 1994b), which cover all industries, but the figures in Table 3-15 only show manufacturing industry. SCB's survey of the small-medium-sized machine industry (Shoko Chukin Bank, 1995) is a comprehensive survey which covers all business activity. In 1995, PFC conducted a survey of small enterprises' FDI (Kokumin Kinyu Koko, 1995), which is probably PFC's first survey of this kind. The conduct of the survey by PFC shows that even PFC's customers, i.e. small enterprises of not more than 50 employees, are becoming a necessary target of policy measures such as the "changing jobs and abandoning jobs (*ten-pai-gyo*)".

In the case of MITI's survey, all firms have overseas subsidiaries and the ratio of overseas production to total production nearly doubled between 1985 and 1992 increasing from 3.2 per cent to 6.2 per cent. In the case of SCB's survey (SCB's customers in the machine industry), the ratio of firms investing overseas rose from 3.0 per cent to 10.0 per cent between 1988 and 1994. At the same time, the ratio of overseas production, including firms without FDI, is also rising sharply, from 0.6 per cent in 1989 to 1.4 per cent in 1994, and is expected to increase further to 3.1 per cent in 1999. The same trend in the shift to overseas production is also clear in PFC's survey. In the case of PFC's customers, the main current is that the textile industries

Table 3-12 The number of small size machine industries

	1952	1960	1970	1980	1985	1990	1993
4-9	12790	16149	50290	74013	78878	80581	76963
10-19	8283	14973	25384	25338	27738	29948	28725
20-99	7220	16368	21966	25559	30551	32439	30906
100-999	1190	3129	5382	5068	6252	6750	6581
1000-	103	252	467	398	462	481	473
total	29586	50871	103489	130376	143881	150199	143648

Source: Tsusansho, *Kogyotokei Hyo*, 1952-1993, each year.
The above machine industries include the steel and iron industry (code no. 31), the metal products industry (code no. 33), the general machine industry (code no. 34), the electric machine industry (code no. 35) and the transportation industry (code no. 36). Calculated by the author.

Table 3-13 The number of people engaged in small size machine industries

	1952	1960	1970	1980	1985	1990	1993
4-9	80167	106601	323857	441641	473897	483954	460350
10-19	112480	205269	362672	349280	384170	412919	396663
20-99	278297	652906	926694	1002646	1211593	1280532	1221983
100-999	296605	728558	1324589	1253989	1544313	1667007	1652498
1000-	246517	626957	1184097	955319	1085371	1079194	1067843
total	1014066	2320291	4121909	4002875	4699344	4923606	4799337

Source: Tsusansho, *Kogyotokei Hyo*, 1952-1993, each year. See the note of Table 3-12.

Table 3-14 The ratio of overseas production (Japanese firms which invested in Asia)

	Ratio of overseas production (%)		Production growth rates (%) (1992 to 1994)	
	1992	1994	overseas production	domestic production
Audio visual (AV) appliances	94	220	41%	minus 40%
AV parts	49	73	33	minus 11
Electric appliances	27	39	28	minus 10
Electric appliances parts	48	73	30	minus 14
Office Automation (OA) equipment	25	31	24	2
OA parts	25	29	29	11
Camera and parts	42	64	26	minus 18
LSIs, ICs, transistors	14	24	101	14
Moulds and dies	55	60	11	1
Automobiles	36	45	16	minus 7
Auto parts	21	31	36	minus 8
Total (includes all machine industries)	35	50	32	minus 8

Source: Nippon Kikai Yushutsu Kumiai (Japan Machinery Export Co-operative), quoted in Shoko Sogo Kenkyusho, *Kaigai Seisan-no Shinten-to Shitauke Kikai Kinzokuseihin Seizogyo-no Kudoka,* March 1995: 24, unpublished. Ratio of overseas production = the amount of the overseas production / the amount of the domestic production

Table 3-15 Japanese firms' foreign direct investment

	surveyor	no. of sample firms	firm size	ratio of firms conducting overseas production	ratio in amount of overseas production	ratio of firms raised labour issues (all world)
manufacturing	MITI	1,789	large	100.0%	6.2%	43.7% (Asean 67.5)%
the machine industry	SCB	1,965	medium	10.0%	1.4%	60.9%
all industry types	PFC	6,087	small	6.8%	n.a.	104.5% (two answers)

Source: Tsusansho(MITI), 1994b; Shoko Chukin Bank, 1995; Kokumin Kinyu Koko, 1995
MITI = Ministry of International Trade and Industry (*Tsusansho*), SCB = Shoko Chukin Bank (*Shoko Chukin*), PFC = People's Finance Corporation (*Kokumin Kinyu Koko*)

including wholesalers and retailers are going to shift their production to China. That seems to be the best way for them to survive.

For entrepreneurs in general, the first motive is to employ low wage workers, the second motive is to expand their markets, either the local market or the third country market. MITI's survey covers most of Japanese *MNCs* and their first motive was local market expansion (68.8 per cent) and the second, labour cost reductions (43.7 per cent). *SMIs'* motives are, firstly, labour issues and, secondly, to follow parent enterprises. For example, SCB's customers raised labour issues first (two answers for each firm); either "labour cost reduction" (52.7 %) or "recruit work force" (8.2 %). The "request by parent enterprise" was about one fourth of the surveyed firms. As for PFC's customers, they are not expected to follow LI's FDI. Their investment is concentrated in Asia, particularly in NIEs and China, in the field of light industries. In PFC's survey, investment in the machine industry is almost negligible and their reasons for investment are almost exclusively labour issues as their raison d'être exists in their labour-intensive, low paid, demanding tasks. The high percentage of labour issues raised by them (Table 3-15) and their concentration in NIEs and China clearly demonstrate this reality.

From the above three surveys it is clear that the main purpose of overseas production is "the labour issue"; cost reduction and absolute labour shortage. At first, relocation occurred inside Japan from urban areas to more rural areas. At the same time, LI's relocation occurred on a small scale to Asian countries, North America or Europe. Later, particularly after 1985, the wave of overseas production surged and spread from LI to SMI. According to the liberalisation of trade and capital, and on account of the wide gap in wages (labour cost), it became possible to establish a profitable enterprise at a lower level of productivity in less-developed countries (Table 2-2).

In conclusion, the key to understand the East Asian development path lies in the flying-geese pattern development and the LI-SMI co-operation system. Many Western economists contended that technology would inevitably spread to less developed countries. Nevertheless, their theories have failed to present a clear mechanism of technology spread from industrialised to less developed countries. From the survey so far, it is not an exaggeration to say that only Akamtsu's flying-geese pattern of development and Yamanaka's LI-SMI co-operation model can clearly show the mechanism of Asian economic development. Industrialisation advances only within cultures and institutions where labour and management co-operates, where LI and SMI co-operate. Otherwise, it seems difficult to understand *The East Asian Miracle* (World Bank, 1993) and its mechanism of catching-up in technology. The following chapters intend to further examine the nature and mechanism of borrowing in Asia.

Chapter 4:
Thailand's Late Industrialisation:
Strengthening a thin Industrial Base
by Hybrid Methods

Introduction

As we have seen in previous chapters, there is a notion in the West and Japan that technology spreads inevitably. Since the last century until now, Japan has borrowed Western technology. At the same time, Japan has spread technology to Taiwan, Korea and Manchuria during their colonial period. In comparison with Japan's borrowing process, the stages of borrowing in Thailand are briefly presented in Table 4-1. After WW2, the spreading of technology from Japan to Asia revived around the 1960s following the global post-war economic recovery. Under this new global framework, Japan's external trade and overseas investment became more active. Thailand, in the mean time, with American and World Bank aid and recommendations, also shifted to a new framework for industrialisation, which was to rely on domestic and foreign private investment.

4-1. Opening of the country

Thailand and Japan opened their economies almost at the same time. Nevertheless, technology spread to Japan, but not to Thailand, at least not until WW2. Why did technology not spread to Thailand? One reason was that Thailand did not have the *intention* to industrialise, believing that a free trade policy was the best for Thailand under the given conditions (Brown, 1988: 181). At the beginning of the 1930s, "the sudden and unexpected development of a major economic crisis with its roots in the world economic order" forced Thailand to seek industrialisation (Batson, 1984: 260). Thus, in the 1930s, for the first time the Thai government adopted a policy of industrialising the country.

Table 4-1 Development stages in Thailand

	stage	years	a brief description
I	Subsistence agriculture	until 1855	Subsistence economy on rice cultivation under the Sakdi Na. The Kingdom exercised trades on monopoly
II	Export of primary industry products	1855-1931	Export of the primary industry products under the colonial free trade policy. Rice, teak, tin and rubber were exported mainly to the British colonies.
III-1	Import substitution of **light industry goods**	1932-1959	The Democratic government gained tariff authority and established state-run factories. This was the first stage of import substitution for Thailand.
-2		1960-1971	Incentives for designated import substitution industries. Modern textiles, electric appliances, automobile industries, etc. were initiated by foreign capitals and technologies.
IV and V	**Export of light industry goods**(IV) and production of heavy industry goods(V).	1972-1986	Export of light industry goods including food process industries expanded. The government policy shifted to the export promotion and the second stage import substitution (i.e. local contents policy for automobile industry).
V and VI	Production(V) and export(VI) of **heavy and chemical industry goods.**	after 1987	Export of electric parts and appliances, automobiles, etc. and the Eastern Seaboard projects, local engine projects, the steel industry projects, etc. This was brought by the government policy to call for foreign capital and technologies for export.

Source: Murakami's model was applied to Thailand by the author (see Chapter 3: Table 3-3)

However, 1932 was an unfavourable year for Thailand. She could not find a source from which to borrow at that time, and concentrated on her indigenous development at low levels. Consequently, Thailand had to wait until the end of the war to start borrowing technology. It is interesting, however, to note that, in general, in the case of Japan, borrowing meant indigenous development of technology by learning from the West, whereas in the case of Thailand borrowing meant setting up complete operations by foreigners, and learning was not necessarily intended nor achieved. Sporadic trials for indigenous development of technology tended to result in the degradation of technology, due to the disdain towards technology on the part of Thai elite, and the lack of incentives for technological development.

At the outset, as regards Thailand's borrowing of technology, following two questions need to be clarified. One is about the agents of industrialisation in Thailand. Who were supposed to lead industrialisation in Thailand and take the lead in borrowing technology? The second question is about the free trade policy of Thailand. Why did Thailand choose a free trade policy and did it help the spread of industrial technology to and within Thailand?

4-1-1. The lacking of industrialisation agents

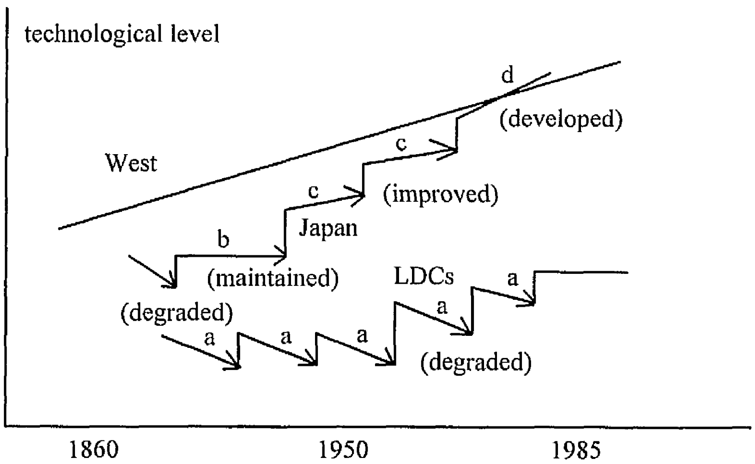
When the policy for industrialisation started, the industrial basis was lacking in Thailand. First, Thai people lived in a subsistence economy under a system of serfdom called Sakdi Na. Under Sakdi Na, political and economic power was concentrated in the hands of the king and nobles.[48] Second, Chinese immigrants were usually the poorest peasants from the southern part of China and did not bring specific industrial skills (Skinner, 1981: 55) in contrast to the case of the British immigrants to Europe or the USA (Veblen, 1939). Under the *corvée* system, craftsmen's talents and creative impulses tended to fade away gradually (Skinner, 1957: 96). Sakdi Na prevented the craftsmen's evolution into an independent bourgeoisie (Brown, 1988; Suehiro, 1989). Degradation of skilled craftsmen seems to have been the Thai heritage under Sakdi Na (Ingram, 1971: 18). Furthermore, Thailand's free trade policy undermined both local Thai and Chinese craftsmen's skills. "Many of the goods purchased were imported, and many domestic industries began to decline" (Ingram, 1971: 112). Ito found that in developing countries transplanted technology tends to stop development and soon decline (Figure 4-1). "[T]he production technology could not be maintained at its initial level, and downgraded, often very quickly, after the supplier's experts left the site on termination of the agreement" (Ito, 1986: 336).

Technology becomes degraded and obsolete unless it is continuously developed to keep up with that of advanced countries (Ito, 1986: 335-6; 1989: 58-9; Takeuchi, 1991: 204-5). This fade-out model is applicable to Thailand also. In an industrialised country like Japan, technology has been improved and developed as shown (Figure 4-1). The theory of accumulation also explains this mechanism (Cantwell, 1989: 186; Pavitt, 1988: 130; Chantramonklasri, 1990: 56).

The case of Thai ceramics is illustrative. Thailand, once borrowing technology for ceramics from China, used to produce high quality products and exported them to Borneo and India for over 600 years. However, the technology later disappeared. The technology in existence was crude and not exportable (Shamu Kyokai, 1929: 530-2). Silk technology from Japan at the beginning of the 20th century (Shamu Kyokai, 1929: 533-5) and the foundry at

Siam Cement were other examples of fade-out. The Thai government once invited silk experts from Japan to develop a modern silk industry. However, the technology disappeared after all the Japanese experts left. Siam Cement borrowed foundry technology from Denmark in the 1940s. Nevertheless, the technology did not develop and has faded out.[49]

Figure 4-1 Technology catch-up in Japan and LDCs



Source: IDE, 1985: 22; Ajiakeizai Kenkyusho, 1985; Ito, 1986: 336; 1989: 59; Takeuchi, 1991: 204)
a = degraded after the transplant, b = maintained after the transplant, c = improved after the transplant
d = developed after the transplant

To sum up, the lack of technology encouragement and incentives inhibited the development of technology in Thailand in the past. "Basically the kingdom appeared to lack the essential ingredients for industrialization" (Tate, 1979: 533). "In south and south-east Asia, where the historical background for maintaining traditional craftsmanship, as found in advanced countries, is lacking, manual labour is traditionally generally despised" (Takeuchi, 1991: 199). In addition, domestic markets and competition were lacking. The system for capital accumulation using industrial technology did not exist. The government did not promote industry. Serfdom and the undeveloped transport infrastructure discouraged craftsmen's skills.

In the case of the early stage of development in Meiji Japan, leaders of industrialisation were the *samurai* class (bureaucrats). After establishing the new power of the Meiji government, the *samurai* class itself took the leadership in borrowing technology. In the case of Thailand, until the "Thai-ification" policy by the Democratic government after 1932, trade, finance, shipping, forestry, mining and industry had been mostly left in the hands of foreign, especially Chinese, people. The government was not interested in commerce and industry and the Thai people were mostly engaged in agriculture (Prasertkul, 1989; Skinner, 1957: Ingram, 1971). Except for a few Westerners and Chinese, few economic agents for industrialisation existed in Thailand.

4-1-2. Free trade policy

Comparing the policies of Thailand and Japan, it is argued that free trade policy was not only forced by Britain but also was willingly chosen by the Kingdom. Japan opened its markets to the United States in 1854, while Thailand opened the country to Britain in 1855. Both countries were forced to open their economies without resistance having learnt from the bitter lessons of neighbouring countries: Japan from the Opium War (1840-2), Thailand from the Burmese defeats (1826, 1854). After the opening of the countries, however, the two took somewhat opposite paths. Japan adopted a policy of a strong interventionism, Thailand a free trade policy.

"King Mongkut's foreign policy was friendship with Great Britain" (Syamananda, 1981; 120). With the Bowring Treaty, the Thai government abandoned its monopoly of external trade and shifted to a virtual free trade policy with three per cent import duties. The three per cent was the lowest in Asia.[50] It was argued that the free trade policy was not only forced by the Bowring Treaty or the later British advisors, but also it was actively chosen by Mongkut and Chulalongkorn as the best policy for Thailand (Ikemoto, 1988: 3-4; Steinberg, 1987: 118-9). Ingram said that the Kingdom was "willing to trust the trade mechanism" (Ingram, 1971: 75). They did not attempt to bring in radical reforms in the government in spite of the fact that foreign advisors requested such reforms. The bureaucracy headed by royal families remained essentially unchanged (Steinberg, 1987: 120; Yasuba and Dhiravegin, 1985: 23).

As regards the operation of trade and financial institutions, British advisors, stationed in the Royal government, directed the policy. British financial advisors exercised a conservative influence which the Kingdom preferred. The Kingdom's main interest was in increasing its income from all sources.[51] In contrast to the experience of Japan, industrialisation was hardly attempted because her role in the world economy was confined to the export of primary goods to the British colonies and the import of industrial goods from the West at a low tariff rate (Brown, 1988: 181). Long term investments in commerce or industry, financed by foreign countries, were not considered as government tasks (Ikemoto, 1988: 13-4). It was feared that the incurred debts might threaten the sovereignty of Thailand (Brown, 1988: 175).

Exceptions were a bank, a cement plant and a steamship company until the early 20th century (Brown, 1988: 170-181). Infrastructure was weak, power sources were lacking, communications were undeveloped, capital and human resources were scarce (Tate, 1979: 533). Sporadic business enterprises by princes and nobles resulted mostly in failures (Prasertkul, 1989: 231-4). Commerce and industry were basically thought to be the responsibility of Westerners or the Chinese (Skinner, 1981: 64-71; Prasertkul, 1989: 243-62).

For Thailand, the opening of the country did not lead to the borrowing of industrial technology as did in Japan. Rather it confirmed that business should be done by foreigners. A small change was that the Chinese monopoly was partly invaded by Westerners after the Bowring Treaty (Skinner, 1981: 70). The principle of free trade was thought to fit the "fatalistic" attitude of the Siamese people (Yasuba and Dhiravegin, 1985: 21). And "changes were kept as limited as possible" (Yasuba and Dhiravegin, 1985: 24). An industrial policy was almost non-existent as the People's Party in its six-point platform stated:

> ... the traditional ruling group attempted to raise import duties on selected goods. The primary purpose of this policy was not to protect the local infant industries but to enrich their own pockets.... They have never really considered the economic situation of the people. They have always looked down on the people as if they were slaves or animals. (Chawalit Wayupak, 1976, quoted by Suehiro, 1989: 106-7)

Those sent to study foreign methods of government and business were limited to royal members. As regards education, Japan introduced compulsory education in the 1880s and enrolment for the required six years reached nearly 100% by 1915, whereas in Thailand compulsory education was not introduced until 1921 (Jumsai, 1951: 31; Yasuba and

Dhiravegin, 1985: 26). While Japan established educational institutions in science and technology, including universities and high schools in the 1870s, in Thailand it was not until 1913 that an engineering school was established at Hor Wang (Yasuba and Dhiravegin, 1985: 26). This neglect of education in science and technology shows that the Thai government had no *intention* of implementing policies for industrialisation. This was the free trade policy of Thailand, or acceptance of the given conditions, the best policy half forced by the West under her historical, geo-political status, which was not comparable to Japan's practice (Brown, 1988).

4-2. The first industrialisation

4-2-1. The Pibul's period: First Phase

The will for industrialisation emerged first in Thailand after the coup of 1932. The new (Democratic) government attempted to seize control of her economy from foreigners; the British, French, Chinese, and so on. In 1938 Pibul Songgram was appointed Prime Minister. Pibul's government started the nationalisation of the Thai economy. Throughout the whole period of Pibul's leadership (1938-57), Thai people were encouraged to work hard and to engage in commerce and industry (Syamananda, 1981: 168), while the Chinese were discouraged unless they became Thai nationals (Skinner, 1981: 157-160).[52] The Department of Industrial Promotion (DIP) was first set up as a division of the Ministry of Commerce in 1936 (Department of Industrial Promotion, 1993). The Factory Act (1939) controlled factories. In 1942, the Ministry of Industry (MOI) was established. Under this new institution, the government took over some trade and industries, from the Chinese and Westerners, and transformed them into new enterprises such as paper factories, textile factories and sugar factories (Suehiro, 1989: 122-30). However, the government very often "depended on leading Chinese for both management skills and a part of the necessary capital funds to sponsor state companies" (Suehiro, 1989: 133).

Syamananda evaluates the contribution of the new government after 1932. Firstly, education for the general public was emphasised and titles of nobility were discarded.

Secondly, sovereignty was recovered with equal treaties and judicial and fiscal autonomy were regained (Syamananda, 1981: 167-75; Batson and Shimizu, 1990: 41). This point was crucial for Thai industrialisation. The new government, regaining the authority to control and levy duties upon imported goods, began industrialisation for the first time in her history. Another important contribution by the new government to industrial development was the assimilation of Chinese as Thai nationals. For example, Chinese language education was restricted and discouraged since 1939 (Skinner, 1981: 162). As the result of the Thai-ification policy, "many Chinese changed their nationality to Thai and used Thai names" (Suehiro, 1989: 134). Concerning the industrial policy, Santikarn criticised the new government's probable rationale:

> First, the young intellectuals who then returned from abroad, classified a "civilized state" as one which possesses machine(s) necessary to produce manufactured goods, regardless of where the comparative advantage or the absolute advantage of that country lies. Second, often considered to be the prime reason for industrial promotion, was the perception that industry was the means of allowing the government to transfer control of the Thai economy, from the hands of the Chinese and European, to the Thai elite. (Santikarn, 1988: 169)

Her second criticism of the transfer of businesses from Chinese and European hands to Thai elites was understandable. As Santikarn pointed out, the restriction on Chinese businesses was primarily political and against rational economic principles. *In principle*, economic activity should be managed by the rule of efficiency (free trade policy), not by inefficiency (interventionism). Nevertheless, Santikarn's first point, concerning comparative or absolute advantage, is a controversial issue, for the *free trade policy* had kept Thailand "backward" until 1932.

4-2-2. Policy of the Ministry of Industry

MOI was established to promote Thai industry by Thai nationals under the nationalistic, military government. The concept was different from that of BOI which was later established to encourage foreign investments under the influence of the post-war US ideology of free trade. Industrialisation policy under Pibul's leadership comprised three main pillars:

(i)The Thai economy being run by Thai people for Thai people, (ii)The setting up and operation of state-run factories and

(iii)The technical training for villagers and promotion of Thai products.

A brochure about the history of the Department of Industrial Promotion wrote:

> Then, in 1939, there was a war in Europe. The government decided to set up projects to promote Thai industry. The reason was that if we had to import industrial products, there would be some problems like transportation problems and unstable prices of products. As the result, we had to produce our own industrial products. Marketing channels for Thai industrial products should have more branches in different provinces. There were promotions for Thai people to use Thai products and training to support some Thai industries like Thai style umbrellas, leather goods, wicker works, toys, hats and so on. (Department of Industrial Promotion, 1993)

"Thai economy by Thai people for Thai people" was a central part of the campaign for the construction of a new state. Pibul issued a series of Rathaniyom (State Conventions) and encouraged Thai people to work hard in order to achieve a good living (Syamananda, 1981: 168). New regulations requested factories to employ at least 75 per cent of Thai nationals (Skinner, 1981: 159; Department of Industrial Works, 1988). On the other hand, the government established its own factories or purchased foreign-owned ones (Suehiro, 1989: 122-30). As shown in Table 4-2, from 1934 to 1941, weaving factories, a paper factory, a meat factory (under Ministry of Defence), a silk factory, sugar factories (under Ministry of Commerce), liquor distilleries and a tobacco factory (under Ministry of Finance), etc. were established (under Department of Industrial Works, 1988). In addition, in order to restrict foreigners' trading business and promote Thai people's trading business, the government established trading companies in the main provinces in the early 1940s (Suehiro, 1989: 126-8; Silcock, 1967: 312-3). Defeat in the war for Thailand and victory for China and the Allies brought a setback to MOI. "Its budget was curtailed and many of its ablest civil servants left" (Silcock, 1967: 260).

4-2-3. The Pibul's period: Second Phase

The second Pibul government strengthened the Thai industrialisation policy after 1948. Many factories were established or placed under government control although they were mostly light industries except the Bangkok Dock Company, the Engineering Company, a metal sheet factory and the Battery Organisation (Table 4-2). Around 1953 the government operated 16 breweries, 6 sugar factories, a weaving factory, a tanning factory and two paper factories (Skinner, 1981: 244). In 1954 MOI disclosed plans for a steel and iron plant and an aluminium plant. The expansion of the paper plants and the weaving plant in the hand of MOI was also announced (Skinner, 1981: 244).

Table 4-2 The state-run factories in Thailand

	MOI and DIW	Silcock	Suehiro/Tsuneishi	total
1935-41	Cotton spinning and weaving factories (1934 and 1941, MOD), Paper factory (1938, MOD), meat factory (1938, MOD), silk factory (1936, MOC), sugar factories (1937 and 1941, MOC), alcohol factory (1941, ED)	Thai Salt Co. (1940, COOP)	Tobacco Monopoly (1941)	11
1942	tobacco monopoly*, liquor distillery (1 + 3*), silk factory, paper factory (2*), meat factory*, weaving factory (2*)	Pharmaceutical Factory (1941, Medical Science Dept.)		10
1943	Spinning and Weaving Co., Ltd., Thai Cloth Co., Ltd. (MOI, JVs with Japan)	**Bangkok Dock Co. (Navy)**		3
1944	Saphaharn Co., Ltd. (preserved food, a JV with a Thai private)			1
1945	tanning factory (8*), rubber factory*, soap factory*, printing paper factory*			11
1947	liquor distillery (14)*, sugar factory (2), brown sugar factory (11), weaving factory			28
1948		**Engineering Co.** (MOD)		1
1949		gunny bag factory (DIW)		1
1950	hat factory paper factory	Wool Industries Co. (MOD)		3
1951	gunny bag factory, sar paper factories (Chiangmai, Phranakon, DIP)			1
1952	leather factory, preserved food, footwear, cloth, etc. (DIP)	Thai Gunny Bag (MOF) wickerwork factory (DIP)	Bangkok Umbrella Factory Thai Plywood Co. Thai Sack Co.	7
1953	lackerware factory (from Japan, DIP), sar paper factory (DIP)	Northeast Gunny Bag (ED)	Pin and Clip Manufacturing Factory	2
1954	tanning factory, **sheet metal factory**	glazing equipment factory (DIP)	Thai Jute Mill Co.	3
1955		**Battery Org.** (MMI), Glass Org. (MMI), Weaving Org. (MMI), Tanning Org. (MMI) Prepared Food Org. (MOD)	Shoe-black Manufacturing Factory, Glue Factory, Bamboo Products Factory	8
1959		Cholburi Sugar (ED)		1

Source: Department of Industrial Works (DIW), 1988; Ministry of Industry (MOI), 1983; Silcock, 1976: 312-3; Suehiro. 1989: 124; Tsuneishi, 1989.
(Abbreviation)
MOI (Ministry of Industry), DIP (Department of Industrial Promotion), DIW (Department of Industrial Works), MOD (Ministry of Defence), MMI (Ministry of Military Industry), ED (Excise Department), COOP (Co-operative Department), MOF (Ministry of Finance)
Factories bought from the private sector were included as factories under DIW.
* denotes factories transferred from other Ministries.
( ) denotes the number of factories.

4-3. Free trade revisited

4-3-1. Thai-US co-operation

The end of WW2 ushered in a favourable environment for Thailand to borrow technology. However, the policies for borrowing were not co-ordinated. Rather, they were fragmented and often isolated, with mixed aims. The two main lines of policies were the continuation of the nationalistic approach initiated by the Democratic government and the development economics approach brought in by the USA. The latter was called modernisation policy by Silcock (1967: 258; Wyatt, 1984: 278-290). As Thai-US relations critically defined the politics and the path of the borrowing of Thailand after WW2, it is important to understand why Thailand built up relations with the USA. In short, the Cold War made Thailand approach the USA and vice versa (Caldwell, 1974: 27, 39-40). The two countries became close because of the political situation. Therefore, although Thailand accepted the American technical assistance, the Thai nationalistic thinking was also encouraged and obstinately survived.

In 1948, when Pibul took the power, "an upsurge in anti-colonial or anti-government insurgency in Burma, Malaya, Indonesia, the Philippines and French Indochina" was emerging (Wyatt, 1984: 267). The communist influence was spreading on an extensive scale in South-east Asia (Syamananda, 1981: 177). In 1949 Mao's Communist Party established the People's Republic of China and influenced Chinese society in Thailand. Labour unions, the Chinese schools, the Chinese press and community organisations became pro-Communist (Wyatt, 1984: 267; Skinner, 1981: 213-8). In 1950 the Korean War broke out, to which Pibul instantly sent soldiers to support the US army (Syamananda, 1981: 177).

Under these circumstances, Thailand concluded an Economic and Technical Co-operation Agreement with the USA in 1950 (Syamananda, 1981: 180). With technical assistance and aid from the USA, the World Bank, etc., development plans were proposed and implemented (Caldwell, 1974: 34-5). Development plans were mostly centred on infrastructure building. For example, from 1954 to 1960, 46.9 per cent of aid funds were used for transportation and

17.7 per cent for industry, power and mining (Caldwell, 1974: 163). Also many feasibility studies were conducted for the promotion of rural and small industries to maintain the security of the border especially after the mid 1960s (Rondinelli, 1987: 29-31; Caldwell, 1974: 41-3; Yoshioka, 1976: 96). By 1959 over two thousand young Thai were sent abroad using public funds, half to the USA, to learn western thinking and the technology necessary for the construction of the country (Montgomery, 1962: 27). The government of Pibul invited the World Bank mission, which spent a whole year from July 1957 to June 1958 collecting data, and submitted recommendations to the Thai government (Silcock, 1967: 262-4; Syamananda, 1981: 181). The Thai-US co-operation after WW2 was thus initiated during the Cold War (Rondinelli, 1987). The impact lasted at least until the US retreat from the Vietnam War in the 1970s.[53]

Although it is normally thought that Thailand switched from a state enterprise policy to a private investment policy with the establishment of the Board of Investment (BOI, 1959) and National Economic Development Board (NEDB, 1959, later NESDB), the matter was not so simple. As mentioned earlier, MOI was set up under a strong nationalist ideology by Pibul's leadership.[54] Therefore, MOI's main function was to control foreign businesses and promote Thai industries. On the other hand, BOI and NEDB were set up on the advice of the USA and the World Bank (Warin and Ikemoto, 1988a: 84; 1988b: 82; Kesavatana, 1989: 63-6). These agencies had different origins and opposing objectives; MOI to control foreign businesses, the latter to invite foreign investment (Warin and Ikemoto, 1988a: 93-6; 1988b: 94-104).

The first Industrial Promotion Act was introduced in 1954. The government guaranteed not to compete with the private sector in 1958 (Marzouk, 1972: 197). The next year, in 1959, the BOI was established to assist investors under the provisions of the 1954 Act. The USA and the World Bank's strong advice was to switch from state-run industrialisation to private industrialisation. In 1959, George Beitzel, an economic consultant to President Eisenhower, visited Thailand with a number of American industrialists to study the investment climate. Their report offered guidelines for the revision of BOI in 1960 and 1962; to set up an independent institute to simplify the procedures, to give tax exemptions and protections to private investments, and to categorise potential industrial sectors into three groups

(Kesavatana, 1989: 64-5; Insor, 1963: 159). The beginning was not smooth, and the approved projects were not numerous. Tawee Bunyaket, a former prime minister and the first chairman of the Board, announced that he was against the idea of extending to foreign investors all the privileges that the Malayan government allowed (Insor, 1963: 160). Meanwhile, Sarit Thanarat[55] expressed his frustration about the troubles[56] caused by foreign investment:

> Those who expressed interest in investment asked at first for protection. We have offered protection. They asked for tax holiday. We have given them that. In the end they said that Communists are near Thailand and they want us to give the guarantee that Communism would not come to Thailand. Who can give such a guarantee? ... These people simply cause a headache. (Insor, 1963: 160)

Sarit also said, "We don't want foreigners to become the masters of the business and industrial community here" (Insor, 1963: 160).

MOI continued its efforts to foster state-run factories. In the 1950s twenty six state-run factories were established. New establishments and re-organisations of state-run factories were emphasised even in the Five year Plan (1967-71).[57] MOI also continued a strong control on establishments and renewals of factory operations through the Factory Control Act (1939/1969) until its total revision in 1992.[58] In the meantime, the promotion of small industries, handicrafts and cottage industries was continued at the Department of Industrial Promotion (DIP), this time with UN assistance. According to the MOI paper in 1964, the following institutions were established or planned with UN and ILO assistance: Thailand Management Development and Productivity Center (TMDPC, 1962), Small Industry Finance Office (SIFO, 1963) and Small Industry Service Institute (SISI, 1966).[59] It was reported that, for small industry promotion, Thailand was going to send 16 members to India for small industry technology training (Ministry of Industry, 1964: 13).

4-3-2. The performance under the new framework

The institutional framework for industrialisation—BOI, NEDB, the Budget Bureau, IFCT, TMDPC, ISIS, etc.—as well as the physical framework—railroads, irrigation, ports, highways, dams, etc.—were constructed mainly with the assistance of the USA, the World Bank and the West. Their technical assistance and aid facilitated the economic growth of

Thailand. Especially, the investment promotion for the private sector facilitated the industrial development of Thailand. Due to the new framework arranged by the USA and the World Bank, a steady increase in the share of the manufacturing sector and a decrease in the agriculture sector of the Thai economy, both in GDP and exports, were apparent (Table 4-3, Table 4-4). The USA's contribution to the development of Thailand was crucial, particularly in infrastructure, education and agriculture (Caldwell, 1974: 153). The following sections intend to review the development process of the manufacturing sector in more detail, focusing upon the machine industry in Thailand. The role of FDI from the West and Japan will be a focal point.

Table 4-3 Share of Thailand's GDP by sector (in 1972 prices)

	1960	1965	1970	1975	1980	1985	1990
agriculture	40.2	36.1	32.2	30.4	24.9	19.9	14.4
manufacturing	12.0	14.3	15.5	18.2	20.7	20.7	24.7
the rest	47.8	49.6	52.3	51.4	54.4	59.4	60.9
total	100	100	100	100	100	100	100

Source: National Account Division, NESDB, in Kaigai Konsarutingukigyo Kyokai (ECFA), 1992: 31

Table 4-4 Share of exports by commodity group in Thailand (million baht : %)

	million baht			%		
	1960	1970	1980	1960	1970	1980
food	3,912	6,957	59,338	45.4	47.1	44.5
crude materials	4,303	4,262	19,095	50.0	28.9	14.3
manufacturing	110	2,247	37,941	1.3	15.2	28.5
machinery	1	15	7,618	0.0	0.1	5.7
others	288	1,291	9,205	3.3	8.7	6.9
total	8,614	14,772	133,197	100	100	100

Source: Bank of Thailand, quoted in TDRI, *Productivity Changes and International Competitiveness of Thai Industries* (Bangkok: TDRI, November, 1987)

4-4. Promotion of the machine industry by BOI

4-4-1. Definitions of the machine industry

The *machine industry* in general and the automobile industry in particular is supported by a wide range of *engineering industries* and other related industries, which are called *supporting industries* (Damri, 1989; Kaigai Konsarutingkigyo Kyokai, 1992; UNIDO/ECFA, 1993; JICA/UNICO, 1994a). In Japan the supporting industries are called *shitauke* and constitute a huge industrial complex, or a "castle-town". In Japan four industrial groups are included in the machine industry following Japan's standard classification of official statistics. They are general machines, electrical machines, transportation machines and precision machines (Shoko Chukin Bank, 1993; Kikaishinko Kyokai, 1989). In Thailand the terms "engineering industry" or "supporting industry" are normally used instead of "machine industry". Engineering industry includes basic metals (MOI code no. 59, 60), fabricated metal products (61-64), non-electrical machinery (65-70), electrical machinery and appliances (71-74), transport equipment (75-80), precision instruments and apparatus (81-83) following the MOI classifications (Industrial Management Co., 1984; *Bangkok Bank Monthly Review,* April 1988). The classification of factories is not easy if a firm is engaged in an engineering process such as stamping both for automobile and electrical appliances. It could be classified as either metal products, automobile industry, or electrical appliances industry. This difficulty lies in the nature of engineering industries, supporting industries or machine industries. A report by Industrial Management Co. (IMC), focusing on the nature of the engineering industry, drew a table as shown (Table 4-5).

If the emphasis is placed on an engineering process such as casting or forging, the industries may be called *engineering* industries. If the emphasis is placed on products such as tractors or rice cookers, the industries may be called *machine* industries. If the nature and structure of the industries concerned are thus understood, it is clear that the four terms, engineering industry and supporting industry in Thailand and machine industry and *shitauke* in Japan, usually refer to the same thing. The difference, however, remains in the perspective emphasised by the each term. In the following we observe the development of the automobile industry. It should be understood that our ultimate aim is the study of technology as a whole. In other words, our review of the automobile industry is intended to examine the machine industry, *shitauke*, engineering industry or supporting industry in general.

Table 4-5 Necessary "engineering processes" for typical "supporting industries"(denoted by x)

necessary processes ↓	tractors	rice cookers	air-conditioners	electric fans	TVs	engines	auto parts
casting	x			x		x	x
forging	x					x	x
heat treatment	x					x	x
welding	x		x	x			x
machining	x			x	x	x	x
stamping	x	x	x	x	x	x	x
plating	x	x	x	x	x		x
*plastic or casting mould	x	x	x	x	x	x	x
*metal die	x	x	x	x	x		x

Source: Industrial Management Co., 1984: 23. * = added by the author. x denotes that a specific process (casting, etc.) is necessary for the manufacturing of specific products (tractors, etc.)

4-4-2. Promotion of the machine industry

When the Democratic government took power in 1932, Thailand was basically an agricultural country. The industrial basis was very weak and the capital goods industry was not developed at all as Miyahara described:

> At present, the only developed industries in Thailand are rice mills and lumber mills. In addition, there are some small scale industries in beer, matches, cement, paper and so on, to supply the domestic market. However, they are all in consumer products. Capital goods industries are almost non-existent except for the Bangkok Dock Company operated by British capital and the government workshops for the navy, the railway and so on. (Miyahara, 1939: 101, translated by the author) [60]

The Democratic government started an industrialisation policy in the 1930s. However, factories bought or established by the Democratic government were mostly light industries. The government had little interest in the machine industry. As mentioned, what could be classified as the machine industry were only four; the Bangkok Dock Company (in 1943 by Navy), the Engineering Company (in 1948 by Ministry of Defence), a sheet metal factory (in

1954 by MOI) and the Battery Organisation (in 1955 by Ministry of Defence). The first one, Bangkok Dock Company, seems to have been obtained from a British firm.[61] Information about the second one is not available. The third, a sheet metal factory, was established by MOI as a pilot plant in 1954. Nevertheless, it was dissolved in 1958 (Ministry of Industry, 1983: 45; Skinner, 1981). As for the battery manufacturing, already in 1939 at least five Chinese battery firms were producing 15,500 pieces per month (Miyahara, 1939: 119). It seems the army intended to manage the production and distribution of batteries for its own use.

Table 4-6 Machine industries promoted by BOI (BOI Act, 1962)

Grouping	in Category A (23 groups)	in Category B (12 groups)	in Category C (21 groups)
Iron and steel	Iron smelting industry, Steel making industry		8 industries
Smelting	Tin, Lead, Zinc, Copper, Antimony, Tungsten, Manganese		
Shipbuilding		Shipbuilding industry	
Vehicle	Tractor producing or assembling industry, Bicycle or tricycle with or without engine industry	Passenger car and truck producing or assembling industry	
Vehicle parts	Motor vehicle spare parts industry, Motor vehicle tire or inner tube industry		2 industries
Engine	Internal-combustion or electrical prime-moving engine industry	Internal-combustion or electrical prime-moving engine assembling industry	
Other machinery and metal products	Agricultural machinery industry, Water pump industry, Machine tool industry, Cast-iron, steel, asbestos or plastic pipe industry	Agricultural machinery assembling industry, Water pump assembling industry, Machine tool assembling industry, Carpenter or black-smith tools industry, Producing or assembling sewing machine industry	4 industries
Electric machine industry	Household electrical appliances industry,	Household electrical appliances assembling industry	3 industries
Electrical parts	Radio parts industry(32), TV parts industry(33), Electrical products industry other than 32 and 33.	Electric wire or cable industry, Electric accessories	1 industries
Other	Watch and/or clock and their component parts producing industry	Food canning industry	3 industries

Source: The Promotion of Industrial Investment Act (1962), amendments up to year 1965. Names of industries in Category C are omitted.

In contrast to the above industrialisation programmes, which showed little interest in the machine industry, the BOI included in its promotion list a significant number of machine industries. The Table 4-6 shows 23 industry groups of machine industries in the category A (49 industries) and 12 groups in Category B (19 industries). Category A was given full exemption of taxes and duties. Category B was given 50 per cent exemption of taxes and duties. Category C includes 80 industries among which 21 belonged to the machine industry. Category C was given 33.33 per cent exemption. In total, fifty six machine industries were included in the promotion list of categories of A, B and C. Promotional incentives prepared for new investors under the BOI Act were a five year corporate tax holiday, exemption or reduction from business tax, import duties on machinery, equipment, accessories and materials used in the setting up of factories. In addition, tariffs on the imported raw materials were exempted or reduced for the first five years (Santikarn, 1981: 42; 1988: 185). From 1959 to 1963, BOI received 540 applications and issued 217 promotional certificates. The numbers of applications and approvals at BOI are shown in the Table 4-7.

Table 4-7 Promoted investments by BOI (1959-63)

	1959	1960	1961	1962	1963	total
number of application	159	78	76	93	134	540
number of approval	23	39	41	48	66	217
number of persons employed	3,397	12,365	5,110	6,340	10,861	38,073
ratio of start up year (%)	13	22	28	25	12	100

Source: Ministry of Industry, 1964

The approved industrial sectors at the initial stage were in the electrical machines, electric wires and cables, automobile assemblies, automobile parts and agricultural machinery sectors.

In 1960, the same year as the enactment of the new BOI Act, new tariff rates were introduced for 1,097 items; a 40% rate on luxury items and 25-30 % on general items. Tariff rates were further raised in 1964 segregating the consumer goods from intermediate goods (Warin and Ikemoto, 1988b: 181, 211, 217). Coupled with the BOI promotion, the rising tariff rates encouraged the domestic production of previously imported goods. In addition, specific industries were protected by the direct control of imports. The number of protected industries increased year by year following the request of the local industries.[62] The above industrial policy and the people's efforts together with the foreign capital and technology enabled the self-supply of the domestic market on a considerable scale. The result—local production saturated the domestic market in many fields by the early 1970s (Table 4-8).

Table 4-8 Industrial goods 100 per cent supplied by domestic production

Food	canned food, glutamine soda, sugar, condensed milk
Textile	synthetic fibre fabrics, gunny bag, cotton yarn*, cotton fabrics*
Chemical products	oxygen, sulphuric acid, caustic potash, glass, detergent
Construction material	cement, plywood, vinyl floor tile, galvanised steel*
Vehicle	bicycle tire, bicycle spring, bicycle*

Source: Yoshida *et al*, 1977. * denotes 90% or more of the domestic market was supplied.

4-5. Development of the automobile industry in Thailand

4-5-1. The beginning of the automobile industry

In the past, as seen in Japan and Korea, technology has developed from light industry to machine industry. The same rule appears applicable to Thailand. As for the borrowing of technology in the case of the textile industry, Santikarn recognised the important role of foreign investment in the borrowing of technology. Teachers were found to be predominantly Japanese firms. Santikarn stated: "Once one decides to take the Thai textile industry as a case study of the transfer of technology, Japan is invariably singled out as the most prominent transferor" (Santikarn, 1981: 161). The following section intends to examine the borrowing of technology in Thailand focusing mainly upon the automobile industry. Thailand began producing automobiles in 1961, when 525 cars were assembled using completely knock-down kits (CKD)[63] from the West. Thirty four years later, in 1995, more than 500,000 cars were assembled (Table 4-9) using both local content and imported parts, mostly Japanese brands. In 1961 Ford, Benz and Fiat started the assembling of automobiles (CKD), followed by Nissan (1962), Toyota (1964), Prince (1965) and Mitsubishi, Isuzu and Hino (1966). From 1961 to the present, 16 assembly plants were established, among which three were closed down (Table 4-10). In 1965 and 1966 the number of assembled cars reached about 10,000. In

1966 it was reported that Toyota, Nissan, Isuzu, Hino, Prince and Mitsubishi (six Japanese firms) were competing with Benz, Ford and Fiat (three Western firms). The competition was so hard that Japanese firms sold cars with instalments of 18-24 months. Consequently Japanese firms succeeded in their marketing and the share reached 60% of the whole Thai market by 1965.[64]

Table 4-9 Car sales in Thailand (unit: 1000)

year	'82	'83	'84	'85	'86	'87	'88	'89	'90	'91	'92	'93	'94	'95
car sales	90	118	113	86	78	101	145	208	302	264	357	420	434	572

Source: *Thailand Automobile Industry, Directory,* 1994: 62; Higashi, 1995: 40; 1995; *Nihonkeizai Shimbun:* 1 February 1996

In 1968 the government stopped the BOI incentives for CKD assembling to control the number of assemblers and models. It was thought that too many assemblers and models would affect the efficiency of local auto parts production. In 1969 the government announced the elimination of four items from the import list of CKD parts. Excluded items were batteries, tiers, radiators and leaf springs (Kuroda, 1994: 42). This was the start of auto parts manufacturing promotion in Thailand.

The Automobile Industry Development Committee (AIDC) was set up in 1969 at MOI, and members were composed of representatives from MOI, BOI, Customs Department and Department of Transportation. The government then began making plans for the local content of automobiles. In 1971 AIDC announced a new automobile promotion policy (1971 auto policy) to take effect from July 1972, which included

(i) the 25 per cent local contents requirement, and

(ii) the limitation of the number of car models and engines (Kesavatana, 1989; Aoki, 1971).

Table 4-10 Automobile assemblers in Thailand

Start-up	company	share	car brand	
1961	Ford*	MJ	Ford	Ford stopped operation (sold the plant to Isuzu in 1976) and let Karnasutra assemble. Mazda took over the assembly of Ford in 1986**
1961	Thonburi	O	Benz	
1961	Karnasutra*	MN	Fiat	Karnasutra stopped the assembling (sold the plant to Honda in 1990)**
1962	Siam Motor and Nissan	O → MN	Nissan and Suzuki	Nissan took 25% share in 1990
1964	Toyota	MJ	Toyota	
1965	Prince*	O	Prince	In Japan, Prince merged with Nissan in 1966
1966	MMC	MN	Mitsubishi	started as the United Development Motor Industry (UDMI)
1966	Isuzu	MJ	Isuzu	
1966	Thai Hino	MJ	Hino	
1968	Bangchan	MN	GM, Honda, Holden, Opel and Daihatsu	Thailand 52%, GM 48% in 1978 GM stopped assembling in 1978***
1973	Yontrakit	O	BMW and Peugeot	Ceased operation in 1990
1974	Sukosol and Mazda	MJ	Mazda	
1975	Thai Swedish	MJ	Volvo and Renault	
1977	Siam Nissan Automobile	O → MN	Nissan (trucks)	Nissan took 25% share in 1990
1983	Thai Honda	MJ	Honda	
1986	Thairung	O	Chee Tah (Isuzu)	

Source: Tara Siam Business Information Ltd., 1993: 35, 67; Suehiro, 1989: 209; Higashi, 1995. MJ=foreign majority, MN=foreign minority, O=no foreign participation.
* denotes resolved companies. **Based on the hearing from MOI in 1995. ***Kesavatana, 1989: 145

Prior to the announcement of this 1971 auto policy, the import duties on CKD parts and completely build-up cars (CBU) were raised in 1970; CKD parts from 30 to 50 per cent, CBU from 60 to 80 per cent. This aimed to curb the import of CKD parts and CBU and promote local production. Assemblers voiced complaints that the tax increase would jeopardise the operations of assemblers. Ford, Siam Motor, Toyota and Karnasutra demanded that the government put the CKD tax back to the old one otherwise they would stop their production and lay off workers (Kesavatana, 1989: 117-8). Anti-foreign investment sentiment, especially against Japanese investment, became strong.

The tax increase badly affected the auto market in Thailand. A study carried out by DIP found that demand for cars declined from 4,000 units per month to 2,400 units after the 1970 import duty increase (Kesavatana, 1989: 118). For example, the import of passenger car CBU decreased from 15,224 in 1970 to 8,991 in 1971, and 7,248 in 1972.[65] The termination of the tax exemptions for assemblers, the tax increase and the requirement of local contents, together with the strong anti-foreign sentiment, constituted hardship for foreign firms in Thailand. "Some even called for a total ban on imported CBU or a plan for a national car" in 1972 (Kesavatana, 1989: 125).

The US firms and the newly built Japan-Thai JV plant, Bangchan General Assembly (licensed in 1970), were particularly affected by the tax increase and the 1971 auto policy. For example, Bangchan had scheduled to assemble cars for VW, Opel, Austin and Mazda, four makes and nine models, whereas the new policy allowed only two models for a plant (Kesavatana, 1989: 126). Although a coup in November 1971 made the 1971 auto policy defunct, which was to be implemented from July 1972, the 1972 auto policy, a revised version, introduced the 25 per cent local contents. No reference to the model/engine limitation was included.

The introduction of democracy after the 1973 coup brought political instability. Economic development brought about by foreign investment was accused of increasing the gap between the rich and the poor, and the cause of the gap was attributed to Japanese capitalism. Santikarn described the storm over Japanese investment in the early 1970s as follows: "Anti-Japanese sentiment culminated in a ban on purchases of goods from a Japanese-owned department store. Demonstrations and books on the 'economic monster' soon appeared on the local scene" (Santikarn, 1981: xi). Between 1973 and 1975 labour disputes rose to a high level and disturbed factory operations at hundreds of firms.[66] The storm over foreign operations became harsh. The number of BOI promotions decreased from 251 a year in 1974 to 70-90 a year during the period 1975-77 (Kesavatana, 1989: 130). Under the anti-foreign sentiment, the government (BOI) strengthened the restriction on the foreign capital shares in 1975. In the case of production for the domestic market, the Thai share was set at a 60 per cent minimum. If the Thai share is between 40 and 60 per cent, one of the following conditions must be met:

(i) local content should be over 50 per cent,

(ii) the factory should be set up in a promoted zone, or

(iii) new technology should be adopted (Santikarn, 1981: 51-2).

Ford stopped assembling in Thailand in 1976; the reason for their cessation was controversial. Some said Ford stopped following the withdrawal of the US army from Indochina, as they were afraid of communist insurrection. Others said it was because of failures in marketing. Meanwhile the local-content-regulation by AIDC became effective in January 1975, which was 25 per cent for passenger cars and 20 per cent for commercial vehicles.[67] In 1976 the volume of CKD overtook that of CBU import for the first time in Thailand. The limitation of the number of models was abandoned in that year.

4-5-2. The local content issue

From 1976 to 1978 the demand for cars turned upwards and the balance of payments deficit became an issue again. In order to decrease the deficit in the balance of payments and to promote the local auto industry, the government announced a new regulation in 1978. The contents of the regulation were as follows:

(i) the import of CBU was banned,

(ii) the tariff on CKD parts was raised from 50 per cent to 80 per cent,

(iii) the local content for passenger cars was set to increase 5 per cent every year from 25 per cent to 50 per cent by 1983,

(iv) the local content for commercial cars was set to increase from 20 per cent to 50 per cent by 1984,

(v) the limitation on the number of car models was resurrected.

The method of the calculation of the local content was changed from the actual market price method to the given percentage method with this new policy. The given percentage method refers to the calculation of the local content according to the fixed official rates for each part announced by the government. Subsequently, GM stopped assembling in 1978 as it could not follow the limitation of the model numbers implemented in 1978 (Kesavatana, 1989: 145). Hilman, Simca, Dodge and Holden quit the market because of the CBU import ban in 1978 (Doner, 1991: 199). Later, Karnasutra for Fiat also stopped assembling and sold the plant to

Honda in 1990. The contents of the auto policy were frequently revised as shown in Table 4-11. It could be said that the Thai auto regulations have been changed almost every year.

Table 4-11 Automobile policy in Thailand

	import ban on CBU	local content (passenger car)	local content (commercial car)	number of models
1972		25% (by 75)	20% (by 75)	
1975		25%	20%	
1976				lift of limitation
1978	ban	25% → 50% (by 83)	20% → 50% (by 84)	limitation
1983		→ 45%	→ 45%	
1984		→ 65% (by 88)	→ 60% (by 88)	
1985	lift of ban over 2300cc	→ 54% (by 87)	→ 45%	
1986			pickup 61% (by 88) local engine for pickup (by 89)	
1990				lift of limitation
1991	lift of ban under 2300cc			

Source: Aoki, 1971; Kesavatana, 1989; Toyota Motor Thailand's leaflet, unpublished, 1993

It is not unusual that the governments request a higher local content while foreign firms tend to resist this. In the 1950s the Brazilian government requested 100 per cent local content to all CKD assemblers within a short period. By 1962 the local content reached almost 100 per cent for eleven firms in Brazil (Dahlman, 1984: 320).

Why did foreign assemblers obstinately resist the increase of local content requirement in Thailand? The reason was the high price and low quality:

> There is another example showing that some certain domestic auto assemblers do not want to use locally made torsion bar (although it is sometimes cheaper than imported one) because of its unendurable quality and being not up-to-standard. It is easily broken when 'shock load' appears. (Choosak, 1977: 37)

Against assemblers, local parts manufacturers contended that quality and price of local products are reasonable. Assemblers are just reluctant to co-operate:

> The reluctance to co-operate of auto assemblers has brought insufficient demand for local parts and components, resulting in a very limited market for local component manufacturers to feed domestic auto assemblers. Hence, sub-standard quality in order to reduce cost of production and

price to compete with imported components [high price] is what seems to be local components manufacturers' motto.[sic] (Choosak, 1977: 37)

The following example shows how costly the local contents were in comparison with imported parts. On average, the local content cost 30 per cent more than imports in the case of the Fiat 124 and 60 per cent more in the case of the Fiat 125. Locally made radiators and safety glasses cost nearly four times as much as imports (Choosak, 1977: 38; Table 4-12). This miserable situation for local manufacturers was caused by small orders from assemblers.

Table 4-12 Cost comparison between imports and the local content

	Fiat 124			Fiat 125		
	imports(I)	local(L)	L/I	imports(I)	local(L)	L/I
	(baht)	(baht)	(ratio)	(baht)	(baht)	(ratio)
tiers	1,166	1,165	1.0	1,397	1,475	1.1
battery	172	285	1.7	172	285	1.7
fuel tank	39	65	1.7			
radiator	153	550	3.6	155	574	3.7
torsion bar				158	250	1.6
safety glass				224	840	3.8
mufflers				220	350	1.6
total	1,530	2,065	1.3	2,326	3,774	1.6

Source: Choosak, 1977: 38

The government listened to local manufacturers and wanted to promote them because it was expected that greater local production would decrease the balance of payment deficits at the same time. The limitation of the number of assemblers and car models were expected to improve the productivity of local manufacturers (Kesavatana, 1989: 135-7). The tariff increase and the CBU import ban were expected to protect local manufacturers from competition. Ford and GM gave up manufacturing in Thailand. Japanese assemblers, although they had not given up, also voiced complaints against the repeated changes in auto policies and the increase in the local content requirement.[68] Particularly, they were not happy with the idea of a national car plan and the 100 per cent local content goal which was expressed by Industry Minister Ob.[69]

Firstly, local industries were not yet developed and, secondly, auto industries needed long term investment plans. The preparation of a new model takes a year or two, and involves a huge amount of capital and human resources. The establishment of a new plant needs more money and energy than a model change. The enforcement of the local content under the present situation would have incurred problems in the quality of products and a rise in prices. That would inevitably have affected local demand and contradicted the local consumers' interests.

Kesavatana explained that two different views arose in the 1980s (1989: 137-9). One was the nationalistic aim to restrict foreign capital and promote local manufacturers. The other was international hegemonistic thinking to support foreign capital and local capital tied-up with them (Kesavatana, 1989: 269-71). The "hegemonistic" thinking, linked with the structural adjustment loans from the World Bank, supported local content rules frozen at 45 per cent in favour of Japanese investors (Kesavatana, 1989: 150, 251). The nationalistic sentiment was found mostly among the Thai intelligentsia (Kesavatana, 1989: 204, note No. 44).

It should be noted that the engineering and machine industries in Thailand were not yet developed to a high technology level in the 1970s and '80s. Even in the 1990s they were still in a fledgling state. Borrowing of technology was indispensable.

4-6. Development of the supporting industry

4-6-1. The engineering industry as a fundamental base

A study submitted to NESDB in 1984 (IMC report) argued that Thailand still lacked technological capability in the engineering industry. Although there was a large demand for the output from the engineering industry, Thailand had to depend on the import of engineering products: "There are many causes underlying the present situation. They are: (i) lack of basic knowledge of industrial engineering techniques; (ii) [the] relatively low level of production technology resulting in a lack of capability to produce products of even quality, etc." (Industrial Management Co., 1984: 19-20).

The IMC report then recommended upgrading the process technology of casting, forging, heat treatment, welding, machining, metal forming and plating in general, not specific products or industrial sectors as proposed by other recommendations.[70] The IMC report pinpointed the importance of the engineering industry and argued that Thailand had not yet developed the technological capability in the engineering industry in general. In conclusion, it proposed three main lines of recommendations. First, optimisation of technology flow, second, the setting-up of an Engineering Industries Development Institute under DIP, and third, the strengthening of the industrial standards system. The first seems to be slightly misleading because the screening of technology contracts, and the adaptation of technology to suit the local conditions should be done by the private sector, not by the government as the IMC report proposed. Brimble and Chatri also criticised the idea of screening and controlling technology flow by the government (Brimble and Chatri, 1994: 15). The IMC report understands that "technology can be viewed as a commodity" (Industrial Management Co., 1984: 25). As a consequence, it proposed to control the flow of technology. It said: "The domestic technology production in its early stage of development needs protection, in the same way as industrial production. An organisation should, therefore, be created to regulate and balance the technology flow from foreign countries" (Industrial Management Co., 1984: 28).

The IMC report proposed to minimise the cost of imported technology and maximise the utilisation of technology in stock. This type of concept seems to be popular in the government and academic societies in Thailand. Borrowers want to restrict the inflow of technology. It is understandable that they wish to develop their indigenous technological capability without borrowing. However, technology cannot be developed without practice. Despite their desire to restrict the inflow of technology, Thai local manufacturers, especially those tied-up with "hegemonists", are learning technology from Japanese private firms or from the Japanese government. They are working practically. Technology is inevitably spreading as Part II of this thesis will show.

4-6-2. Development of the local auto parts suppliers

A survey in the early 1970s reported that about 15 local firms were recognised as "capable" auto parts suppliers among which only two were 100 per cent Thai owned and both used technology from Japanese firms (Ajiakeizai Kenkyusho, 1986: 234). A list of local manufacturers obtained from MOI showed that by the middle of the 1970s the number increased to 45-50 firms (Choosak, 1977: 40). They were manufacturers of tyres (3), batteries (6), radiators (3), springs (4), exhaust mufflers (1), brake linings (1), radiator fans (1) paints (2), nuts, screws, etc. (3), shock absorbers (1), and auto seats (25-30). A later survey recognised that, by 1980, there were 132 auto parts manufacturers among which foreign JVs numbered 41 firms (33 Japanese JVs).

In about ten years, the number of auto parts manufacturers increased to more than one hundred, from 15 to 132 (Choosak, 1977: 40). The cluster of supporting industry was, however, still very small at this stage although it was growing rapidly. The weakness of the supporting industry in Thailand was depicted as a "reversed pyramid shape structure" in contrast with that of the Japanese pyramid shape of *shitauke* (subcontracting) structure. That means assemblers in Thailand had to rely upon a small number of suppliers. Therefore, the competition among assemblers was severe, but competition among suppliers was lacking (Ajiakeizai Kenkyusho, 1986: 234-5). This was the result of the hasty increase of the local content obligations. From 1978 to 1985 the local content for passenger cars was raised to 54 per cent. As for pickup cars, from 1978 to 1988 the local content was raised to 61 per cent. Urged by the local content and change in tariff rates, assemblers fostered local suppliers and brought in their Japanese *shitauke* firms. In that sense, the local content policy was successful at least in Thailand.

Chapter 5:
The Role of Japanese FDI in Thailand: Exploitation or Desideratum?

5-1. Japanese firms in Asia

5-1-1. The Japanese type FDI

Comparing the Japanese *type* and US *type* foreign direct investment (FDI), Kojima said that the US *type* FDI:

> does not transfer technology, nor increase the income of local people, but monopolistic profits are absorbed by the parent firm. Moreover, those industries supply luxurious goods for the benefit of a small number of wealthy people in the developing countries, with no benefits being spread to [the] ordinary mass of the people. (Kojima, 1977: 11-2).

This interpretation of US *type* FDI corresponds to the theory of multinational corporations (MNCs) of Hymer-Kindleberger-Caves (Ozawa, 1979: 42-4). However, Kojima and Ozawa did not apply this theory of MNCs to the Japanese FDI. On the contrary, they argued that the Japanese *type* FDI would play the role of tutoring in technology transfer and would facilitate the catching-up process of developing countries. The theoretical background of Kojima's argument was derived from Akamatsu's flying-geese pattern development which presented a theoretical framework for less developed countries' catching-up. Referring to Akamatsu, Kojima said, "I would like to recommend a steady catching-up" process which:

> the Japanese 100 year modernization has experienced, namely, a gradual upgrading and diversification in the order of industries from agriculture to light industries and then to heavy and chemical industries, and within each industry imports are substituted by domestic productions which grow later to be exportable through the learning process and economies of scale. (Kojima, 1977: 12)

Then, he named the FDI which facilitate technology transfer "the Japanese type" or *a tutor* of industrialisation:

> ... the catching-up process is efficiently supplemented by foreign direct investment if it is properly used. Certainly the Japanese type or orderly transfer of technology through direct investment meets more properly this objective. The main role of direct investment is to transfer superior technology through training of labour, management and marketing, from advanced industrial countries to lesser developed countries, or, in brief, it is the transfer of superior production function which replaces inferior ones in the host country. Foreign direct investment **should be an initiator and a tutor** of industrialization in less developed countries. (Kojima, 1977: 12, emphasis added)

Kojima's theory was criticised from the viewpoint of *internalisation* theory (Buckley, 1991: 106; 1989: 186-8). Kojima's approach is rather normative. "He switches at will between what is and what **should be**" (Buckley, 1989: 188, emphasis added). It was also argued that Japanese FDI is not always a tutor type and US FDI not always a monopolistic type (Cantwell, 1989: 200-1). Although Kojima was criticised in his theoretical points, a substantial part of Kojima's theory is relevant (Buckley, 1989: 191; 1992: 86). The "underlying developmental process" described by Kojima and Ozawa was considered applicable to an economy which is growing rapidly, such as Japan, West Germany or the NIEs (Cantwell, 1989: 201).

By contrast, some literature evaluates the positive sides of firms including US *type* MNCs (Schumpeter, 1942: 96; Chandler, 1990: 593; Komiya, 1972: 161). The nature of the firm differs according to time, country and sector (Chandler, 1990: 51, 235, 393; Buckley, 1989: 195; Buckley and Casson, 1991b: 28). What follows is a description of the special nature of Japanese FDI; firstly, the government's support, coupled with the moral encouragement by the notion of Akamatsu's theory of industrial development; secondly, the significance of the number of small and medium size investors; thirdly, the high withdrawal and low profit rates of Japanese FDI. The above three points are all inter-related.

5-1-2. Peculiar features of Japanese FDI

As seen in the previous chapter, the Japanese industrial policy does not support declining industries as they are and, instead, encourages declining industries to find another way to survive or find a new path even if the challenge may fail. The origin of this policy will be found in the "changing and abandoning of jobs (*ten-pai-gyo*)" during war time (Chapter 3: 3-

1-3). Death is regarded as destiny or history but efforts to survive are considered to be in order (Chapter 3: 3-2-2). The government's support of FDI is based on this notion. SMIs are encouraged to devote the rest of their lives to developing countries. Ozawa described Japan's FDI policy as a national *desideratum* (1979: xx) and "a policy officially encouraged and wholeheartedly supported by the Japanese public" (1979: 235). He said:

> Japan has been driven to resort to overseas production as a matter of national economic survival, although the majority of individual firms (aside from large trading companies and a handful of giant corporations) are incapable of doing so on their own and are "immature" in size, technological sophistication, and financial strength by Western standards. Ironically, however, from a macroeconomic viewpoint, those types of industrial activities in which these "immature" Japanese firms are engaged are judged both appropriate and ready to be transplanted overseas. Consequently, a multitude of supportive functions, both financial and managerial, are being mobilized or newly arranged by both government and industry to defray part of the private costs and to realize the social benefits of overseas production. Overseas production is now emerging as an integral part of both Japan's economic growth strategy and her foreign economic diplomacy. (Ozawa, 1979: xx-xxi)

In sum, Kojima, Komiya and Ozawa all understand FDI as a tutor, however, Kojima and Ozawa differentiated US and Japanese *type* FDI. For Kojima and Ozawa, US *type* FDI, or FDI in general, is a monopolistic exploiter, but Japanese *type* FDI is a tutor in the sense of Akamatsu's theory of technology spreader. Whereas, for Komiya, FDI, in general, including Western FDI in Japan, is also a tutor, in his own words, "a Schumpeterian innovator".

The high ratio of SMI in Japanese FDI is related to the first point mentioned, i.e. the government's support and encouragement. In addition, Japan's closeness in distance and culture to Asian countries helped Japanese FDI in Asia's and NIEs' learning process (Vogel, 1991: 90-1). By 1980, among Japanese FDI all over the world, 41.3 per cent was shared by SMI. The ratio of SMI was particularly high in Asia. For example, in Korea 67.3 per cent of Japanese FDI and in Taiwan 58.8 per cent of FDI were shared by SMI (Table 5-1). The main industrial sectors were labour-intensive light industries, or declining industries, such as textile industries, sundries, and low end assembly lines in electrical industries, which were already mature in Japan. Ozawa explained this trend of FDI as an "escape from the Ricardo-Hicksian trap"[71] (Ozawa, 1979: 65) or "industrial immigration" (Ozawa, 1979: 70). Industrial immigration from Japan to NIEs is comparable to that from Britain to the Continent in the 19th century described by Landes (Chapter 2: 2-1-1).

Table 5-1 Japan's manufacturing FDI by region at the end of 1980 (number, %)

	SMI	(SMI)%	LI	(LI)%	total	SMI/total
North America	222	11.8	364	13.6	586	37.9
Latin America	110	5.9	373	14.0	483	22.8
Asia	1,459	77.9	1,545	57.9	3,004	48.6
Taiwan	399	21.3	279	10.5	678	58.8
Korea	525	28.0	255	9.6	780	67.3
Other Asia	535	28.5	1,011	37.9	1,546	34.6
Europe	46	2.5	192	7.2	238	19.3
World total	1,874	100.0	2,667	100.0	4,541	41.3

Source: Chushokigyo Cho, 1981: Annex Table 40

Foreign direct investment is defined as the new purchase of equities. SMI includes (i) individual persons, (ii) legal persons of the number of employees not more than 300 or the capital amount not more than 30 million yen and (iii) joint ventures with large enterprises. The data include foreign direct investments of the amount not less than 3 million yen which were supposed to report to the Ministry of Finance.

As Ozawa mentioned, the government's FDI promotional policy is a *desideratum* and an escape from the Ricardo-Hicksian trap. Especially for SMEs, "risks are perceived to be great and the firm has no international experience on which to draw" (Buckley, 1989: 43). Foreign direct investors are not guaranteed survival nor large profits overseas. In order to examine this point, we will see the withdrawal and profit rates of Japanese FDI. This type of survey is rare in Japan. Only three sources of data were available at the survey time.

The first is MITI's data on the "clearance of equities" for the period of fiscal years 1973-86 (Horaguchi, 1992: 108-11). During the period 1973-86, the number of purchases of equities in manufacturing industries totalled 9,763 and the number of clearances of equities totalled 2,034. The withdrawal rate, 2,034 divided by 9,763, was 20.8 per cent in all (Table 5-2). This denotes the average *withdrawal rate* through the whole period. By continent, Africa showed the highest withdrawal rate (35.5%) followed by Latin America (26.5%), and Asia (17.6%). By industry, textiles showed the highest withdrawal rate (28.7%) followed by ferrous and non-ferrous metals (21.2%), while transportation equipment showed the lowest withdrawal rate (11.2%). It should be noted that the samples of the above MITI's statistics are comprised of higher percentage of large industries (70-80 per cent) than small-medium industries (20-30 per cent). In other words, the above withdrawal rates are probably lower than the real withdrawal rates which include SMIs.

Table 5-2 The withdrawal rates of Japanese manufacturing FDI (1973-86)

year	FDI (purchase of equities)	withdrawal (clearance of equities)	withdrawal rate
	a	b	b/a
1973	1,012	70	6.9
1974	603	122	20.2
1975	425	136	32.0
1976	413	164	39.7
1977	448	211	47.1
1978	727	184	25.3
1979	783	106	13.5
1980	719	106	14.7
1981	803	121	15.1
1982	748	116	15.5
1983	706	124	17.6
1984	677	227	33.5
1985	718	222	30.9
1986	981	125	12.7
1973-86	9,763	2,034	20.8

Source: Tsusansho (MITI), *Wagakuni Kigyo no Kaigai Jigyo Katsudo, Dai 10-11, 12-3, 15 kai,* quoted in Horaguchi, 1992; 108. The figure of withdrawals for 1981 was not available. Therefore, it was estimated by the author, postulating the withdrawal rate (15.1) between 1980 (14.7) and 1982 (15.5).

Regarding the *withdrawal rates* of SMI, the Small Business Finance Corporation (SBFC)[72] carried out a survey in 1985 and 1987, which is the second available data. According to this survey, the average withdrawal rate (withdrawals divided by withdrawals plus FDI) was 24.9 per cent (105 ÷ (105 + 316)). By continent, the rate for North America was 14.8%, Europe 21.4%, Asian NIEs 27.4%, ASEAN-4 29.8%, Asia total 28.3%. The withdrawal rates in NIEs and ASEAN were higher than the average.[73] Since most of FDI by SMI occurred after 1985 and showed sharp increases, the denominator (withdrawals + FDI) in the equation became large to lower withdrawal rates because of the recent increase in FDI. Therefore, the high rates of 25-30% up to 1987 imply that SMI's FDI operations in the past often did not last long.

The third data source was the annual directories of the *Toyo Keizai Shimpo-sha* and is called the *survival rate*. This rate denotes the ratio of firms still in existence in the later years. The names of the firms in 1975 were checked by Kaku and Horaguchi in the directories of the years 1980, 1985 and 1990 to see if those names were still in existence or not. The average survival rate for manufacturing industry in 1990 was 46.6 per cent (Table 5-3). This

Table 5-3 The survival rates of Japanese firms overseas (1975-90)

	number of firms	survival rates		(%)
	1975	1980	1985	1990
Agriculture, fishery	155	69 %	52 %	25 %
Mining	171	61	49	25
Construction	137	76	63	50
Manufacturing	2378	75.2	64	46.6
Commerce	1502	86	76	62
Service	328	77	64	45
Other service	251	79	65	42
Finance, insurance	290	80	71	58
Total	5212	78.2	66.9	49.9

Source: Kaku and Horaguchi (1993: 16). rate = (firms in existence ÷ firms in 1975) × 100.

Table 5-4 Sales after tax profit rates of Japanese firms overseas (1976-89)

	Asia	North America	Latin America	Europe	World
Agriculture, fishery	2.63	-1.25	-14.59	0	-0.28
Mining	-2.5	-27.69	12.87	-2.96	4.42
Manufacturing	2.54	0.32	0.3	-0.09	1.44
Commerce	0.36	0.23	0.71	0.46	2.99
Others	11.39	-3.2	4.68	4.37	2.83
Total	1.3	0.25	0.92	0.47	0.53

Source: Tsusansho (MITI), *Wagakuni Kigyo-no Kaigai Jigyo Katsudo,* in Kaku and Horaguchi (1993: 19)

Table 5-5 Income and profit rate of Anglo-Iranian Co., Ltd. (unit = £ 000)

	1930-39	%
Income less expenses (before tax and royalty)	83,400	100.0
Royalty and tax to Iranian government	22,134	26.5
Depreciation, amortisation, etc.	16,763	20.1
UK income tax	8,749	10.5
Net profit after tax	35,754	42.9

Source: Penrose, 1968: 68.

shows more than half of the firms disappeared in fifteen years. In particular, two thirds of the firms in North America disappeared by 1990. In the NIEs, 46.3% of firms remained, in ASEAN 53.9%, in Asia 48.6%. On the other hand, the average profit rate during the period of 1977-89 was 1.44 per cent according to a MITI's survey (Table 5-4). Most of the industrial sectors in North America showed losses, while in Asia all manufacturing sectors showed profits although the levels were low as compared to oligopolistic industries such as oil (Table 5-5).

The correlation between survival rates and profit rates is high. This means that if the investors are not able to make profits they tend to withdraw sooner or later (Kaku and Horaguchi, 1993). The period of operations from the start-up to the withdrawal varied. Among them, the withdrawal after five or six years showed the largest numbers. According to Horaguchi, one factor seems to be the expiration of incentives. If the firm could not operate in profit within the given five years of the incentives, the firm may discontinue operations. Horaguchi also found that many textile firms that invested in Asia had been urged to invest abroad by the wage hikes and yen revaluation in 1972-3. Nevertheless, some of them faced difficulty after the second oil shock in 1979 and were forced to withdraw. Also, when local partners master technology and wish to be independent, the withdrawal of Japanese firms may result. Among the cases of withdrawals, Horaguchi reported two cases of Korean textile firms which were showing good performance after the Japanese withdrawal from JVs (1992: 174-5). The examples showed that the role of a "tutor" was complete. It is not difficult to find examples of successful tutors. Amsden also reported some examples (Chapter 2: 2-1-2).

5-2. The nature of MNCs

5-2-1. Hymer's negative view of the role of MNCs

Just as technology can be either beneficial or harmful, so can be firms. "Capitalism has been international since its inception. ... Moreover, the multinational company [MNC] ... contains within it both the seeds of progress and the potential for a grim harvest" (Mirza, 1992: 149):

> There is nothing very new about MNEs [MNCs]. They have played a significant role in the world economy since the early seventeenth century, when English and Dutch chartered companies held monopolies of colonial trade, and operated plantations for the export of food and raw materials (Casson, 1979: 1).

In the literature where MNCs are described as monopolistic and exploitative (Lall and Streeten, 1977: 45-6; Penrose, 1968: 46-7; Sampson, 1993: 54), the term "MNCs" refers to the monopolistic type of enterprises. Before WW1 single crops such as sugar in Cuba, bananas in Costa Rica, tea in Ceylon and rubber in Liberia were controlled by monopolistic MNCs (Casson and Pearce, 1987: 94). Another report says:

> Corporations anchored in North America, Western Europe and Japan implanted subsidiaries in their colonies, and their quasi-colonies such as Latin America and China. This signalled a prodigious extension of horizontal and vertical integration in quest of raw materials, investment opportunities for surplus capital, markets and an undifferentiated mass of labour which, with rare exceptions, was tantamount to forced labour. (Clairmonte and Cavanagh, 1988: 8).

From the latter 19th century to the turn of the 20th century, MNCs such as the Royal Dutch Company [later the Royal Dutch/Shell] and the Anglo-Persian Oil Company [later the British Petroleum] began exploring for oil in Indonesia and Persia respectively (Zakaria, 1987: 108). By the inter-war period, MNCs' activities further expanded—oil in the Gulf Mexico, the Dutch East Indies and the Middle East; copper and iron ore in Africa; bauxite in Dutch and British Guyana; precious metals in South Africa and ferrous metals in South America. Investments in sugar, tropical fruit and tobacco were also continued (Casson and Pearce, 1987: 95). After WW2, American FDI in consumer products spread to the world markets, followed by Japanese and European FDI (Casson, 1979: 1; Chandler, 1990: 615). Casson admitted that it could still be argued that the characteristic of the MNCs[74] has changed little since its inception over three hundred years ago. He listed several points to prove the lack of change in the characteristic of MNCs. Among them, the most important point is that technology diffusion to the indigenous people of less developed countries had failed (Casson, 1979: 1).

Hymer analysed the monopolistic nature of the above type of MNCs, followed by Kindleberger and Caves (Ozawa, 1979: 42-4; Ahiakpor, 1990: 13; Horaguchi, 1992: 16-8). Like Casson, Hymer argued that MNCs have not changed their characteristics (Hymer, 1972: 21-2). For him, MNCs are not helpful, but harmful to the host countries: "a system of multinational corporations holds little promise for promoting widespread participation and its benefits are largely restricted to a minority population, in the world as a whole and within the

United Sates itself" (Hymer, 1972: 31). The main characteristics of MNCs described by Hymer are as follows.

(i) The large size of MNCs

The parent firms occupy a dominant position in the United States economy and the subsidiaries are often amongst the largest firms in the countries in which they operate.

(ii) Oligopolistic character of MNCs

Approximately 40 per cent of MNCs' direct investment in manufacturing are in industries where the market share concentration ratio is greater than 75 per cent.

(iii) Entry barriers for local firms

MNCs invest in industries where barriers (technological, economies of scale, or differentiated products) exist and local firms can not enter the market.

(iv) Perpetuation of dependency

Although technology and managerial skills may be brought in, direct investment tends to perpetuate the gap between the centre and the periphery, the leader and the lagger, through the vehicle of corporate control (Hymer, 1972: 35-44).

Penrose pointed out the monopolistic nature of the oil industry. Large oil companies are vertically integrated from the crude oil production to the final distribution to consumers (Penrose, 1968: 46). Furthermore, monopolistic MNCs require full ownership or majority share holdings. In ASEAN, it is commonly understood that "Japanese firms have ... been willing to accept equity restrictions common in ASEAN, whereas US firms have generally strongly preferred majority ownership" (Doner, 1991: 79). Daniel Parker explained this point as follows:

> an important part of Parker's assets is not just being able to make superior writing instruments, but the share of mind (the value of brand) that we have in the markets of the world. We will not come in and share ownership with local nationals on the basis of balance sheet costs. Multinationalism, be it European or Japanese or American, involves similar principles—the values that go beyond *pro forma* balance sheets of a proposed local national company. Such sharing is unlikely and illogical. But each such endeavour can be benefited from and needs industrial infrastructure [of the local area]. The nationality of the source of supply [human resources or other inputs] is an unimportant matter. (quoted in Hymer, 1972: 49)

In conclusion, it is now clear that both Hymer and Kojima recognised that MNCs have negative aspects from the viewpoint of the host countries. Nevertheless, more careful inductive studies on MNCs' country specific nature seem to be helpful (Ozawa, 1979: 41; Vernon, 1973: 97; Buckley, 1989: 195, 202-25; Dunning, 1991: 320).

According to Chandler and Hymer, American MNCs are huge organisations and the management functions are divided into three levels (Table 5-6). The president of an MNC conducts international business from the top of a skyscraper. He is not in charge of daily operations or the co-ordination of managers. In contrast, in the case of a Marshallian firm (a firm at the stage of low development in the managerial structure),[75] all three levels of functions are undertaken by an entrepreneur in the factory (Hymer, 1970: 442). The managerial organisation of Japanese FDI, particularly that of SMI, is still in the Marshallian stage (Figure 5-1) or still undeveloped, and was characterised as peculiar (Buckley and Casson, 1991a: 30-1).

In the case of Japanese FDI, especially in the case of SMIs, the separation between the top and the shop floor is not so strictly observed. "The Japanese organization often appears to be a coalition of semi-autonomous component units rather than a monolithic entity controlled by a central office" (Mowery and Rosenberg, 1989: 230-1; Ramstetter, 1993: 16). On the contrary, in the case of Western MNCs, the separation between the management and the shop floor workers is great (Kawahara, 1995: 144; Buckley, 1989: 213). Michio Morishima has likened Western style management to a Naval hierarchy and the Japanese style management to foot soldiers of an infantry regiment. The former relies on the top down management, while the latter tends to rely more on soldiers' autonomous actions (Mihashi, 1992: 67-8).

People in developing countries normally wish to become white collar officers in hierarchical style of organisations. Even if they are employed with Japanese manufacturing firms, they want to behave like white collar workers and reluctantly go down to the shop floor. If the Western MNCs have a monopolistic power, the management style may be established as a hierarchy and local white collar employees may not have to go down to the shop floor. However, this does not happen in the case of Japanese manufacturing firms. This is discouraging for local people with high education. They tend to avoid working for

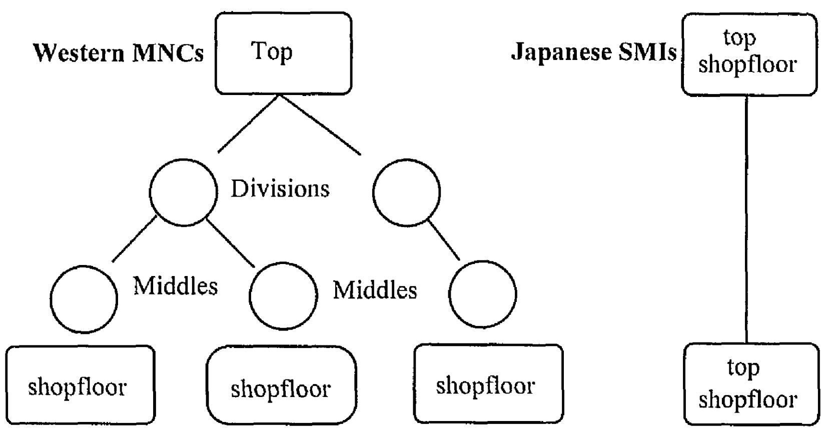
Japanese manufacturing firms and complain that Japanese firms do not transfer technology. In Japan higher degrees such as master's degrees are not always considered important. Firms prefer to train young people inside from the beginning.

Table 5-6 Chandler's three stages of the management system

	the size of the firm	the management system
The Marshallian firms	an entrepreneur in a factory	(i) daily operations, (ii) co-ordination of managers, and (iii) goal setting and planning are all in the hands of the entrepreneur
Large national corporations	several divisions for different product items with the continent-wide strategy for production and marketing	(i) daily operations by managers, and (ii) co-ordination of managers and goal setting and planning by the president
MNCs	HQ and separate autonomous independent units	(i) daily operations by managers, (ii) co-ordination of managers by the president of each unit, and (iii) goal setting and planning for the whole MNCs by HQ in a skyscraper

Source: Chandler, A. *Strategy and Structure,* 1961 (quoted in Hymer, 1970: 442)

Figure 5-1 Management organisations of foreign subsidiaries



Source: Chandler, *Strategy and Structure,* 1961 (quoted in Hymer, 1970: 442). Illustrated by the author.

5-2-2. Summary of the debates on Japanese firms and MNCs

It is now apparent that Hymer's theory of MNCs is not suitable for explaining the nature of Japanese FDI. Some proposed more systematic research into the distinctiveness of MNCs;

why are Japanese MNCs different from that of their US and European counterparts? (Casson, 1987: 252-3; Vernon, 1973: 97; Dunning, 1991: 320). What follows is a summary of debates on MNCs in the previous section. The main contents are shown in Table 5-7. The summary will be discussed in the following order, (i) MNCs in colonial times, (ii) MNCs after WW2 and (iii) SMIs and immigrants.

It is commonly understood that the nature of MNCs in colonial time was, on the whole, monopolistic and exploitative (Casson, 1979: 1; Hymer, 1972: 21-2; Clairmonte and Cavanagh, 1988: 8). However, if we observe MNCs more closely, Japanese MNCs must have had a different nature. It has been argued that the key to the economic development of Asian NIEs after WW2 can be found in the colonial experience of those countries (Vogel, 1991: 90-1; Hart-Landsberg, 1993; 106-9, 139-40; Kohl, 1994; Leys, 1984: 181; Yamamoto, 1992: 171). For example, it was reported that in Indonesia Japanese occupation had a different impact:

> During the brief Japanese occupation, the western managers were replaced by Japanese administrators and for the first time Indonesians had a chance to rise to middle-level management positions. The Japanese interlude in many respects stimulated social and political development and was an eye-opener for Indonesians. Wartime control of enterprises became the forerunner of a more ideologically motivated type of state control of the modern sector of the economy. (Sadli, 1972: 201)

Thus, Western MNCs, in colonial times, were in general monopolistic and exploitative. Japanese MNCs were also monopolistic and exploitative, but, at the same time, possibly, gave more opportunities to indigenous people, as Sadli said.

Table 5-7 The summary of debates on American and Japanese *type* MNCs

	type	Monopolistic	Tutorial
MNCs	American (Hymer) *type*	OO	
in colonial time	Japanese (Kojima) *type*	O	O
MNCs	less spill over	O	O
after WW2	more spill over		O
SMI			O
Immigrants(individuals)			O

Source: The author. OO denotes "applicable", O denotes "probably applicable".

It is argued that the nature of Western MNCs has changed little from colonial times to the present (Casson, 1979: 1; Hymer, 1972: 21-2). However, after WW2, most colonial territories became independent. Nevertheless, the point to be noted here is that many of them had not yet started industrialisation and still remain undeveloped. Western rulers and MNCs in the colonial time had not trained indigenous people to be ready to start industrialisation. The colonial authorities of the British Empire followed policies which were inimical to the development of capitalism. They tried to maintain colonies as subsistence economies (Havinden and Meredith, 1993: 158).

After WW2, broadly speaking, the former colonial territories were split into two zones, the capitalist zone and the communist zone. In the case of the capitalist zone, MNCs remained or came back and resumed the same type of businesses. In the case of territories in the communist zone, MNCs were taken over with or without compensation.

Although many countries achieved independence, the economic situation of developing countries often did not change. MNCs in developing countries repeated the same function of profit maximising, as they had done before. And the spill-over effects were limited. That is why MNCs were defined again by post-war economists as monopolistic and exploitative after WW2 (Kojima, 1977: 11-2; Lall and Streeten, 1977: 45-6; Casson, 1979: 1). In this context, the strong urge for technology transfer expressed by developing countries in the meetings at UNCTAD can be understood (Oman and Wignaraja, 1991: 26; Fikentscher, 1980).

From the viewpoint of the spill-over effects, MNCs after WW2 will be classified into two types, the old type and the new type. The old type is defined as MNCs with less spill-over effects to the local economy. The new type is defined as MNCs with more spill-over effects. The difference is a matter of degree. The spill-over effects depend on the degree of the technology gap. If the technology gap between the home country and the host country is wide, foreign MNCs inevitably have to form an enclave (Kojima, 1977: 6). The spill-over effects will be less in this case. Because of the existence of the wide gap, the host country is almost unable to acquire the technology. This type of investment is called *reverse-order* technology and it is contended that it results in *no-transfer* (Kojima, 1977: 8-9). On the contrary, if the technology gap is small, MNCs are likely to assimilate into the local climate and spill-over effects will be larger. This is called *orderly* transfer (Kojima, 1977: 12). The implication of "orderly" technology is close to "appropriate" technology although the real implementation is quite different.

The technology gap depends on the characteristic of the firms or industries. Oil extraction and oil refinery differ from the apparel industry. Branded beverages and patented cosmetics differ from sandals and shoes. Labour-intensive IC parts assembly of imported raw materials differs from the electric appliances manufacturing using 100% local content. The formers have wider gaps than the latters. If the gap is wide, the possibility for the host country to catch-up and overtake is low. From this viewpoint, the technology gaps should be taken into account. It is widely understood in developing countries that IC assembly brings in higher technology than rice cookers. This is a big misunderstanding (Takeuchi, 1991: 201; Ajiakeizai Kenkyusho, 1992: 224-6). The spill-over effects of manufacturing of rice cookers on local manufacturing technology should not be overlooked from the viewpoint of technology gaps.

Lastly, and most importantly, the degree of the spill-over effects depends on the attitude and the climate of the host country (Ahiakpor, 1990: xi; Chen, 1993: 56-7). The matter is a question of whether they are ready to learn or not, and then who is ready to learn which technology.

Hymer presented statistics of the USA's FDI by size for the year 1957. The smallest size of the investment value covered by the statistics was US$ 5 -15 million dollars and the largest size was over $100 million dollars (Hymer, 1972: 35). In Japan, statistics of FDI included even very small FDI. As a result, in 1957, the *average* size of Japan's FDIs was US$ 472,000, less than one tenth of the minimum size covered in the US statistics (Hamada, 1972: 174).[76] It is difficult to believe that in the USA there is no FDI of smaller size. In reality, there must be quite a number of FDIs by SME also in the USA. This difference in the size of firms between the USA and Japan seems to be a reason for the interpretation of the difference in the nature of US and Japanese FDI (MNCs). As a consequence, it is truly understandable to say that "differentiation of Japanese FDI (by Kojima) has been exaggerated" (Buckley, 1989: 191).

From Japan to Taiwan and Korea there emerged FDI by SME because of their proximity. It is happening again from Japan to China for the same reason. It is conjectured that the same thing may be occurring in the USA between San Diego and Tijuana, Mexico, or Detroit and Windsor, Canada. The fact is probably that, in the USA, FDI by SMI exists. In the 1980s there emerged a surge of FDI by Japanese SMEs to the USA, to support Japanese MNCs or to expand their own markets in the USA. Later, it was found that some Japanese SMEs in the USA, with or without capital participation, shifted partly or wholly their production bases to Mexico, leaving their offices in California.[77] It is therefore probable that the local SMI, other than that of Japanese involvement in the USA, may have invested in Latin American countries. This type of investment is counted as FDI in Japan. For example, "Japan has more than 600,000 Korean residents who immigrated there before WW2, and many Korean businessmen in Japan made considerable investments in their mother country" (Bhon, 1985: 182) and these investments are counted in Japan's FDI to Korea.

In summary, FDI as a whole, both by large firms and SMIs, is supposed to exist and must have extensive spill-over effects (Casson, 1987: 260-1) not only in Asia but also in Latin America or elsewhere. However, that type of FDI seems to be of less interest in the West because the impact of FDI by SMEs is minor, whereas the impact of each MNC is large and very visible.

5-3. Criticism of Japanese firms

There are at least three points for which Japanese firms are criticised by local elites in ASEAN countries. They are:

(i) Domination by Japanese expatriates

(ii) No plan to transfer technology

(iii) The unattractive working conditions

5-3-1. Domination by Japanese expatriates

Japanese firms send more expatriates abroad for longer periods than Western firms (Tran, 1993: 73). Then, as described below, Japanese expatriates dominate the operation of the plant and the management of the whole firm. Consequently, local staff have few chances to learn technology. In Western MNCs technology transfer is smooth and quick: "In textiles, dominated by the Japanese group, the speed of technology transfer appears to be slow" (Soehoed, 1981: 135):

> Apparently these [European-American] multinational corporations operate under the broad policy of their headquarters to transfer as much skills as possible to the Indonesian nationals. ... In an European multinational corporation not under a joint-venture arrangement, all expatriates have been replaced by Indonesians within a period of ten years. Indonesian nationals have occupied important posts and carried out day-to-day responsibilities in accordance with their job descriptions, in strategic areas including production planning, process engineering, product design, and quality control.... Among fully foreign owned subsidiaries, technology transfer is more evident in European and American corporations: here are clear voluntary programmes for the replacement of expatriates. (Soehoed, 1981: 136-7)

Japanese firms are blamed for not teaching technology to local staff. Instead, many expatriates (more than 10) stay for many years and control operations themselves. Consequently, local staff have little chance to learn technology, even after more than 15 years (Thee, 1994: 150-151). Japanese firms "do not view technology transfer as a priority", instead they "take advantage of cheap labour in the country" (Anuwar, 1994: 108). Japanese staff are reluctant "in transplanting their knowledge to local workers (Chinwanno and Tambunlertchai, 1983: 206). Santikarn also reported that: "of the 84 Japanese affiliates appearing in *the Million Baht Information Directory (1991),* only 15 firms, or 18%, had a Thai managing director, as against 52 of 153 (33%) non-Japanese foreign firms. Japanese TNCs ... are criticized as being reluctant to localize their business" (Santikarn, 1994: 84-5).

In short it is said that Japanese firms are reluctant and slow in technology transfer. In contrast, among Western firms, especially among fully foreign owned subsidiaries, technology transfer is more evident. They have clear voluntary programmes for the replacement of expatriates. As regards the capability of technology transfer, after quoting an ideal example of technology transfer of Esso Singapore (Chong, 1983), Chen remarked: "It is of interest to find out whether Asian (including Japanese) TNCs are capable of doing a better job than Western TNCs in their transfer of managerial and organisation technology to Asian host countries in view of the cultural affinity factor" (Chen, 1994: 23).

Western managers are considered by local employees to be superior to Japanese managers both in management and technology transfer even with a fewer or no staff.[78] An unpopular way of Japanese teaching in a JV was reported:

> The [Japanese] general manager supervises the production with **army-like discipline** and members of the Malaysian staff admit that many fear the Japanese boss. ... In the past [during the period of Malaysian management when the company was losing money], we had a say in the project. Now we only take orders from the Japanese. (Bartu, 1992: 80, quoted in Jomo, 1994: 280, emphasis added)

Under the Japanese *army-like* management, the company later became profitable.

Concerning the Japanese dominance and the comparatively high ratios of Japanese expatriates, a US scholar (Mr. X),[79]comparing Japanese and Western business cultures in Thailand, pointed out the difference between the two. According to him, the Japanese want to force their value system, whereas the Westerners do not try hard to push. General attitudes of the Japanese and Westerners in Asia are different.[80] Two factors raised by Mr. X for the Japanese higher ratios in expatriates are, firstly, their lack of familiarity with foreign environments and their strong belief in the superiority of the Japanese style management. He says, "Since they have little experience abroad it is easier to just do what has already been done in Japan. To try to do that requires a lot of Japanese managers/ engineers on the ground in transplants". He pointed out that Japan has, in addition, a push factor to send "a surplus of mid-level managers/ engineers in Japanese companies". In his view, Japanese firms send comparatively more expatriates for longer periods in order to push the Japanese production system in spite of their lack of experience in foreign businesses.

The ASEAN young elites argue that Japanese expatriates stay to hide technology, to maintain the management posts, not to transfer. The fact of Japanese dominance is equally admitted although their interpretations differ, one to hide, the other to push clumsily the Japanese style management. In either case, the Japanese dominance is not welcome.

5-3-2. No plan to transfer technology

As mentioned above, the Japanese are often accused of trying to hide their technology. The root of the accusation lies in the large number of expatriates. A survey in Taiwan has found that there are more expatriates in Japanese firms than in US firms and then derived the following proposition:

> This phenomenon [more expatriates] appears consistent with the resentment in many developing Asian economies, where there are reports that Japanese firms tend to be more reluctant to transfer technologies to local firms and thus need more foreign employees to protect their technology and management know-how. (Tu, 1994: 177)

Thai elites and businessmen do not want to be controlled by Japanese expatriates. They want to be independent as soon as possible:

> [A] prominent and knowledgeable Thai businessman commented that though a large number of joint-venture firms with 60 or 70 % Thai equity participation exist, they are still under Japanese control.
>
> In another study it is also noted [as this thesis argues] that Japanese partners have frequently exercised considerable powers of direction over even minority owned subsidiaries by their insistence on retaining powers of decision over operational and managerial policies.
>
> The Thai businessman mentioned above thus went on to propose that the Thai state limit the maximum equity participation of foreign firms and see to it that the Thai share be adequately increased in due time. (Suthy, 1991: 70)

Another accusation comes from the inappropriate content of the training. A study on technology transfer in Thai machinery and electronics industry reported that:

> In many instances, the training programmes offered at the Japanese parent companies were arranged mainly for psychological as well as moral purposes rather than for real technology transfer.
>
> ... some Japanese TNCs were accused of concealing certain important technology and of offering inappropriate training programmes in the sense that they were for the purpose of boosting morale rather than for technology transfer. (Nathabhol *et al*, 1987: 72, 76)

Another study also blamed the content of the training: It says, "Although they send local workers for training in Japan, the numbers are very limited and the training period is rather short, usually less than six months; and the Thai workers have to spend quite some time studying the Japanese language during the six-month period" (Chinwanno and Tambunlertchai, 1983: 206). Thai economists consider that learning of the Japanese language and business culture is unnecessary. More time has to be spent on learning technology than culture. They have a narrow understanding of technology.

Tiralap studied the technology transfer in Japanese firms. After surveying five Japanese electrical firms, Sanyo, National, Mitsubishi, Toshiba and Hitachi in Thailand, he concluded that even after more than thirty years of operation in Thailand, technology was barely transferred to these JV firms in Thailand from Japan. Thai JV firms have acquired only operative capability.

> the assessment points out that there is almost no technology transfer from Japan to Thailand for the joint-venture firms. However, in purely Japanese owned firms, some technical skills and perhaps know-how are transferred and accumulated, despite limited to technology accumulation in the assembly process. (Tiralap, 1995: 10)

Quoting the experience in Japan and the East Asian countries, Tiralap urged the government to implement policy to upgrade indigenous technological capability, especially the R&D capability in the private sector (Tiralap, 1994: 132). He suggests that Thailand should not stay at the stage of simple operation.

Santikarn studied the technology transfer in the automobile industry and reported that as for design technology, a key component of the automobile industry, Thai industry had not been given the opportunity to absorb technology. Consequently, "Thai technicians are as yet unable to design major parts and components, let alone a complete vehicle" (Santikarn, 1994: 86). Also, in the Malaysian automobile industry, there were complaints that Japanese training "did not include design, research, and development—prerogatives MMC (Mitsubishi) reserves for itself" (Jomo, 1994: 286). "Very little R&D is carried out by local subsidiaries as such activities are usually only conducted by parent companies". This phenomenon is more pronounced among Japanese firms than US firms (Anuwar, 1994: 121). In conclusion, expecting a national car, Santikarn proposed "technology augmentation policies to upgrade the skills of local firms". In her understanding, MNCs can be only a catalytic force for technology transfer, but this channel cannot be a primary condition for success: "Success must be home-grown" (Santikarn, 1994: 86-7).

In summary, it is contended that because Japanese firms have no intention of transferring a high level of technology, Thailand must develop the indigenous capacity by itself. However, it is interesting to note that: "the claims that Japanese firms undertake FDI but do not transfer technology [management know-how] have been heard from Thailand and other Southeast Asian countries but are almost unheard of in Asian NIEs" (Tran, 1995: 328). Probably, cultural and language barriers are greater in operations in ASEAN than in NIEs. This suggests the importance of cultural factors in technology transfer.

5-3-3. The unattractive working conditions of Japanese firms

In addition to the domination by Japanese expatriates mentioned above, there are two other criticisms made by local people. One is the lack of proper job descriptions. The other is the inferior working conditions in Japanese firms.

Japanese firms have long been criticised for the lack of job descriptions. For local staff, it is very difficult to learn what is expected of them without clear job assignments and job descriptions. A study on technology transfer in a Japanese textile firm in Indonesia stated that: "In any case, while some Indonesian nationals have occupied important posts in production units, there are often considerable discrepancies between stated job descriptions and day-to-day responsibilities" (Soehoed, 1981: 135). Japanese firms are latecomers with little experience in foreign business operations. Few Japanese expatriates are educated in English speaking countries; communication between expatriates and local staff is not smooth (Kawabe, 1991: 264-6). In Japan, job descriptions are not common. Manuals exist but are not widely used. A survey showed that Japanese firms put more emphasis on OJT than manuals (Table 5-8). However, it is considered that in order to adapt to the local climate, the adoption of manuals is also important and effective.[81]

Japanese firms are also criticised for their inferior working conditions. The most critical issue is slow promotion in Japanese firms. If university graduates work in Japanese firms it could take decades to be promoted to senior manager level, if ever. In Singapore, Japanese firms offer lower wages and inferior fringe benefits compared with Western MNCs or public enterprises (Lim, 1991: 116-7). In Malaysia, university graduates are not treated as resource persons with high qualifications. They are treated as if they were high-school graduates. This is perceived as strange as Malaysia is a kind of *qualification society*, much influenced by British tradition. Consequently, university graduates often leave Japanese firms (Kawabe, 1991: 260). In Japan, young university-graduated engineers work under experienced high school graduates and learn the shop floor management and technology. In Thailand, it is very difficult to let university graduated engineers work under high school graduate managers or supervisors. They feel insulted (Ohashi, 1987: 17).

Table 5-8 Training methods of local staff in Japanese firms in ASEAN

	Number of firms	%
Manual	24	18.9
OJT	90	70.9
Training in Japan	87	68.5
Separate training programmes in the firm	44	30.4
Total answer	127	100.0

Source: Keizai Doyukai, "ASEAN niokeru Gurobaru Keiei no Tenkai to Genchika, Jinzai ikusei" (October, 1991: 16). Each firm was requested to answer two among seven training methods.

Concerning this criticism from local people, it is argued that local staff of high education are influenced by Western culture and consider themselves something different from the workers from the countryside. They do not want to work with local people of low education from the countryside (Kawabe, 1991: 260). Training of these uneducated people in industry is more often done by expatriates from Japan, NIEs or ASEAN. Highly educated elites often do not want to engage in this task. Japanese expatriates are doing this job.

5-4. Japanese firms in Thailand

In this section, the literature on the characteristics of Japanese firms in Thailand will be surveyed. The main points are as follows. Firstly, Japanese firms are latecomers and have often been operating with low profit rates. Secondly, in light industry, at least in the textile industry, Thai firms have borrowed technology from Japanese firms, not from Western firms.

5-4-1. A latecomer to Thailand

In the 1960s, under the new framework of the government promotional system, there was a "massive" inflow of FDI in Thailand. By 1974, accumulated FDI constituted 30 per cent of total registered capital in the promoted investments for the period 1960-74. The leading countries of FDI were Japan with 42 per cent and the USA with 14 per cent, followed by China (10 per cent) and Britain, France, West Germany, Netherlands and Denmark (10 per cent in total). The residual 24 per cent was scattered amongst Malaysia, Israel, Hong Kong, Singapore, India, Panama, the Philippines, Portugal and so on (Santikarn, 1981: 42-3). From the BOI statistics as shown above, it is usually understood that Japan was the dominant investor in Thailand from the beginning. It is true for the BOI statistics, but not true for all investment if non-BOI investments are also included (Tambunlertchai, 1977: 9). This becomes clear if we see Suehiro's list.

Suehiro listed the 85 world top MNCs which had direct investments in Thailand by 1980. Among 85 firms, 46 were US firms, 22 Japanese and 17 European (Suehiro, 1989: 198). If we focus on the top 20 firms, 10 are US firms, eight are European and only two are Japanese (Table 5-9). The dominance of the US and European firms is evident.

Furthermore, it should be noted that the industrial distribution of Western (US and European) firms and Japanese firms was quite different. Western firms were concentrated in monopolistic markets such as oil extracting, whereas Japanese firms were clustered in more competitive markets such as textiles, electrical machinery, automobiles and auto parts industries (Table 5-10). In addition most Western firms have full ownership (Tambunlertchai, 1977: 12; Chou, 1988: 168; Table 5-9). If we adopt Kojima's terms, Western firms invested in *reverse-order* or *no-transfer* technology, while Japanese firms invested in *orderly* technology (Kojima, 1977: 8-9, 12). Santikarn described this tendency as follows: "Japanese investments are more concentrated in industries where Japan is losing comparative advantage, especially in the production of textiles" (Santikarn, 1981: 84).

Table 5-9 Investment by world top 20 MNCs in Thailand

	name	year of the investment	country	capital
1	Exxon	65	US	100
2	Mobil	62	US	99
3	GM	72	US	100
4	Caltex	49	US	100
5	Ford	61	US	100
6	IBM	49	US	100
7	Standard Oil	67	US	100
8	ITT	n.a.	US	100
9	du Pont	71	US	100
10	Philips Petroleum	n.a.	US	100
11	Shell	46	UK/Dutch	100
12	Unilever	32	UK/Dutch	90
13	Philips	52	Dutch	100
14	Hoechist	52	Germany	100
15	Byer	38	Germany	100
16	BASF	38	Germany	100
17	Nestle	67	Swiss	100
18	Imperial Chemical	62	UK	100
19	Toyota	52	Japan	72
20	Nissan	62	Japan	0

Source: Suehiro, 1989: 317-8. World top 20 = ranking in the total annual sales in US$ million of the parent company in 1980 recorded in *Fortune* (4 May and 10 August 1981). year of the investment = the year of the establishment in Thailand. capital = the capital share of the investment in Thailand.

Table 5-10 Industrial distribution of MNCs in Thailand (1980)

	USA	Europe	Japan	Total
Petroleum	**12**	**5**		17
Mining	1	2		3
Food	7	2		9
Chemicals	**8**	**6**	6	20
Pharmaceuticals	**4**	**7**		11
Soap, toiletries	8	1		9
Textiles	1		**7**	8
Metals, steels	3	2	**7**	12
Automobiles, auto parts, tyres	4	1	**18**	23
Electricals, machinery	6	4	**17**	27
Others	3	1		4
total	57	31	55	143

Source: Suehiro, 1989: 198, 318-22. Figures show the number of direct investments by the world top 85 MNCs in Thailand from 1932 to 1980, surveyed by Suehiro.

Table 5-11 Oligopolistic market in Thailand

industry	oligopoly	US	Europe	Japan	Thailand	share(%)
Oil refinery	O	x	x		x	99
Tin smelting	O		x			99
Condensed milk	O		x x		x	83
Condiments	O			x	x	96
Soft drink	O	x			x x	93
Sanitary paper	O	x x			x	81
Detergents	O	x	x	x		89
Polyester staple	O		x	x		100
Tyres	O	x x		x		94
Sheet glass	O			x	x	100
Tin plate	O			x		100
TV sets	O			x x x		*44*
Refrigerators	O			x x x		*55*
ICs	O	x x				91
Passenger cars	O			x x		*64*
Trucks(ten wheels)	O			x x x		94
Motor cycles	O			x x	x	95

Source: Suehiro, 1989: 205. Modified by the author.
"O" on the left hand side = the market share over 90% by top three firms, "O" in the middle = over 80%, "O" on the right = less than 80%.
x denotes the distribution of the oligopolistic firms (top three or less).

On the other hand, many US investors remained minority shareholders of less than 10 per cent (Tambunlertchai, 1977: 12). This occurred probably in order to avoid risks in the case of competitive markets. What then are the competitive markets in Thailand? Table 5-11 will show this. Japanese firms had concentrated on textiles and machine industries which, in general, did not constitute monopolistic markets. TV sets, refrigerators and passenger cars are listed in the table of oligopolistic markets, the market shares of the top three being 44%, 55% and 64%, lower than other products (Table 5-11).

Santikarn analysed 184 technology contracts and summarised that the major proportion of Japanese technology suppliers were in "rather simple industries, such as textiles, household electrical goods, and vehicle assembly", i.e. in *competitive* markets (Santikarn, 1981: 112). In contrast, Western technology contracts were concentrated in *monopolistic* markets: "the United States and other developed countries concluded a larger proportion of contracts in industries associated with imperfect markets and goodwill. Even the American technology sold to the textile and garment industries are all associated with trade names" (Santikarn, 1981: 112).

In sum, it has become clear that BOI statistics alone cannot provide the whole picture of FDI in Thailand. The industrial distribution of Western firms and Japanese firms are quite different. Western firms concentrate in monopolistic markets and tend to sell goodwill, or tend to avoid risks in competitive markets. Whereas Japanese firms concentrate in competitive markets for standardised goods with lower technology fees (Santikarn, 1981: 143-4). Most Western firms have full ownership or sometimes become a smallest minority share holder, whereas many Japanese firms were established as JVs (Santikarn, 1981: 154). In some of the monopolistic industries such as condensed milk or pharmaceutical industries, the ratios of royalties to net profits are extraordinarily high (Santikarn, 1981: 143). The cost of Japanese technology is cheap relative to that of Western nations. In some of these monopolistic industries, the production technology only involves the blending of chemical ingredients or simple assembly (Santikarn, 1981: 113-4). Santikarn properly attributed the cause of the difference to the following points. First, Japan was a latecomer in Thailand. Second, Japan is heavily involved in the production of standardised commodities which have low technological barriers (Santikarn, 1981: 144).

The superior position of Western firms had not changed much by 1988. Ajiakeizai Kenkyusho's report by Takeuchi calculated assets and profits of the top 100 firms in Thailand in 1988 (Table 5-12). According to this information, 15 Western and 6 Japanese firms are included in the top 100. The share of assets of Western firms is 3.5 per cent, while that of the Japanese is 1.4 per cent. The top 100 profits makers include 19 Western and 10 Japanese firms. Among Western and Japanese firms, Unocal Thailand (natural gas extraction, US 100%) is ranked third, but no Japanese firm is ranked in the top 30 firms. The share of profits of Western firms is 16.2 per cent and that of Japanese firms is 4.4 per cent, nearly a quarter that of Western firms. If Thai-Western and Thai-Japanese firms are included, the share of Western firms becomes 21.2 per cent and that of Japanese firms becomes 5.6 per cent. The dominance of Western firms is evident (Ajiakeizai Kenkyusho, 1992: 219-23). Under this situation Japanese firms paid 14.5 per cent of corporate tax and 24.3 per cent of business tax

Table 5-12 Country share of assets and profits of the top 100 companies in Thailand (1990)

	firm	public	Thai	Japan	West	Asia	T/J	T/W	T/A	total
Assets										
	No. 1-30	42.3	29.7		0.5		1.2	8.7		82.4
	No. 31-60	2.1	5.3	0.7	1.6		0.2	0.6	0.4	10.7
	No. 61-100	0.9	2.3	0.7	1.5		0.8	0.5	0.2	7.0
total share		45.2	37.4	1.4	**3.5**		2.2	**9.8**	0.6	100
no. of firms		(27)	(33)	(6)	(15)	(0)	(7)	(8)	(2)	(100)*
Profits										
	No. 1-30	49.1	7.0		11.4		0.9	2.0	2.2	72.6
	No. 31-60	1.9	5.5	3.4	2.4	0.8		1.2		15.1
	No. 61-100	3.7	2.4	1.0	2.5	0.3	0.3	1.8	0.3	12.3
total share		54.8	14.8	4.4	**16.2**	1.1	1.2	**5.0**	2.5	100
no. of firms		(33)	(22)	(10)	(19)	(3)	(2)	(9)	(2)	(100)

Source: Ajiakeizai Kenkyusho, 1992: 259-61. Shares are calculated by country and by ranking group (1-30, 31-60, 61-100) of the top 100 companies listed in *Million Baht Business Information Thailand, 1990*. Public=the state owned, Thai=T=Thai private, J=Japan, W=US and Europe, A=NIEs, etc. T/ J, T/W, T/A= joint ventures. *100 includes 2 firms of which countries were not identified. Abridged by the author.

to the whole payments in Thailand in 1988 according to the survey by the Japanese Chamber of Commerce in Bangkok.[82]

In conclusion, because Japanese firms are latecomers and work in competitive markets with standardised commodities, the volume of accumulated assets is not significant and profit rates are low. For Japanese firms, profits from investments are not guaranteed. Nevertheless, Japanese FDI still continues because the role of Japanese firms is understood as spreading *orderly* technology, even if unintentionally for each firm. If local firms learn technology from Japanese firms and catch-up with Japanese technology, the *raison d'être* of Japanese firms inevitably disappears. Japanese FDI is a national *desideratum*, not monopolistic rent seeking as Ozawa explained. "Boomerang" effects to accelerate the hollowing of Japanese industries are the destiny of the Japanese economy. How to solve the problem of the hollowing in Japan is another issue.

5-4-2. Japan as a tutor in textiles

In Japan it is understood that technology will spread from industrialised countries to less-developed countries through trade and investment, from light industry to heavy and chemical industries (Akamatsu, 1962; Kojima, 1977: Ozawa, 1979; Tran, 1989: 83; Murakami, 1990).

This notion is different from the theory of MNCs by Hymer, which expresses the characteristic nature of monopolistic MNCs. This section uses the case of the Thai textile industry to show that Japanese FDI after WW2 is different from monopolistic MNCs which have existed since colonial times. The textile industry had large spill-over effects on many people and in fact facilitated the industrialisation of Thailand. The scale of spill-over effects is far-reaching when compared to that of Esso Singapore for example. The share of value added from the textile industry in Thai manufacturing doubled from 7 per cent in 1966 to 15 per cent in 1976 (Santikarn, 1981: 41). The value added of the textile industry tripled from 4.5 billion baht in 1970 to 15.3 billion baht in 1980 according to TDRI data.[83]

In 1943 the Thai government (MOI) established two JV textile factories, Spinning and Weaving Co., Ltd. and Thai Cloth Co., Ltd. with Japan. They were closed down when WW2 ended (Ministry of Industry, 1983: 33). "Since 1960, direct foreign investment in the form of joint ventures has become the most important means of technology transfer" (Santikarn, 1981: 153-4). Meanwhile, the first post-war textile factory by a Japanese investor appeared in 1961, a blanket factory with a full Japanese ownership by a wartime Japanese businessman in Thailand, a case of FDI by SMI (Chushokigyo Jigyodan, 1991: 27), followed by a number of Japanese investments. By 1975, out of the 63 BOI promoted textile firms, only 12 were wholly owned locally, 27 were Japanese related JVs and the residual were Chinese-related or Indian-related firms. Japanese firms thus became the most important JV partners for the Thai textile industry. During the period 1960-73, the share of Japanese capital in BOI promoted textile industry reached 55.8 per cent and this constituted 52.2 per cent of Japan's total promoted investment (Santikarn, 1981: 161-2). Through these joint ventures and technology assistance from Japanese firms, local entrepreneurs gradually acquired technology and became independent. They first borrowed manufacturing technology and then marketing technology (Santikarn, 1981: 156-7). Santikarn did not argue the increase of dependence of local entrepreneurs in these JV activities which was normally criticised in other places. Rather she observed that this happened because local entrepreneurs wanted short cuts to acquire modern technology (Santikarn, 1981: 156). Santikarn reported several cases in which local entrepreneurs had become capable and independent entrepreneurs learning technical, managerial and marketing technology through JVs with Japan (Santikarn, 1981: 172-5). To sum up, in Santikarn's words, the local industrialisation policy has provided: "local Schumpeterian merchants with new and more varied opportunities, using foreign joint ventures as stepping stones to accomplish a totally new role as industrial entrepreneurs" (Santikarn, 1981: 175). It is thus evident that Japanese firms have played the role of tutors in the textile industry of Thailand. This illustrates the operation of the historical law of "technology spread" which is widely accepted in Japan.

Ogawa and Tran also surveyed the technology transfer in the Thai textile industry. Ogawa surveyed six Japanese joint venture (JV) factories in Thailand in 1975-6 and compared them with five Japanese related textile factories in Korea which he surveyed in 1976 (Ogawa, 1976). At the time of the survey, Japanese JV firms in Thailand were managed and assisted by many Japanese expatriates, meanwhile factories in Korea had no Japanese managers or engineers.

A JV factory in Thailand had 13 Japanese expatriates in 1,700 employees. Among them, five expatriates were working for the dye and finishing processes or pattern making process. These processes need long experience and skills, which Thai staff lacked (Ogawa, 1976: 56). In Korean factories, staff had already acquired these technologies through JVs or license agreements with Japanese firms. In a spinning mill in Thailand, a female worker was responsible for 10-12 spinning machines on average. This ratio of machine-worker was only 50-60 per cent of the corresponding figures of Japanese factories (Ogawa, 1976: 56). In contrast, in a Korean factory, a worker was responsible for 25 machines. This ratio was even higher than the average of large Japanese mills (Ogawa, 1976: 59). In addition, Ogawa emphasised the lack of supporting industries in Thailand. Thailand had to import hundred per cent of the "bobbins" for synthetic filaments. Whereas, in Korea, a synthetic filament factory had already began a trial order of bobbins from a local firm. At the survey time, Thailand had no textile machine producers, Korea was producing 40 per cent (in amount) of textile machines locally (Ogawa, 1976: 59). These facts suggest a wide gap in technology level between Thailand and Korea at that time.

Ogawa suggested some possible causes of the slow industrialisation in Thailand in comparison with Korea. Firstly, the abundant natural resources of Thailand has an adverse affect. In contrast, the poor natural resources and large population in a small country required the Korean government and the people to work hard for the country's rapid industrialisation. The shortcoming became a stimulus to Korea. Secondly, Korea's proximity to Japan worked favourably in terms of technology information flow [including the role of Korean immigrants in Japan]. Thirdly, Korean people had far better capacity in understanding Japanese. Both Korea and Japan use Chinese characters (*kanji*) and this assisted a faster technology acquisition. In addition, Korea achieved a higher level of education than Thailand. The high school registration rate in Thailand was about seven per cent, while in Korea the rate was 50 per cent in 1974. Lastly, Korea had more experience in textile industries than Thailand. Before WW2, Korea had already established a wide range of textile industries (Ogawa, 1976: 60-1). In contrast, Thailand completely lacked this kind of experience prior to the war, with only a few exceptions as explained in the previous chapter.

Tran surveyed synthetic fibre firms, i.e. the upstream textile industry in Thailand (Tran, 1989; 1993; 1995), and compared them with his Korean survey (Tran, 1988). He initially borrowed the concept of technology transfer from Ogawa (Ogawa, 1976), but developed his own idea and pinpointed "management know-how". He divided technology transfer into three levels, "production technology (embodied in equipment and operators)", "administration technology (embodied in middle managers and engineers)" and "management know-how (embodied in top management)" (1989: 81; 1995: 309-10). He thus understands that: "local personnel should eventually not only be able to handle, digest and modify the production technology, but they should be able to manage the operation of the factory and the foreign-related firms as a whole" (Tran, 1995: 310-11). As mentioned above, he understands that management technology is different from production technology. Although Thai people mastered production management, they have not yet mastered management know-how. In his understanding, technology transfer will be completed only when the firm does not need Japanese expatriates. He thus placed an emphasis on the replacement of expatriates. This is different from Ogawa's concept which places an emphasis on technological development on the shop floor. Tran focuses mainly on the replacement of top management staff regarding that production technology is already acquired by local Thai staff.

Tran reported that in Korea, not only production technology and administration technology but also management know-how was already acquired by Korean local staff at the surveyed time, mainly through JVs and license agreements with Japanese firms (Tran, 1989). For example, he explained that, because Sam Yang (established before WW2) had enough accumulation of technology, the firm could rely on license agreements to borrow technology (1988: 394). Also in the case of Sunkyong Fibre, a JV with Teijin, its plant was managed by Korean staff alone from the very beginning as the firm had capable human resources (1988: 388). Kolon Nylon established a JV with a US firm (Chemtex), but technological troubles were solved by Toray's technical assistance from the beginning. Kolon had 10 Japanese expatriates from 1963 to 1978 and Toray later became a major JV partner. As a result of the technological development, the number of Japanese expatriates at Kolon fell to only one during 1979-85 and zero after that (1988: 399). Thus, Korean firms learnt technology from Japan.

Thailand also learnt technology from Japan. But, in the case of Thai-Japan JV synthetic fibre firms, the situation was not the same. "Production technology" and "administration technology" were already in the hands of local staff (Tran, 1993: 71; 1995: 327). However, localisation of "capital and management know-how" were slow and not yet fully achieved (Tran, 1989: 92; 1995: 327). These factories were still managed and controlled by many Japanese expatriates. In Korea, local firms chose JVs and license agreements to acquire technology. But in Thailand, local firms chose only JVs (Toray in 1963, Teijin in 1967). This occurred, he says, because Thailand had not enough "modern management know-how" (Tran, 1989: 87). Most Japanese synthetic fibre firms withdrew from Korea as the result of the technological development of local firms in Korea. Whereas, in Thailand, Japanese firms still remain and dominate the Thai synthetic fibre industry (Tran, 1989: 92). In Thailand technology transfer was not yet been completed. However, the author considers that it is not productive to discuss the replacement of staff independently from the content and level of production technology. This point will be further discussed in Chapter 9.

Regarding the slow technology transfer in Thailand, Tran suggested that both sides share the responsibility. Firstly, Japanese slow promotion (seniority system) hinders the effective use of the scarce Thai human resources (Tran, 1989: 92; 1993, 75; 1995: 328). On the other hand, the Thai side also needs more efforts in the development of human resources (1989: 92; 1995: 327).

As argued, technology transfer is not yet complete in Thailand. However, it is clear that Japanese firms have played the role of a tutor in Thai textile industries. The case of auto parts and electrical parts industries will be examined in the following chapters.

Part II: An Analysis of the Empirical Survey

Chapter 6: The Plan of the Empirical Survey: Measuring the Learning Levels of Local Staff

6-1. Preparation for the survey

6-1-1. Definitions and concepts

According to the basic concepts reviewed in Chapter 1, this thesis understands that "a system of production" is composed of three strata of productive activities (Ogawa, 1976: 50; 1992: 21; 1993a: 304-7; 1993b: 36-7):

(i) *operation*,

(ii) *improvement*,

(iii) *development*.

(i) *Operation* is the work of men and machines to advance the production process. Assembly work by human hands and co-operative work by humans and machines are both examples of operations. (ii) *Improvement* includes product improvement, process improvement and operation (work) improvement. Process improvement will occur not only through technical or scientific changes but also through production management (see Chapter 3: 3-3-3). The concept of industrial engineering (IE) is included here. (iii) *Development* refers to the development of new products and new processes. It also includes the designing and creating of new equipment and new plant. The two concepts of *improvement* and *development* as a whole are equal to the concept of technical change.[84] The difference between *improvement* and *development* (*creation*) is a matter of degree.[85]

Today's production activity involves *pre-production* and *production itself* (Ogawa, 1982: 12-4; 1984b: 2-3). Pre-production is the preparation for the expected production activity. In today's production, as seen most clearly in the cases of automobiles and electrical appliances, products and processes are changed continuously by "improvement" and "creative" activity. Therefore, the two parts, *pre-production* and *production*, are no longer separable and proceed hand in hand. Pre-production itself does not advance the process from input to output, but it prepares for production and facilitates technical changes such as productivity improvement, the adoption of new processes, and the introduction of new models or products.

It should also be noted that the distinction between *product, process* and *operation* is important. *Operation* is the work of "humans and machines" to advance the *process* of production. *Product* is the final objective of the *process* advanced by humans and machines' *operations*.

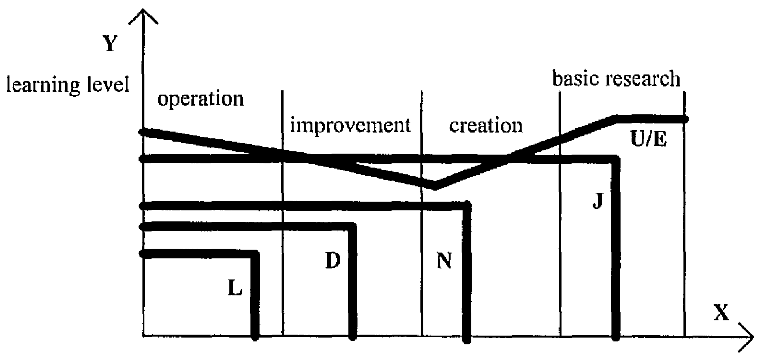
Following the above concept of production, this survey adopts the classification of three strata and ten categories of technology. The three strata are (i) *operational technologies,* (ii) *improvement technologies* and (iii) *creative(-ting) technologies.* Today's continuous production in competitive markets requires not only (i) *operational technologies* but also (ii) *improvement technologies* and (iii) *creative(-ting) technologies.* Further, they are classified into ten categories as shown in Table 6-1.

Table 6-1 Three strata and ten categories of technology

3 strata of technology	10 categories of technology	
(i) Operational technologies	1	Operation
	2	Maintenance
	3	QC
	4	Production control
(ii) Improvement technologies	5	Technology improvement (*kaizen*)
	6	Development of mould/ die/ jig
	7	Development of equipment
(iii) Creative(ting) technologies	8	New Technology
	9	Engineering Design
	10	R & D of new products

Source: Fransman, 1984: 10; Ogawa, 1993a: 304-7; 1993b: 36-7; Nikkeisangyo Shohi Kenkyusho, 1992; etc.

Figure 6-1 A model of technology accumulation



Source: The author
X axis = stages of technology (from operation to R&D), Y axis = learning level
L = least developed country, D = less developed country, N = NIEs, J = Japan, U/E = the USA and Europe

The automobile market in Thailand has already developed to a significant scale and local firms have so far accumulated a solid base for *operational technologies.* Upon this base, *improvement technologies* are being transferred to Thailand. A shift of mould and die technologies to Thailand is a typical example of *improvement technologies* (Table 6-1: category 6). The improvement technologies of mould and die are the first step to the *creative (-ting) technologies* (category 8 to 10). However, it would be impossible to argue that Thailand has a full range of creative technologies.

A model of the learning process (Figure 6-1) will demonstrate the complexity of technology. The Y axis shows the level of learning. In the case of borrowing technology, the learning level advances from the bottom to the top (the case of Table 6-7: Japanese and Western subsidiary firms). At the same time, along the X axis, the learning (accumulation) level of technology advances from "operation" to "improvement", and then to "creation". Technological capability for "basic research" comes after a long history of scientific and technological development. The USA and Europe have the most advanced basic research staff and facilities. In Figure 6-1, least developed countries (L) have accumulated the least amount of technology. The learning level is low. Less developed countries (D) are more advanced, but the scope of technology is limited to "operation" and "improvement". NIEs (N) are capable of carrying out some "creative" activity. However, they do not conduct "basic research". The most advanced countries (U/E) lead "basic research" in the world. A problem of U/E is that they are losing competitiveness in some of operational technologies. Japan (J) stands in the middle. Japan is also loosing some "operational" capability.

In addition to the above two dimensions, "sophistication degree" constitutes another dimension of technology. As mentioned in Chapter 1 (page 16), technology advances from unsophisticated to sophisticated, from simple to complex technology (the case of Table 6-7: Thai firms). In the case of unsophisticated technology, learning of "improvement" and "creative" technologies are not so difficult as in the case of sophisticated technologies.

What follows are definitions of some technical terms used in the empirical survey, which need special reference to avoid misunderstanding and confusion. Technical terms concerned are shown by quotation marks below.

Table 6-2 A sketch of the supporting industries in Thailand (1993)

Machine industry				
	parent enterprises	supporting industries		
Automobile industry	Assemblers (13)*	Auto parts industry (297)#		Parts suppliers and engineering industries (1199) or first, second and third tier suppliers
Electrical machine industry	Set makers (60)**	Electrical parts industry (359)#		
		Auto/electrical parts (35)#		
Other machine industry	Parent enterprises	Other supporting industries (508)		

Source: SEAMECO, 1993; * Table 4-10; **Table 6-6; # 35 firms supply both auto and electrical parts.

"Supporting industries" form a multi-tier structure of the first tier, the second tier and the third tier or more. The case of the Japanese machine industry was explained in Chapter 3 (Figure 3-1a, Figure 3-1b). Already, the Thai machine industry has developed considerably to form linkage relations. As shown in Table 6-2, "the machine industry" is composed of the automobile industry, electrical machine industry, and other machine industries such as basic metals (MOI code no. 59, 60),[86] fabricated metal products (61-64), non-electrical machinery (65-70), precision instruments and apparatus (81-83) (see Chapter 4: 4-4-1). The number of manufacturing firms in the machine industry in Thailand was about 15,600 in 1984 and about

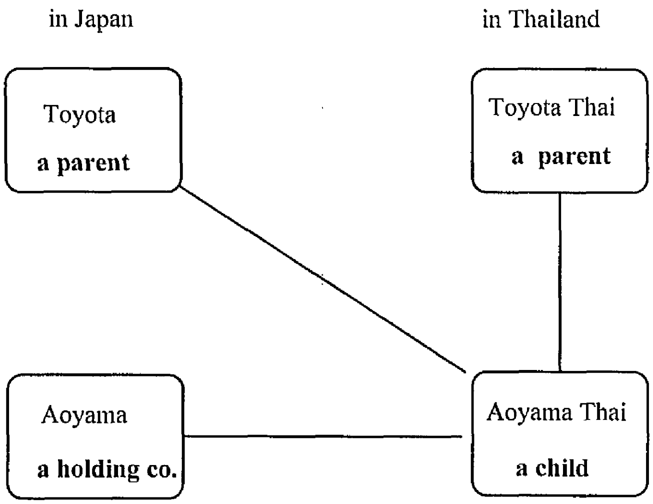
22,000 in 1990 according to the statistics of MOI (Kuroda and Kasajima, 1987: 365; *Bangkok Bank Monthly Review*, April 1988: 175; Kaigai Konsarutingukigyo Kyokai, 1992: 65-7; Ajiakeizai Kenkyusho, 1992: 215).[87]

As mentioned, machine industries are supported by linkage or supporting industries, the engineering industries comprising a central part of these supporting industries (Table 4-5). According to the author's aggregation of the SEAMICO directory (Table 6-2), there are 297 auto parts firms, 359 electrical parts firms, 35 auto/electrical parts firms, and 508 other supporting firms in Thailand (Table B-3, Table B-4). The total number is 1,199 firms, about five per cent[88] of the total number of the machine industry in 1990.

The SEAMICO directory presents each company's profile such as the start-up date, the amount of capital and assets, ownership by country, sales amount, names of main clients, product items and processes, sectors supplied, and so on (SEAMICO, 1993). The directory presents the most exhaustive information concerning Thai supporting industries. The following description of the number of supporting industries is taken from the SEAMICO directory unless otherwise stated.

As shown in Figure 6-2, "a parent enterprise" is defined as a company which regularly orders from its specific suppliers. In Japan, this relationship is called the *shitauke* relationship between a parent (*oya*) and a child (*ko*). This is different from the relationship between "a holding company (*oya*)" and its overseas subsidiaries (*ko*) although the same terms "*oya-ko*" are used in Japanese. For example, Toyota, "a parent enterprise", orders nuts and bolts regularly from Aoyama Japan, "a supplier" in Japan. They have no capital relationship. At the same time, Aoyama Japan is "the holding company" of Aoyama Thailand (Figure 6-2). Thus, in the case of FDI, there emerge four partners; Toyota (a parent enterprise), Aoyama Japan, (a supplier for Toyota in Japan and the holding company for Aoyama Thailand), Toyota Motors Thailand (a subsidiary of Toyota), and Aoyama Thailand (a subsidiary of Aoyama Japan).

Figure 6-2 A parent enterprise and a holding company



In the case of the automobile industry, parent enterprises are called "assemblers" and sub-contractors are called "auto parts suppliers". In the case of the electrical machine industry, parent enterprises are called "set makers". And their sub-contractors are called "electrical parts suppliers". The auto parts and the electrical parts industries were the main target of the survey.

"Worker-expatriate ratio" is defined as the ratio between expatriates and workers including expatriates. For example, Aoyama Thai has four expatriates among 280 employees including managers and expatriates. As the formula is defined as "employees divided by expatriates", Aoyama's worker-expatriate ratio becomes 70 (= 280 ÷ 4). This ratio presents a standard to examine the high ratio of Japanese expatriates compared to the Western subsidiaries.

6-1-2. The number of firms in supporting industries in Thailand

According to the SEAMICO directory (see Appendix B), the total number of the firms in the supporting industry in Thailand was 1,199 in 1993 (Table 6-2). If the number of firms of which country of origin is unavailable is excluded, the number of firms classified by country becomes 1,093 including 10 double counting of 50/50 % JVs because 50/50% JVs have to be counted in two countries at the same time (Table 6-2). Among them, the number of firms in auto and electrical parts industries was 691.

Between 1984 and 1993, the number of firms in the supporting industry increased by 535, more than doubling the total from 448 to 983 (excluding the firms of which the year of establishment was unknown). The increase was especially apparent in foreign firms. The number of foreign subsidiaries increased by 206, from 42 to 248, 5.9 times in that period (Table 6-3). This owes much to the increase in the firms in the electrical parts industry, from 110 to 342. Meanwhile, the firms in the auto parts industry increased by 77, from 146 to 223 during the same period. The two major parts industries (the auto parts and electrical parts industries) explain 57.8 per cent of the firms' total increase of 535 from 1984 to 1993.

Until 1984, Western firms comprised most of the majority ownership foreign investments in the supporting industries. In 1984, the number of Western firms was 24, while that of Japan was 13 and of Asian firms was 5 (Table 6-3). This shows that Japanese and Asian firms are latecomers after 1984. Western firms invested in the less sophisticated processes, while Japanese firms developed more difficult processes. As described in the previous chapter, this probably occurred because Japanese firms did not expect short term profits, and just wanted to survive in a new territory.

Table 6-3 The investment in the supporting industry by country (majority owners)

	Thailand	Japan	Asia	West	Foreign total	total
-1984	406	13	5	24	42	448
1985-1993*	329	106	65	35	206	535
sub-total	735	119	70	59	248	983
year n.a.	87	4	15	4	23	110
total	822	123	85	63	271	1,093

Source: SEAMICO, 1993. The country classification by majority ownership. See Appendix B
* The figures of the year 1993 are only partially included.

If we examine the products of the foreign firms, the picture becomes clear. There are 14 firms in the auto parts industry in 1984. Among them, nine are from Japan, two from Asia and three from the West. The three from the West are tyres (no. 1), forging parts (no. 2) and hand tools for automobiles (no. 3). The no. 2 firm for forging parts was initially established as a Japan/Thai JV and later a part of the share was sold to a US firm. The technology is until now provided by the Japanese minority holder. By 1984, in a sharp contrast, eight firms in electrical parts industries are from the West and three are from Japan.

It is obvious that, until 1984, Japan invested primarily in auto parts whereas the West invested primarily in the electrical machine industry and in other general supporting industries. The examples of the Western investments are switching devices, compressors, transformers, uninterrupted power supplies (UPS), steel furniture, metal cans for food and beverage, hoes, wire rods, sewing machine parts, etc., according to the information of the SEAMICO directory.

After 1985, Japanese and Asian investments increased significantly. As a result, the share of Western investments showed a sharp decline from that of the period before 1984 (57.1%) to the period 1985-1993 (17.0%). Since the latter half of the 1980s, the impact of Japanese and Asian investments on Thai industrialisation has far surpassed that of the West. Japan and Asia have come to play the role of tutors not only in the automobile industry but also in the electrical machine industry, not to mention textile industries.

In Thailand there are 13 car assemblers (Table 4-10). About 95 per cent of the car market in Thailand is occupied by Japanese brand cars. According to the SEAMICO directory, there are 332 auto parts firms including 35 firms which produce both auto and electrical parts (Table 6-2; Table B-4). Among them, 21 are Japanese majority firms (defined as firms with majority capital share), 2 Asian majority, and 8 Western majority. In total, there are 31 foreign majority firms, which is less than 10% of all auto parts firms in the Table 6-2. If the minority JVs are included, the number of Japanese firms becomes 79 (24%), Asian firms 28 (8%) and Western firms 23 (7%). These foreign subsidiaries constitute 39.2 per cent of all 332 auto parts firms in Thailand.

Despite the existence of a considerable number of foreign firms, the main component—245 majority firms (74%) and 22 minority firms (6%) give a total 80% of firms. It should be noted, however, that nearly one quarter (23%) of the auto parts firms in Thailand have at least some Japanese capital shares and borrow technology directly from Japan in the form of JVs.

As for electrical machine industries, there are 60 set makers and 394 electrical parts firms in Thailand (Table 6-2, Table B-4). Thirty five firms from the 394 produce both auto parts and electrical parts and are counted in electrical parts industries as well. The number of Thai majority firm is 213 (54%) and that of foreign majority is 155 (39%). Among the 155 foreign majority firms, 79 firms (20%) are Japanese majority, 50 (13%) are Asian majority, and 26 (7%) are Western majority. If minority firms are added, the number of foreign firms becomes 276 (70% of the total 394 firms)—124 Japanese firms (31%), 99 Asian firms (25%) and 56 Western firms (14%).

In the case of electrical parts industries, the share of Thai owned firms is lower than in auto parts industries (54% for Thai majority firms and 17% for Thai minority firms). At the same time, about one third of the total electrical parts firms are borrowing technology from Japan—21% in the form of JV and 10% in the form of fully Japanese owned subsidiary.

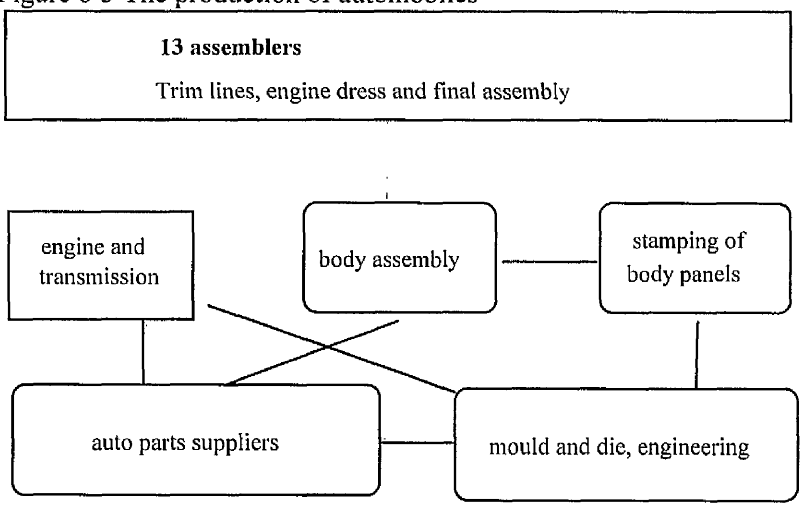
6-1-3. The linkage structure of the auto parts industry

For a better understanding of the following chapters, basic structures of today's automobile and electrical industries in Thailand will be further illustrated below.

As illustrated in the Figure 6-3, the manufacturing process of automobiles is divided into four lines; (1) body, (2) engine, (3) transmissions and (4) chassis. In the case of normal passenger cars, there is no chassis . All components are placed in the body. Some suppliers process engineering and assemble them into parts and components. Other suppliers only share engineering processes such as electroplating, press work and heat treatment. Second and third tier suppliers normally share only a part of the engineering processes. Without these supporting industries, the automobile industry cannot stand economically; parts have to be imported and engineering processes have to be subcontracted abroad. In the case of ASEAN countries, engines, transmissions and outer body panels are in many cases imported from

Japan. These parts need a large amount of investment and high technologies. However, the recent trend has been to relocate these processes to Thailand.

Figure 6-3 The production of automobiles

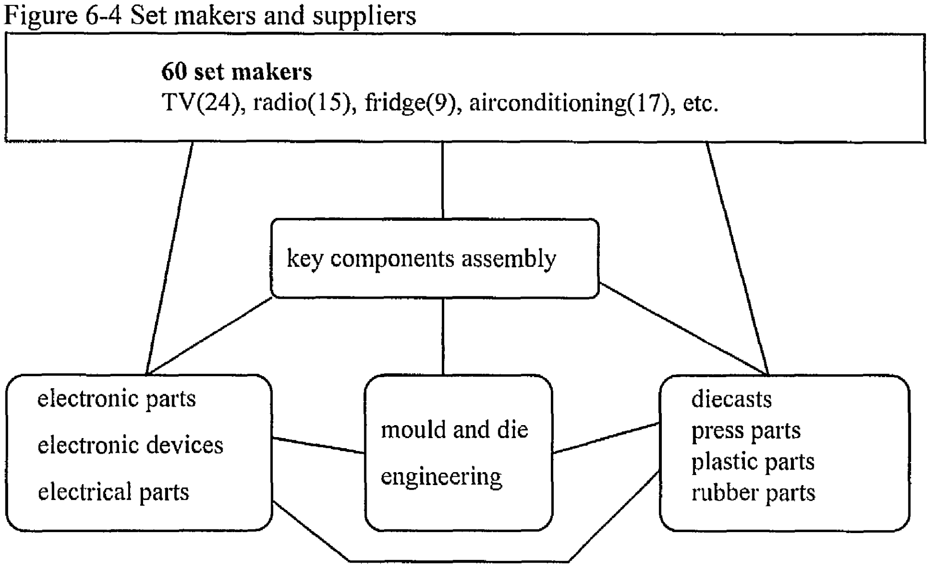


Source: Jenkins, 1987: 66; JICA/UNICO, 1994a: 3-2-27....37(modified)

6-1-4. The linkage structure of the electrical parts industry

The outline of the electrical industries in Thailand is shown in Figure 6-4, Table 6-4 and Table 6-5.

Figure 6-4 Set makers and suppliers



Source: JICA/UNICO, 1994a: 4-1-11, 4-2-19 (illustrated)

Table 6-4 The investment in the general electrical machine industry in Thailand

	Main share holders	establishment	Annual sales
Sanyo Universal Electric Co., Ltd.	Sanyo	1959	1,113
National Thai Co., Ltd.	Matsushita	1961	1,443
Tanin Industrial Co., Ltd.	Thai 100%	1962	50
Philips Electrical Co., Ltd.	Philips	1963	1,243
Kang Yong Electric Manufacturing Co., Ltd.	Mitsubishi	1964	338
Thai Toshiba Electric Industry Co., Ltd.	Toshiba	1969	441
Hitachi Consumer Products Ltd.	Hitachi	1970	528

Source: JICA/UNICO, 1994a: 4-1-2. Yearly sales in 1986 in million baht.

Table 6-5 The investment in the electronics in Thailand

	share holders	establishment	employment
National Semiconductor (Bangkok) Ltd.	US 100%	1973	3538
Signetics Thailand Co., Ltd.	US 100%	1974	
Data General Thailand Ltd.	US 100%	1974	452
Seagate Technology Co., Ltd.	US	1983	5100
Minebea Thai Ltd.	Japan 100%	1985	8600
Minebea Electronics Co., Ltd.	Japan 60%	1988	3496
Toshiba Display Devices Co., Ltd.	Japan 100%	1988	2103
Toshiba Semiconductor Co., Ltd.	Japan 100%	1990	824

Source: JICA/UNICO, 1994a: 4-1-2; SEAMICO, 1993. employment in 1992

Table 6-6 The establishment of "set makers" in Thailand

	Japan	Asia	West	Thai 100%	n.a.	total
1959-69	5	0	1	4		10
1970-79	2	1	2	8		13
1980-89	17	4	1	7		29
1990-92	6	1	0	0		7
n.a.					1	1
total	30	6	4	19	1	60

Source: JICA/UNICO, 1994a: 4-1-20. Japan, Asia, West includes JVs and 100% ownership. The survey is not complete. The number of set makers is 60, but the country and the year of establishment of a firm is not identified.

From 1959 to 1970, seven general electrical machine companies—five Japanese, one Thai and one Western—invested in Thailand (Table 6-4). Then in the 1970s, three US companies began the integrated circuit (IC) assembly in Thailand (Table 6-5). The assembled ICs were exported to the USA and contributed significantly to the growth of exports from Thailand. It also stimulated the Thai people's interest in new technologies and encouraged them to learn new technologies. Nevertheless, it was argued that "assembling" ICs is different from manufacturing ICs and that the "assembling" process itself is not a high technology, but a rather simple technology. This point will be discussed later in the following chapters.

From the late 1970s, investment in the electrical machine industry increased (Table B-1). The number of set makers and suppliers increased considerably in the 1980s and the 1990s. Including the general electrical machine industries established until 1970, 60 set makers are recognised in the JICA/UNICO survey (Table 6-6). The 60 firms are grouped by the year of the establishment and the origin country. By country, the 60 set makers comprised 30 Japanese firms, 6 Asian firms, 4 Western firms and 19 one hundred per cent Thai owned firms. The ownership of one firm could not be identified.

Among the 60 set makers, 24 firms produce TVs, 15 produce radios, 9 produce refrigerators, 17 produce air conditioners (Figure 6-4). A set maker normally produces several product items. For example, the Sharp group (two set makers) produces four items; air conditioners, refrigerators, microwave ovens and TVs. While Sanyo (one set maker), the oldest in Thailand, produces seven product items from air conditioners to TVs including electric fans and rice cookers (JICA/UNICO, 1994a: 4-1-19, 4-1-21).

The set makers are supported by many parts suppliers. These suppliers which support set makers are supporting industries. Figure 6-4 shows the linkage picture of the supporting industry.

6-2. The plan of the survey

6-2-1. The aim, the scope and the method of the survey

In order to shed light on the borrowing process and the role of the FDI, the supporting industries in Thailand were surveyed by the author from October 1994 to March 1995. In practice, the survey was planned to measure the learning levels of technology at foreign and local firms. The aim of measuring learning levels is a deeper understanding of the real borrowing process, not the individual technology itself.

The place of the survey was Bangkok and its vicinity. Following the above survey in Thailand, a supplementary survey was conducted in Japan from November 1995 to January 1996.

The Japanese candidate firms were selected from the directory issued by the Japanese Chamber of Commerce, Bangkok (JCC). The JCC's directory includes 415 manufacturing firms. Among them 91 were considered to be in the supporting industry category by the author. Questionnaires were sent to most of them. After that, the author telephoned or wrote to the managing directors or managers to request co-operation. Finally, within the proposed dates during the period from the mid October in 1994 to the early March in 1995, 23 Japanese subsidiary firms co-operated fully with the survey. Several firms partially answered questionnaires were excluded from the following figures although information obtained was used for the analysis.

The list of Thai candidate firms was obtained from the Department of Industrial Promotion (DIP). The author telephoned or wrote letters to the candidate firms. Twenty firms were visited by the author during the above survey time.

Directories of American Chamber of Commerce and British Chamber of Commerce were obtained. The information in the directories was not as complete as that of JCC. Because of shortage of time and difficulty in making appointments, only two Western factories were visited by the author. However, *survey B,* an additional survey of 11 Western firms by telephone and mail, was carried out to collect information on products, processes and expatriate staff.

6-2-2. Questionnaires, measuring the learning levels

Three sets of questionnaires were designed to measure the learning levels of technology. One for Japanese firms in Japanese, one for Western firms in English, and one for Thai firms in the Thai language with English translations. The questionnaire for Western firms is a simple translation of the questionnaire for Japanese firms. Questionnaires for foreign firms were designed from the viewpoint of technology suppliers. The questionnaire for Thai firms was designed from the viewpoint of a recipient, i.e. a borrower of technologies.

The main components of the questionnaires were:

(1) General profile

(2) Management system (only for Japanese and Western firms)

(3) Training system or learning system

(4) Learning levels (measuring of technology transfer) or measuring of technology levels

(5) Inputs/outputs relations

(6) Managing director and entrepreneurship (for Thai firms)

(6)* Managing director (for Japanese and Western firms)

In addition, the following points are covered by interviews and factory visits:

(7) Main products and processes

(8) The sources of technology

(9) Training of local staff in the home countries (Japan or the West)

Table 6-7 The standard for the grading of technology

Grading	Japanese and the Western subsidiary firms (learning degree)	Thai firms (combination of learning degree & sophistication degree measured by markets)
9-10	Nearly finished the learning of technology	excellent, comparable to those of industrialised countries' leading firms
7-8	reached a considerable level but still needs more efforts	very good, comparable to industrialised countries' average firms or to leading firms (including foreign firms) in Thailand
5-6	learnt half of the technology	good, better than the average Thai firms
3-4	on the first stage of learning	the average Thai firms, the low-end local market
1-2	a minimum level of technology	very low, unacceptable at markets

Source: The author. The standard for the local firm (TDRI, 1989: 3-31; Sumeth, 1992: 44)

The technology levels of firms are measured by ten grades (see Table 6-7) in three strata and ten categories of technology (see Table 6-1).

In the case of Japanese or Western subsidiary firms, the technology levels were graded by interviewees comparing the subsidiary firms and the holding companies. The interviewees were expatriates from the holding companies and in a good position to compare the subsidiary firms and the holding companies. If it was considered that the technology acquisition level reached that of the holding companies, the level was scored 9-10. The standard for the scoring is shown in Table 6-7.

I. Question: Measuring of technology transfer (in Japanese and Western subsidiary firms).

I-1. How far the technology transfer is completed for each job (for ten categories of technology)? Please score by 10 grades.

10 ----------Completely transferred.
9
8
7
6
5 -----------Half transferred,
4
3
2
1 -----------Scarcely transferred,
0 -----------not at all

In addition, the level of staff localisation was assessed.

I-ii. *Who really handles* the following jobs (ten categories of technology), local staff or foreigners?

4 local staff,
3 local staff with assistant foreigners,
2 foreigners with assistant local staff,
1 foreigners,
0 no plan to localise

In the case of local firms (Thai firms), the scoring was done by the author through the discussions with the interviewees. The standard for the scoring followed the Table 6-7.

II. Question: Technology accumulation (in Thai firms)

As the result of the accumulation of technology in your firm, how far has your firm developed the technology? Please score the learning levels in each category of technology by 10 grades.

10 ----------Completely learnt and developed (the top level technology in Asia including Japan, Korea and Taiwan).
9
8
7
6
5 -----------Half learnt and developed (medium level technology)
4
3
2
1 -----------Scarcely learnt
0 -----------learnt not at all (have no technology)

This question aims to measure the learning (development) levels of technology. It is argued that on average Thai firms have lower levels of technology than firms in industrialised countries. Lower levels of technology means that the products involve fewer parts and components and/or simpler and shorter processes. Workers are generally very young and lack knowledge, skills and experience. Additionally, the product's competitiveness in the market of the surveyed firms provided a supplementary standard in the case of Thai firms as shown in Table 6-7 (see page 16).

Measuring of technology levels involves judgement from overall impressions. In the case of small workshops, it is easy to observe the whole shop floor and equipment. In the case of large companies, they have several plants engaged in different products and processes with a variety of machines. In the case of large scale companies, although the author visited several plants several times, understanding all aspects of technology was impossible. The result of the scoring should thus not be taken as an absolute, but as relative or comparative.

6-2-3. The number of the surveyed firms

(1) *Survey A*: The interview survey in Thailand (45 firms)

As mentioned earlier, from October 1994 to March 1995, 45 firms were surveyed by the author. These 45 firms were composed of 23 Japanese subsidiaries, two Western subsidiaries and 20 Thai firms (Table 6-8).

By industrial type, the 45 firms were composed of 22 auto parts firms, including two motorcycle parts manufacturers, 18 electrical parts firms and five other machine industry firms. The classification by industrial type denotes only the main products or customers. Some firms produce auto parts, electrical parts and agricultural machinery parts at the same time.

(2) *Survey B*: An additional survey of Western firms in Thailand (11 firms)

In addition to the above *Survey A*, 11 Western firms were surveyed. Questions were about the following topics:

(1) Basic business profile

(2) Data on manufacturing products and manufacturing processes

(3) Data on the number of expatriates

This additional data was collected by telephone and mail in order to compare it with the surveyed 23 Japanese firms. Including the two firms in the *Survey A*, the total number of the surveyed Western firms is 13 (Table 6-8, Table A-2 in Appendix). The surveyed 13 firms are composed of 10 electrical parts firms, two auto parts firms and one general industry. The Western firms are mostly in the electrical machine industry sector and five firms are only for assembling, which are considered easy technology as will be discussed later.

(3) *Survey C*: Supplementary mail survey on technology in Japan (13 firms)

In January 1996, questionnaires were sent to 20 Japanese holding companies. Answers were collected by mail from 13 holding companies. The questionnaires included the following issues:

(1) License agreements and the outline of R&D activity in Japan and Thailand.

(2) Relocation of factories to local areas and overseas

Table 6-8 The number of the surveyed firms (by size, by country)

		Survey A							Survey B	A + B
		Japanese subsidiary firms				Thai firms	Western subsidiary	A total	Western subsidiary	
			**SMI (1-300 psns)*	**LI (301-1000 psns)*	*(over 1000 psns)*					
SMI	(1-200 persons)	8	*5*	*1*	*2*	9	1	18	3	21
LI	(201-500 persons)	10	*4*	*1*	*5*	5	1	16	7	23
	(over 500 persons)	5	*2*	*1*	*2*	6		11	1	12
total		23	*11*	*3*	*9*	20	2	45	11	56

Source: The author's survey. SMI and LI in the left columns refer to the size of the firms in Thailand, both foreign subsidiary firms and Thai firms. **SMI* (*1-300 psns*) and **LI* (*301-1000 psns* and *over 1000 psns*) for Japanese subsidiary firms refer to the size of the holding companies in Japan. See Table 6-9

According to the official definition by Thai MOI (Table 6-9), the 56 surveyed firms in Thailand were classified into 21 small-medium industries (SMI, 1-200 persons) and 35 large industries (LI, over 200 persons). LIs are further divided into two groups; 23 firms of 201-

500 persons and 12 firms of over 500 persons. Then, as for the 23 Japanese subsidiary firms, their parent companies in Japan are classified into three groups according to MITI's classification (Table 6-9); eleven SMIs (1-300 persons), three LIs of 301-1000 persons and nine LIs of over 1000 persons. In fact, some of the Japanese firms are held by plural holding companies. In that case the classification followed the size of the major holding companies.

Table 6-9 Definitions of small-medium industry (SMI) and large industry (LI)

	Firm size in Thailand (definition by Thai MOI)	Firm size in Japan (definition by MITI, Japan)
small-medium industry (SMI)	1 - 200 persons	either 1 - 300 persons or capital amount not more than 300 million yen
large industry (LI)	201 - 500 persons	301 - 1000 persons
	over 500 persons	over 1000 persons

Source: The author. In the case of trading firms in Japan, "small-medium firms" refers to the firm of not more than 50 employees, and "large firms" to over 50 employees.

Table 6-10 Products of the surveyed firms by country

	No. of firms				%			
	Japan	West	Thai	total	Japan	West	Thai	total
Auto parts	8	2	13	23	35	15	65	41
Electrical parts	13	10	4	27	57	77	20	48
General parts	2	1	3	6	9	8	15	11
total	23	13	20	56	100	100	100	100

Source: The author's survey (*Survey A* and *Survey B*).

Table 6-11 The engineering processes of the surveyed firms

group	category		Survey A			Survey B		A + B
			Japan	Thailand	West	West	West Total	Total
A assembly	1	Assembly	2		1	3	4	6
	2	Injection/ Assembly	4			1	1	5
	3	Injection	1			1	1	2
	4	Press/ Assembly	3					3
M metal-working	5	Sheet works/ welding, Press, Machining	3	10		4	4	17
	6	Mould and die	1	5				6
	7	Forging, Casting, Machining	6	5	1	1	2	13
	8	Special process	3			1	1	4
		Total	23	20	2	11	13	56

Source: The author's survey (*Survey A* and *Survey B*). A = Assembly group, M = Metalworking group

By industrial type, 56 firms were divided into 23 auto parts, 27 electrical parts and six general parts firms (Table 6-10). By manufacturing process (Table A-4 in Appendix; Table 6-11), six firms were engaged in "assembly" process (see the right columns of Table A-4 and Table 6-11), five firms in "injection plus assembly" process, two firms in "injection" process, three firms in "metal press plus assembly", 17 firms in the combination work of "sheet works-welding, press and machining", six firms in the "mould and die making" process, and 13 firms in the "forging and/or casting" process. The other four firms were engaged in "special processes" of super hard dies, heat treatment, capacitor manufacturing and PCB.

Chapter 7:
The Spread of Technology by FDI:
Understanding the Dynamic Process

Introduction

As explained in Chapter 5, it was argued by ASEAN people especially by the educated elites that Japanese firms do not transfer technology. The claims are that Japanese firms second more staff for longer periods than Western firms, they dominate subsidiary firms, they do not teach technology, but hide it. They sometimes waste time by teaching Japanese business culture instead of teaching real technology. Furthermore, Japanese firms teach only operational technologies, they do not teach R&D technologies or management know-how. Also, Japanese expatriates dominate top management positions, thus local staff never get a chance to learn management know-how.

Against this argument, Japanese expatriates contend that, in ASEAN countries, staff turnover is rampant, especially among educated local staff. They lack experience in manufacturing industries and they often do not want to work at manufacturing plants. Even if they are employed, they regularly quit their jobs. This attitude retards their learning of technology. They do not really understand technology, nor do they want to learn it.

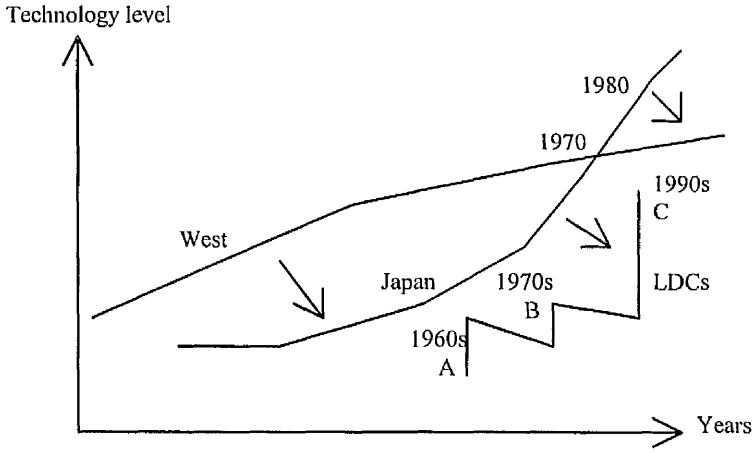
The above contradictory perception gap between technology recipients and suppliers comes from the two parties' different understanding of technology. Therefore, in the following three chapters, what is *technology* and what is effective *technology transfer* will be debated further in the context of the surveyed firms.

Technology transfer is not a once-and-for-all matter, but an ongoing process. In other words, technology is truly dynamic, it continuously changes. The case of the mould and die industry will show this dynamism in technology. As the case studies show, the dynamism in technology causes repeated learning for developing countries until the learning completely catches up with the industrialised countries. Therefore, it is probable that outsiders misunderstand this as hiding or intentional delay. The dynamism in technology is the issue discussed in the first section. Secondly, technology transfers need to be adapted to the local environment. The case studies will show how expatriates and local staff struggled to adapt to a new local environment. These problems happen because Thailand, as a developing country, lacks human resources and supporting industries. The need for adaptation is the second issue to be discussed. In the third section, the reasons for successful and unsuccessful technology transfer will be surveyed. Findings suggest necessary conditions for effective technology transfer. Two important findings of the surveys are "gradualism in technology transfer" and "transplantation of management philosophy". As mentioned previously, inexperienced local people require step-by-step training. Understanding of the importance of quality, cost and delivery time (QCD), i.e. management philosophy is also very important. Complaints about the forced education of the Japanese culture neglects the importance of QCD. Learning is not a matter of word, it is a matter of practice. Finally, the issue of measuring technology whether easy or difficult will be discussed in the eight groups of technology processes (see Table 6-11). Without measuring technology levels, comparing the Japanese technology transfer with the Western technology transfer seems to be futile. The survey results show that Japanese FDI is developing more difficult technology than Western FDI. It seems that Western FDI often just utilises local resources as given, whereas Japanese FDI tries to educate local staff from scratch and bring them up to the same level as their Japanese counterparts.

7-1. Dynamic development of technology

As a result of borrowing technology after WW2, Japanese firms accumulated technology and the technology levels of Japanese industries in some fields overtook those of Western industries in the 1970s. This implies that technologies transferred from Japan to LDCs before 1970 are different from that after 1970. For example, nuts and bolts making technology transferred to Thailand in the 1960s (Figure 7-1: A) is different from that in the 1970s (B) and that in the 1990s (C). Consequently, LDCs had to borrow technology from the West or Japan repeatedly. Technologies are alive and realise changes continuously. Only to maintain the technology at the same level is not sufficient in a competitive market.

Figure 7-1 Dynamism in technology spreading



Source: Ito, 1986: 336; Takeuchi, 1991: 204 (modified)

7-1-1. The case of mould and die making

Mould and die making technology is one of the most critical parts of the modern machine industries. This technology is now being transferred to Thailand. Mould and die technology has achieved dynamic changes in the industrial history of Japan. In Thailand also, mould and die making is considered important. BOI arranged special incentives for mould and die making in April 1993, while MIDI strongly supports the activity of the Thai Tool and Die Industries Association, which was established in 1992.

Between the technology level of Japan and Thailand there still remains a wide gap. Without narrowing this gap, Thailand is not able to manufacture competitive industrial goods for the international market. In many firms, moulds and dies are made in-house. But, there also exist mould and die specialists. Ogihara and SNN (J-17)[89] are typical examples of mould and die specialists for automobiles. They make moulds and dies for other firms. Thai Moritech (J-19) is another example of mould and die specialists which make moulds and dies for electrical parts. Nine Thai firms in the survey are also mould and die specialists. The following story mostly relies on factory visits in Thailand.[90]

In the 1950s and '60s, Japan learnt die making technology from Europe and the USA. Through this learning process Japan accumulated technological capability. As a result, in the 1970s and '80s, Japan's technological level exceeded that of the USA and Europe in die making. This was thought to be one reason for the high reputation of Japanese cars in the US market. Then, the Big Three lost their market shares to Japanese cars.[91] The shortening of the set-up time of dies and jigs is an important factor in determining productivity. The shortening of the set-up time was achieved only with changes in management concepts (Chapter 3: 3-3-3).

In the 1970s and '80s most of the US die makers lost competitiveness and declined. Since then the Big Three changed their policy and now rely on Japanese die makers such as Ogihara.[92] American cars now look more like Japanese cars and have regained their reputation. This shows that Japanese die making technologies are spreading to the USA.

Dies for some outer panels (rear fenders, front fenders, door panels) are the most difficult ones to make. Those parts need three-dimension curves and smooth surfaces. The tolerance should be within 30 micrometers (a micrometer = 1/1000 millimeter), a hair's thickness. The beautiful and smooth surface will be achieved only by accuracy in die and jig making. Furthermore, dies and jigs should be designed with an understanding of the bending nature of steel in the process as pressed steel has a springback nature.[93] Therefore, just to make dies exactly as in the given drawings is not enough. The dies should be made to fit to this bending quality of the steel during the production process. This technology can be obtained only through experience.

Another difficult job is the mating of panels (*ai* or *awase*). If you wish to follow the models in the mating job, it would be both time and energy consuming with an unsatisfactory result. Japan has already accumulated experience and know-how enough to do the mating of panels successfully by using accumulated data. NIEs and ASEAN, however, still need more experience and the accumulation of know-how although the catch-up period may be far shorter than the period Japan had to spend to acquire this expertise.

In Thailand some leading local companies have modern machines such as NC milling machines, NC EDMs, NC W/C EDMs or MCs (see Glossary), however, the method of mould and die making in Thailand is still in the second or third generation (Table 7-1; Table 7-2). This means that although the hardware is quite modern, the production process is still quite old (in older generations).

Table 7-1. Technological change in mould and die making (hardware technology)

1. First generation;	To rely on lathes and shapers, one dimension only.
2. Second generation;	To rely on milling machines and profile milling machines, two dimension manufacturing became possible.
3. Third generation;	Copy milling machines by Keller (Prat and Whitney) were imported from the US in the 1960s. Then, Japan started the domestic production of copy milling machines in the 1970s. Thus, three dimension manufacturing became possible.
4. Fourth generation;	NC milling machines, NC EDM and NC W/C EDM became popular in the 1970s.
5. Fifth generation;	MC (Machining Centre) and CAD/CAM, CAE became popular in the 1980s.

Source: SNN.
NC = numerical control. EDM = electro discharge machining. WC = wire cut. CAD = computer aided design. CAM = computer aided machining, CAE = computer aided engineering

Table 7-2. Technological change in mould and die making (software technology)

1. before the 1960s (correspond to the first and second generation in hardware)

   A sample of a part ⇒ Manufacturing, or

   A sample of a part ⇒ Drawings ⇒ Manufacturing

2. the 1960s and after (correspond to the third generation)

   A sample of a part⇒ Copy milling machines ⇒ Manufacturing, or

   A sample of a part ⇒ Drawings ⇒ A master model ⇒ Copy milling machines ⇒ Manufacturing

3. the late 1970 and after (correspond to the fourth and fifth generation)

   Data of a part ⇒ A master model ⇒ Blinder face models ⇒ Scanning ⇒ NC data ⇒ Manufacturing

4. 1992 and after (the newest generation)

   Data of a part ⇒ NC data ⇒ Manufacturing

Source: SNN

The newest generation technology is capable of making moulds and dies within an accuracy of 1-10 micrometers (President of SNN). However, modern machines alone are not able to make the accuracy of 1-10 micrometers unless the modern software technologies are also obtained. It is interesting to note, however, that in practice the accuracy of less than 10 micrometers needs final adjustment by human hands (the rule of thumb). Therefore, Japanese experts believe that without learning directly from Japanese top level manufacturers, this modern software technology (process technology and skills) will not be transferred to Thai local manufacturers.

For Thai local firms it still seems difficult to acquire or develop these technologies by themselves. Even the US and European firms have not acquired these modern technologies yet. For example, when one of the US Big Three orders dies from a Thai local firm, the US firm presents the design in the form of samples, not in the form of computer data (J-17). Moulds and dies for US cars are now mostly made by Japanese mould and die makers (J-17, Mr. Komechi, see note 91).

It should be understood that machines, operative manufacturing skills and process technologies are different. The development of process technologies can be achieved only by the accumulation of experience and technologies. Teacher-learner contact is most important. Unlike machines this cannot be bought with a lump-sum, but is an ongoing process (J-17). Korea, Taiwan and Thailand have not yet obtained the most advanced technologies of die and jig because of the shorter history of the car manufacturing in these countries. Given this technological gap, Korea, Taiwan and Thailand import dies for some of the outer panels from Japan.[94] This, however, does not mean that Korea, Taiwan and Thailand have no technologies in die making. On the contrary, they have obtained a competitive edge in some fields of die making. For example, inner panels need no accuracy or beautiful finish as do outer panels. Therefore, they are able to compete in the international market in some fields. They have started to catch-up.

Korean cars, even if they have their own brand names, still need imported parts such as engine parts, transmission parts, dies for rear or front fenders, and dies for door panels. Likewise, Malaysian cars, e.g. Proton Saga, still need imported parts. In that sense, Korean and Malaysian cars can be seen as duplicates of Japanese cars. In Thailand, Thairung is making station wagons and passenger vans of original designs. However, these cars use imported parts such as engines, transmissions, etc. Therefore, Thairung cars as well are duplicates of Isuzu cars. This leads to the conclusion that Thailand's technological level is high enough to produce its own design of cars just as Korea and Taiwan are doing. However, the technology here is still far from the R&D technology in Japan. R&D requires considerable investment in human resources, facilities, training, materials and equipment. Practically speaking, most developing countries are not ready for it.

According to the President Furubayashi of J-17, technology is the sum total of human skills. In iron and steel production, Japan succeeded in transforming skills into data. This is the reason that the world's strongest steel industry is in Japan. However, the data were sold to the USA and Korean steel industries. The USA and Korea are now able to produce the same quality of products at cheaper costs. This technology was developed by Prof. Suzuki Hiromi of the University of Tokyo. What is the skill? It is to make steel judging from the colour of the heated iron. It should be understood that technologies in the form of data were born only after the development of skills.

Table 7-3 Time necessary for learning mould making at J-19

techniques to make mould (old type)	5 to 10 years
techniques to make mould (operation of machines)	3 months to 1 year

Source: J-19

Until 15 years ago, learning of mould making took 5-10 years and was an individual art of craftsman (*shokunin*). Today, in Japan, mould making is based on data technologies and is carried out by scientific technologists, not by skilled craftsmen. Therefore, supported by the computer aided design and manufacturing machines (CAD/CAM), people today can learn mould making (operational) technologies within a year (Table 7-3). This means that a part of operational technologies of mould and die became easier than before. However, at the same time, the whole process technology has developed into a new generation technology, at least in Japan. The following case studies of J-17 and J-19 show the practice of technology transfer in the mould and die making industry from Japan to Thailand.

J-17, a Nissan subsidiary, started its operation in 1989 and plans to transfer the most modern technologies. The learning of operational technologies has so far been very smooth. The president is a Japanese expert from Nissan, whereas the managing director (MD) is a Thai who speaks Japanese. Being trained at Isuzu for many years, the MD is also an expert in Japanese QC circles. The Japanese holding company of J-17, as shown in Figure 7-2, does not adopt the scanning method (2a). They directly make die designs (2b) from NC data without the scanning process. At present, Japan alone has this direct method technology (2b). In Thailand, J-17 recently started the scanning method technique (2a). It took local staff about a year and a half to learn.

Figure 7-2 Die manufacturing process at SNN

1. Customer (CAD data, master model, part drawing) ⇒ Data change (to NC data) ⇒
2 a ⇒ NC model mill ⇒ Scan ⇒ 2 b ⇒ Die process engineering ⇒Die design
3. NC machine ⇒ Die try ⇒Die inspection ⇒ Panel inspection ⇒Shipping

Source: SNN (J-17)

President of SNN says that, in Japan, manuals for mould and die making have been made many times but Japanese workers do not use them. Japanese workers on the shop floor have the habit of thinking and learning. They do not rely on manuals. Consequently, manuals have become obsolete and are not well related to the real job. In contrast, in Thailand, manuals played a great role. Thai workers needed manuals because they are beginners. For example, J-17 introduced the scan method (the new technology in the 1980s) of mould and die making. The success of this introduction depended on manuals. The transfer of this technology (operational technologies) was completed in eighteen months. The learning levels of "operational technology" and "maintenance technology" are graded high (point 8), but not "QC (point 5)" and "production control (point 5)". This shows that manuals are useful for learning first-step technologies, especially "operational technology".

J-19, another mould maker, utilises the modern concept of mould and die technologies. This company adopts a policy that mould and die should be made by data technologies not by skills. To learn the technologies of computer software is quicker than to learn the skills of machine operations in the case of J-19. The holding company of J-19 is a typical example of a high technology SMI in Japan. The holding company manufactures "engineering plastics" which are supplied to Canon, Toyota, Mazda, etc. in Japan. "Engineering plastics" are lighter and stronger (anti-shock, anti-oil, anti-chemicals), and reduce costs as compared to metal parts because they are suitable for mass production by way of injection.[95] "Engineering plastics" thus enable cameras, copiers or printers to become smaller, lighter and cheaper. Micro-motors for electric windows and electric side-mirrors of automobiles also use engineering plastics (worm gears). Observing the expansion of the market for engineering plastics, the holding company of J-19 set up a subsidiary company in Thailand in 1991 mainly because of the high price of land and factory building in Japan at that time.

Table 7-4 Acquisition levels of mould making technology at J-19

	process	grade	
1	Drawing of mould designs by CAD (mould base, cavity)	1	A few persons will be trained in Japan (by Japanese manual)
2	Blue prints by three dimensions from customers	10	
3	Data extracting for CAM (WC data, MC data, EDM data)	10	8 persons are sent for training in Japan (4 persons mastered and
4	Manual manufacturing	10	4 persons failed and quit the firm)
5	CAM operation	10	

Source: J-19

J-19 employs new technologies in mould making. Many of the machines are modern and operated by computers (CNC machines, MC, CAD/CAM). The processes are controlled by the most advanced technologies. The staff are trained to maintain high quality and speedy delivery time. They learnt most of the technologies except the drawing of mould designs by CAD (Table 7-4). Because there is always a gap between a mould and its product, the accuracy of moulds has to be severer than the accuracy of products. If the accuracy of moulds is controlled under 5 micrometers, the accuracy of injection products becomes 20-50 micrometers. 20 micrometers is for safety parts of automobiles and 50 micrometers for copiers or other OA parts. "Operational technologies" are graded very high (point 10), but not "QC (point 5)" and "production control (point 3)".

According to the MD of J-19, there are some training courses in Thailand to teach CAD/CAM (Khon Kaen University) or mould making (vocational school at Samut Prakarn). Nevertheless, most of the local firms do not understand the meaning of accuracy. If the products require 20-50 micrometers accuracy, the moulds require less than 5 micrometers accuracy. This kind of manufacturing processes needs special measuring instruments. Recently there are many local firms with modern machines, however, they normally lack software technological capability in designing. They lack technology to draw mould designs in data forms (see Table 7-2). Therefore, even if they are given designs in data form, they do not understand the meaning of data. Instead, they want samples rather than design data. It is difficult for the MD to trust the accuracy of moulds made from samples. The new technology of mould designs was developed only recently in Japan, around 1980. The average technology level of Thai local firms is that of Japan before 1980.

7-1-2. Dynamism, the cases of other industries

The cases of the condenser maker Tanin (J-18) and the clutch maker FCC Thailand (J-5) also present examples of dynamism in technology.

J-18 manufactures aluminium electric capacitors (condensers). The firm's specific process is as follows: slitting of aluminium foils, welding & winding of aluminium lead, impregnating, sealing, curling, inserting and ageing. The case of J-18 presents two lessons:

(i)Technologies in a protected market in the 1960s and '70s were different from that in the competitive market in the 1980s and '90s. Hence, local firms that could not adjust to the new market environment declined.

(ii) Even in the 1990s there is a wide gap between technologies in Thailand and Japan although the gap is going to decrease.

The production methods (technologies) of condensers in Thailand and Japan are quite different (Table 7-5). This wide gap comes from the difference in labour costs, the market size and the workers' knowledge level. The production methods cannot neglect this difference. Recently, however, the technology level of the Thai subsidiary is rising. The gap will be further narrowed according to the development of the workers' knowledge level and the Thai economy in general.

Table 7-5 Development of condenser technologies (Japan and Thailand)

generation	processes	Thailand	Japan
Generation 1	Manual labour	**O**	up to 1975
Generation 2	Assembling by machine, insertion by hands	**O O**	
Generation 3	Assembling by machine, insertion by machine	**O O**	
Generation 4	Taping and assembling by one machine		**O O**
Generation 5	Taping, assembling and impregnating by one machine.		**O O**

Source: Tanin Condenser. **O** = Partially adopted methods. **O O** = The main production methods.

Tanin Industrial (set maker) was established in 1964 and became the most successful electrical appliance maker in Thailand. Tanin Electric (parts maker) was established in 1977 by Tanin Industrial to supply electrical parts such as resistors, capacitors, volumes, speakers, etc. to Tanin Industrial. Tanin Industrial received technical assistance from Zeneraru Denki, a Japanese firm. Meanwhile Tanin Electric received technical assistance from Elna in capacitor making, requested by Zeneraru Denki, the then owner of Elna. The Tanin group became the most prominent local company group.[96]

J-18 is now owned by Elna and Tanin Electric. However, the share of Tanin Electric decreased. That means Elna increased its capital share to take leadership in the management of J-18. Tanin Electric seems to have stopped operations and, probably, Tanin Industrial has also stopped operations. It was said that Japanese investment in Thailand had hindered local industrial development.

It is fruitful to study more carefully the reason why the once most successful local manufacturer had to stop operations. This is another example illustrating the dynamism of technologies. The technology imported in the 1960s by a Thai firm is not the same technology in Japan in the 1980s or in the '90s. In other words, the technology in the protected market of the 1960s and '70s is different from the technology in the competitive market of the 1980s and '90s. As shown in Chapter 6, in the 1980s and '90s, FDI in the electrical industries increased and, in turn, competition became hard. Most probably, it is the reason for the decline of the Tanin group.

Elna began technical assistance in 1977, and became the JV partner in 1980. The sales volume increased from 11 billion pieces in 1985 to 123 billion pieces in 1994. In 1994, 90% of the products were exported, and 10% were consumed domestically. Raw materials were imported, 38% from Elna Japan, 60% from NIEs and Malaysia. Only 2% was purchased locally. The shop floor is divided into two parts, the small size condenser section and the large size condenser section. The total number of employees is 1,165 and the floor operation is managed or assisted by six Japanese expatriates. In addition, an expatriate stays in Bangkok.

Dynamism in the case of condenser technology is shown in Table 7-5. In Thailand (J-18), manual labour (generation 1 in Table 7-5) still exists, although it will be replaced by machines soon. In Elna Japan, manual labour disappeared about 20 years ago. In Thailand, machines are used for assembling and insertion, however, the capability of machines in Thailand and Japan are not the same. In Japan, machines of the generation 4 (taping and assembling by one machine) and the generation 5 (taping, assembling and impregnating by one machine) are the most popular. On the other hand, in Thailand, machines of the generation 2 (assembling by machine, insertion by hands) and the generation 3 (assembling by machine, assertion by machine) are still in use

Engineers and technicians have been sent to Japan for training for 2 -3 months every year since the late 1990s (2 - 4 persons per year). The chiefs of the machine department and the production control department are Thai. A Thai is already capable of maintaining, improving and repairing the machines. The person has 5 - 6 years of technology accumulation including training in Japan. In addition, grinding machines for cutting tools of slitters will be introduced soon. MCs will also be introduced soon. The technical level of the Thai firm is rapidly improving. Each of the "operational technologies" in the strata 1 are graded high (point 10, 8, 7, 8). However, to truly catch-up with an industrialised country, "improvement technologies" and "creative technologies (R&D, etc.)" must also be acquired by Thai local staff. Technology gaps between Thailand and Japan in these categories are still very wide.

The next is the case of motorcycle clutch technology. When WW2 ended, FCC, the holding company of J-4, was one of the small bake-lite makers in Japan. It started making parts for supplementary engines for bicycles in 1948. Since then FCC has grown up to an international firm that dominates the world technologies and the world market in motorcycle clutches. The manufacturing technology is refined and the production method is rationalised with original equipment.

Following the request of Thai Honda Manufacturing Co., Ltd. (established in 1965), FCC (the holding company in Japan) set up J-4 and started its operation in 1990. J-4 supplies motorcycle clutches to four motorcycle assemblers, Honda, Yamaha, Suzuki and Kawasaki in Thailand. All four companies have capital shares of J-4, three per cent each. In 1993 J-4 manufactured 1,120,000 motorcycle clutches to supply four motorcycle manufacturers in Thailand. J-4 transplanted the most advanced technology into the Thai factory although the most critical and difficult technology such as the clutch-facing material process and most R&D are carried out in Japan. The Thai firm was designed as a production base. However, not only the operational technologies but also the improvement technologies (development of jigs, dies, and equipment) are being transferred.

The plant is composed of the following sections: lining (clutch-facing, 52 persons), die-casting (23 persons), machining (39 persons), assembly (43 persons), parts (12 persons), QC (10 persons), production control (3 persons). For the moment, dies are imported from Japan or subcontracted to Nippon Denso Thailand. Levels of "operational technologies" in J-4 are graded high (point 8, 8, 6, 8) except "QC". "Creative technologies (R&D, etc.)" are not planned to transfer.

FCC is thus another example of technological dynamism. How has FCC become a monopoly in motorcycle clutches? In the case of FCC, a dynamism in clutch technology in Japan is shown in Table 7-6. After WW2, the motorcycle market expanded in Japan. At the beginning, there appeared many small motorcycle workshops. However, Honda, Yamaha, Suzuki and Kawasaki grew up to be the Big Four. Being the main supplier to Honda, FCC became the biggest supplier of motorcycle clutches in Japan. Attracted by the FCC's quality and the cost, Yamaha, Suzuki and Kawasaki also became customers of FCC. In Japan, the production of motorcycles reached 1 million in 1960 and 4 million in 1964. Japan thus became the world's biggest motorcycle producer in the 1960s. Many of the motorcycle and tricycle producers such as Honda, Suzuki, Mitsubishi (Mizushima) later developed into car manufacturers. In the 1990s, the biggest market for motorcycles has shifted from Japan to other parts of Asia. At present, China, India and Thailand are the largest markets for motorcycles.

Table 7-6 Development of clutch making technologies at FCC

year	development stages	new plant
1939	Establishment as a bake-lite goods maker	
1944	Bake-lite parts for aeroplanes	
1948	Manufactured casting and injection parts for Honda's supplementary engines for bicycles.	
1949	Mass production of clutches for Honda's supplementary engines	
1954	Supplied motorcycle clutches to Suzuki	
1956	Supplied motorcycle clutches to Yamaha	Mikatagahara plant(1960)
1971	Supplied motorcycle clutches to Kawasaki	Suzuka plant(1963)
1973	Completed production lines from materials to the final products at Suzuka	Kyushu plant(1972)
1986	Licensing to Richo Auto Industries Ltd. in India	Ryuyo plant(1984)
1987	Licensing to Asian Auto Parts Co., Ltd. in Thailand	
1988	Licensing to Taiwan	FCC Thailand(1989) Hosoe plant(1989)
1990	Licensing to Indonesia. Supplied clutches to a UK firm	Philippine plant(1993)

Source: FCC

7-2. Dynamism in the transfer process

Established firms in a new land have to acquire new technologies in the process of technology transfer because the original technologies are sometimes insufficient in a different environment or due to an unexpected change of the situation. FDI very often gives them a chance for a technological jump, a new dynamism in technology development. The cases of BEW (J-2), Kanaech (J-7) and TRW Fuji Serina (W-13) are examples of dynamism found in the survey.

7-2-1. Forced technology diversification

The first case is that of J-2, a unique firm established by a group of Mitsubishi's subcontractors at Mizushima in Japan. Upon request, the group established an auto parts plant first in the USA and then another in Thailand. The members of this group have developed from zero after WW2 to a leading world player. They consider that their interests and destiny are to follow Mitsubishi. In a sense, their investments abroad were a challenge beyond just a financial calculation. It is unique that 18 suppliers invested in a group.

The technology level of the holding company (an SME's co-operative)[97] in Japan is high. However, the learning levels of the Thai subsidiary are low. The scores of "operational technologies" are, on average, 6. QC and production control are supervised by Japanese expatriates. The period of the past five years was not enough to transfer even basic technology because of the unexpected changes in the market. Why? It is necessary to understand the background of the holding company which is an SME's co-operative by subcontractors, a unique organisation.

J-2 is owned by the following three companies:

(1) Nippon Eagle Wings Industries Ltd. (NEWI, Japan), capital share 62 %,

(2) Eagle Wings Industries, Inc. (EWI, USA), 19 %,

(3) SAS (a Thai business group), 19 %.

NEWI[98] is a limited company organised and owned by an SME's co-operative in Japan. At present, the co-operative is composed of 18 subcontractors of Mitsubishi Motors Corporation in Japan. Originally, this group of *shitauke* was gradually formed before and during WW2 (see Chapter 3: 3-2-3) and made parts for armaments. In 1962, 23 subcontractors formed a co-operative according to the SME co-operative law and moved into an industrial estate developed by the government. The co-operative has a power station, a waste water pond, a cafeteria, a clinic, a sport ground, etc. If the companies were not united, those facilities would not have been available and it would have been difficult to attract young people to the country area like Okayama.

In 1987, this co-operative (of 18 firms) established a 100 % owned firm in Illinois, USA, to supply to the Mitsubishi automobile plant, originally a JV between Mitsubishi and Chrysler. EWI was the first FDI for the co-operative. Following the establishment of EWI in the USA, the co-operative established another firm, this time in Thailand, a JV, in order to supply Mitsubishi in Thailand. SMIs in Japan are expected to work with LIs, at the same time, they are supposed to help and compete with each other. The leaders of a co-operative are supposed to work for all member firms, not for their own company alone. It is a difficult job to work for all, but somebody is supposed to take responsibility. Requested by Mitsubishi, the leaders wished to accept the challenge and proposed the idea to the members. Mitsubishi did not provide any guarantees, only provided an opportunity. Every member knows that. But, members agreed to take the challenge. The co-operative decided to take the risk as a group.

The president of J-2 is from Mitsubishi. Other technical staff are from each member company of the co-operative. The 18 members have a variety of technologies. For example, one company makes brake pedals, upper and lower arms and hand brakes, another makes hubs, fly-wheels and brake discs, and other assembles frames and doors. In Thailand, J-2 first planned to supply press parts to Mitsubishi. The initial plan for J-2 was to borrow dies and jigs from Japan and conduct the press works in Thailand. However, the demand was not enough. First, the planned export of cars by Mitsubishi was not successful. The orders had disappeared when J-2 was ready to start. Secondly, as a result, J-2 had to pick up any orders it could. J-2 thus moved to a totally new job, the assembling of whole pick-up trucks and station wagons. Chassis with engines and transmissions were supplied by Mitsubishi. J-2's job was to carry out the body press, body assembling and trim works on the chassis. The orders were not simple mass production, but needed flexible adjustments for each car. J-2 received three types of orders,

(1) station wagons,

(2) double cabs for police cars, and

(3) double cabs for Turkey.

The job was not suitable for inexperienced local workers. J-2 had to request more staff from Japan than originally planned. The number of workers reached 350 and the number of expatriates reached 34 at the peak, including short-term experts. The job was not easy but 3-4 years later local staff acquired most of the technology.

When the local staff had almost learnt the technology, the government changed the tax system on the assembling of station wagons. From August 1993, under the new system, an excise tax was levied on the whole sales amount, not on the value added part as had been done previously. As a result, the retail prices had to be raised about 40 per cent. J-2 stopped the assembling of those cars except for export to Turkey.

In 1994 Mitsubishi ordered press works for a new model. The preparation normally takes more than a year. The plan was to start the production in April in 1995. This time J-2 strongly hopes that the order would last long. If the consumers do not like the Mitsubishi cars, the order for J-2 will not last long.

Next is the case of J-7. The holding company of J-7 is not a large enterprise, but a small second tier subcontractor of Nissan. This investment was not done upon request, but was an independent risk-taking action by a Japanese SMI. It was unlucky for J-7 that the initial plan had to be discarded due to the change in the Japanese car market. After the investment in Thailand, orders from Nissan in Japan declined sharply. J-7 thus struggled to survive in Thailand. J-7 was established in 1991 by Kanae Kogyo, an SMI in Japan. Kanae Kogyo is a subcontractor of Yamakawa Kogyo. In other words, Yamakawa Kogyo makes assembly parts for Nissan cars, while Kanae Kogyo makes small stamping parts for Yamakawa Kogyo. This is called a second tier subcontractor in Japan because Kanae Kogyo does not supply the parts directly to Nissan. Facing increased labour costs and the trend of internationalisation of industries in Japan, the firm decided to set up a production base in Thailand on its own initiative. J-7 started its operation in 1991 with 35 persons at Laemchabang Industrial Estate, an Export Processing Zone. The firm's initial plan was to export its products from Thailand to Japan. However, the Japanese economy entered a depression period and the volume of demand from Yamakawa Kogyo decreased. In 1994 the volume was decreased to one third the level of 1991.

Luckily, J-7 found a new customer—Fujitsu General Thailand Co., Ltd., established in 1991 at Laemchabang. Fujitsu General needed a stamping process to produce press parts for the air-conditioners. After studying the equipment of J-7 and the performance of the holding company in Japan, Fujitsu General decided to order press parts from J-7. J-7 has 16 press machines (mostly "single press") up to 200 tons for stamping work. The firm also has machining tools for die maintenance such as a milling machine, a surface grinder, a lathe. The technology level of J-7 is lower than the holding company in Japan both in equipment and processes. In 1994 90% of the sales came from Thai customers such as Fujitsu General and Murata Electronics Ltd. (established in 1989), only the residual 10% from the holding company in Japan for Nissan's parts. Thus, J-7 now depends firmly on Thai customers, not on the initially planned customer in Japan. The market of the holding company is declining, whereas the market of J-7 is in rapid growth.

J-7 is capable of "progressive dies", though at a beginner's level from the viewpoint of the holding company. At J-7, the average stamping steps is three steps for press parts, the maximum is seven steps. The firm maintains about 600 stamping dies which are supplied by customers and maintained by two Thai workers with Japanese technical assistance. The holding company in Japan is far advanced in technology both in machines and processes. As compared to the advanced technologies in Japan, the scores in J-7 were graded low. "Operational technology" is rated as point 6, but other categories are still at 5 or 4.

The third case is that of W-13, a Western (51%), Japanese (24.5%) and Thai (24.5%) JV, which produces engine valves. The start of this plant was a Japanese FDI. At first, Hino, Isuzu, Mitsubishi and Nissan Diesel requested Fuji Oozx to invest in Thailand. This was to follow the local content policy of the Thai government. Fuji Oozx manufactured parts for large size trucks. However, soon after W-13 had started the production, the market disappeared due to the car market depression in Thailand around 1985 (Table 4-9). In order to sell to TRW in Europe, W-13 sold a part of the share to TRW, Ohio, in 1985.

At first, the MD and the plant manager were despatched from Japan. After 1985 they left Thailand and TRW sent an American MD, a Vietnam war veteran who speaks the Thai language. Thus, the ownership and the top management were changed from a Japanese firm to a US firm although the basic Japanese technologies on the shop floor were not changed. The quality of the products is equal to that of the Japanese holding company. However, the "operation" and "maintenance" technologies are still far from those of Japan (point 7 and 5). In Japan, the production lines flow on belt conveyers and one person operates many machines and processes. In this firm, the production is carried out by the batch system and one person operates one machine and one process. Technology in Thailand belongs to an older generation.

Technologies on QC and production control are scored high (point 9 and 9). The plant manager answered that this plant adopts American QC and production control systems. This point is worthy of note. In fact, this firm is managed by an American MD. Meanwhile, technologies are given by the Japanese holding company. The plant manager considers that American QC and production control are excellent. However, it is good only for American style management (see Table 3-10). The targets from Ohio for 1995 are as follows.

(1) Productivity: 380,000 pieces of engine valves per month.

(2) Quality: Reduce defect goods (DG) and repairing works (RW).

(3) Cost and Delivery: *kanban* system and the decrease of works in process.

(4) Activity: ISO 9002,[99] suggestion system (SS) and 5S (keeping the shop floor clean).

The above targets illustrates that the firm adopts the Japanese IEs such as *kanban*, SS, 5S, and also carries out QC circles. The chief of QC activity is the American MD, probably a nominal position, and a Japanese expatriate plays the role of advisor. This case illustrates a typical US *type* management overseas, owned and controlled by a US firm, operated by Japanese experts and technology. However, there is a wide gap between the US and the Japanese management concepts. The gap has to be bridged by the following technology contract. In 1990, W-13 concluded a technology contract with Fuji Oozx. The responsibility of Fuji Oozx is as follows:

(1) The supply of the list and specifications of the equipment, machines and tools.

(2) Supports to the designing of products

(3) Recommendations of proper manufacturing processes and the supply of process flow charts.

(4) The despatch of technical advisors on newly designed and bought machines.

(5) Quality tests and evaluations of the products of W-13.

The above agreement shows that technology comes from Japan, not from the USA, even though the US firm maintains the majority ownership to control the firm. The American style QC systems is excellent only for checking defects, but not good for decreasing them. Consequently, the US MD has to rely on Japanese experts and technology.

7-2-2. Acquisition of new technologies

Sanko (J-16), Aoyama Thai (J-1) and Muramoto (J-11) are cases of dynamic acquisition of new technologies in the transfer process.

J-16 (an anchor bolts maker) is a typical SMI in Japan located in the industrial district of Tokyo. Due to the labour shortage in Japan, Sanko planned to relocate its production base. Heat treatment and electroplating are both new technologies for the firm because in Japan the holding company subcontracts both processes outside. In Japan, every process is available outside and subcontracts are given to the supporting industries. In Thailand, however, it is difficult to find supporting industries. Therefore, this firm had to develop technologies (heat treatment and electroplating) by itself.

The maintenance service for machinery is also lacking in Thailand. In Japan it is easy to request machine makers to repair machines, but in Thailand it is costly to call them from Japan. Thus, the firm has to repair the machines by themselves. Thai staff drew the design of damaged parts and ordered the manufacturing of the parts. They fixed the machine without calling people from Japan.

The firm, at first, subcontracted the heat treatment process to local firms, however, the result was not satisfactory. First, firm X (100% Thai capital) had trouble in time scheduling. Second, firm Y (100% Thai capital) could not present satisfactory results, probably because the furnace was a batch system. Bolts need a continuous furnace. Finally, J-16 was forced to start the R&D activity in heat treatment by itself. The staff was sent to Taiwan to learn technology. There are many nuts and bolts makers in Taiwan where the equipment and technology originated in Japan. Although the subcontractor of the holding company in Japan is technologically capable, the subcontractor in Japan relies on skills and the equipment is older than Taiwan's. That was why J-16 learnt technology from Taiwan, not from Japan. Finally, a Taiwanese firm in Thailand satisfied J-16's requirement. The Taiwanese firm installed new equipment for J-16. After five years experience with the firm, J-16 has no problem with this subcontractor. Although J-16 subcontracts the heat treatment process to the above local firm (a Taiwanese FDI), the treatment formulas are provided by, and the process is controlled by, J-16.

In addition, J-16 invested a huge amount of money for its size in the electroplating equipment and its waste water treatment to avoid pollution. It was a big challenge for the firm to invest in equipment with which the firm have had no previous experience. The equipment was installed but the result was not successful. The R&D activity had been done inside the firm. Thai staff, a Thai university lecturer and a Japanese expatriate co-operated to obtain electroplate technology and finally succeeded in the manufacturing of anchor bolts in Thailand.

The defect ratio of the firm is lower (0.3 - 0.4%) than that of the holding company in Japan. The reason is that, firstly, the firm has 16 QC staff at six points in the whole process with two final inspectors at the end. Meanwhile, the holding company has only four inspectors at the end. Second, the sampling ratio for the final inspection after the heat treatment is 250 pieces per lot in the firm, while the ratio is 5 pieces per lot in the holding company. As a result, the firm has achieved a lower claim ratio. However, it does not mean that the holding company has a problem. Most of the workers at the holding company have 25 years experience. In contrast, local staff in the firm have only three years experience on average. The holding company and its subsidiary both satisfy customers, by adopting different methods.

In Thailand, J-16 has to rely much on QC section. The j-16's QC section was given the authority to stop the operation of the process at six points. This is not conducted in the holding company. Learning levels in "operational technologies" are high. "Operation" and "maintenance" are point 8 each, "QC" is 9, but "production control" is 5.

The second case is J-1, a nuts and bolts maker. J-1 started its operation in Thailand with about 70 workers in 1966, following a request by Toyota. Second-hand machines were brought in from Japan. When J-1 was established, the market was very small and the machines brought from Japan were old. Although the defect ratio in Japan became zero due to the QC movement, the defect ratio of J-1 has been around eight per cent. In addition, for nearly 10 years, the firm continued losing money mainly because of the limited size of the local market. Mr. Aoyama Mitsuo, a younger brother of the owner of Aoyama in Japan, became an expatriate to Thailand to take care of J-1 in 1973. What Mr. Aoyama did was to find customers other than nuts and bolts users. J-1 tried many new products and diversified into motorcycle parts in 1973. The firm also started the production of tools in 1986. At present the firm manufactures hand tools, motorcycle handles, stands, pipe products, press parts, etc. in addition to the nuts and bolts. Recently, the Thai market has expanded rapidly. Accordingly, J-1 established a new factory with new machines in 1995.

Table 7-7 Development of nuts and bolts technologies (Japan and Thailand)

Holding company in Japan		Subsidiaries in Thailand	
1950	Start up of Aichi factory(No. 1 factory)		
1957	Start up of Ibaragi factory(No. 2 factory)		
1965		1965	Start up of Aoyama Thailand (No. 3)
1976	Kanban System	1973	Motorcycle parts and auto parts
1984	Start up of injection mould factory(No. 6) Toyota QC prize	1986	Tool kits for car
1988	Injection mould academy prize	1988	Start up of AFTC(bolts for export)(No. 10 factory)
1991	TPM prize	1991	Die making
1992	Kumamoto factory(No. 11 factory)	1994	Expansion of Bangkok factory

Source: Aoyama Thai. The holding company has 11 factories including 2 Thai subsidiaries. The parent firm is thus developing and upgrading its equipment and technology. That is a cause of the intermittent technology transfer even in the case of internal technology transfer within subsidiary firms.

There is a wide gap in technology between Japan and Thailand in nuts and bolts making. The technology level of Aoyama Japan is high. Being a first tier subcontractor of Toyota, Aoyama Japan introduced the *kanban* system in 1976, won a QC prize from Toyota in 1984 and won a TPM prize in 1991 (Table 7-7). This means that technology of Aoyama has changed continuously in the past 20 years following the technology development in Japan

(Figure 7-1). In contrast, the technology level of J-1 has been low. High turnover of staff hindered the firm's accumulation of technology. The increase of FDI after 1985 deprived J-1 of the staff trained in Japan because they spoke Japanese (see Table 9-12). Recently, J-1 started 5S and QC. The gap is going to be narrowed. The learning level of "operation" is point 8, but other categories are graded as point 5 or lower. This comes from a wide gap existing between J-1 and the holding company although the gap is expected to narrow steadily.

In 1987 J-11 was established by Muramoto, a small-medium metal press specialist at Kobe. Muramoto had been a supplier of small press parts and had no technology in assembly or injection. It made an amazingly rapid and successful expansion in Thailand by acquiring new technologies. Because there are only a few subcontractors (*shitauke*) in foreign countries, Japanese set makers have to rely on any Japanese suppliers that have good established facilities with well trained workers. Muramoto has established a very good production system with the company's strict policy on quality and delivery time. Due to the policy, sales grew very rapidly. The firm diversified step-by-step following the increase of orders.

The project succeeded at first in the press process, and then started the assembly of "loading" mechanism. Although J-11 had no know-how other than press, the firm was successful also in the assembly process and the plastic injection (Figure 7-3). Three Thai students employed at the Kobe factory in Japan contributed greatly to the success of J-11. They became familiar with the company's policy. When they returned to Thailand, they became crucial in the start-up of the factory. They wrote manuals in the Thai language. President Muramoto believes that Thai workers are as good as Japanese workers. Especially in the assembling process, Thai workers are more capable than Japanese workers. In Japan, it is difficult to find workers who are willing to work on simple tedious assembly lines.

The case of J-11 (Figure 7-3) illustrates how a set maker (Sanyo) fosters a supplier (Muramoto). Once they have established the mutual trust (*shitauke* relationship) concerning the QC and delivery time, both firms start working under a solid relationship. After this, the set maker provides raw materials, parts, moulds and dies together with technologies. This is a mode of technology transfer from a set maker to a subcontractor called quasi-internal borrowing (QIB) (see Chapter 8: 8-1-2). As a result, both "operation" and "maintenance" scored point 8, but "QC (point 5)" and "production control (point 3)" still scored low. Learning of zero defect technology and the JIT system is not easy. Thus, the firm now employs QC and production control specialists from Kobe Steel—a renowned Japanese steel maker. This factory is another example of unintended diversification after investment in Thailand.

Figure 7-3 Learning of new technologies at Muramoto

(1) Original technology	Metal press(1987)	→	CRT parts: 1 million/month
(2)New technologies	Assembly(1988) Injection(1989)	→	VTR components: 1.2 million/month Microwave oven parts: 50,000/month FDD components: 500,000/month CD drives:

Source: Muramoto

7-3. Successful transfer

Even if the technologies involved are difficult to learn, FDI can be successful if it is planned carefully step-by-step. Musashi (J-12) and Muramoto (J-11) are examples of successful FDI. Failures are often caused by the gap between the plan and the slow pace of real learning by local staff. The learning pace depends considerably on the understanding by local staff of the Japanese management philosophy. From the viewpoint of local staff, the speed of learning depends on the effectiveness of Japanese technology transfer because Japanese expatriates normally speak neither English nor Thai. In the case of J-12, J-11 and J-17, the Japanese management philosophy was well understood because the projects started from a small scale. In contrast, in the cases of J-6 and J-22, the Japanese management philosophy seems not to have been understood so well.

7-3-1. Gradualism

The holding company of J-12 is Musashi Seimitsu Industry Co., Ltd., a motorcycle parts supplier of Honda. Requested by Honda, the holding company first established a subsidiary in the USA and then in Thailand (and in the UK). Musashi has done very well in Thailand compared to some other cases of failures. How was it a success? Firstly, the Thai market had been favourable, it had expanded rapidly since 1988. In 1985 Honda's sales volume was 54,000 motorcycles, half of Yamaha, third in sales ranking among the four. In 1989, the year of J-12's start-up, the volume increased to 231,000, first among the four. The timing was therefore favourable (Table 7-8). Secondly, the firm invested cautiously. In other words, it took a "gradual shift" method and avoided the risk of "all at once" start-up. It planned to transplant the production system step-by-step, initially with only 15 persons including four Japanese expatriates. The learning process was divided into three steps. The first step was the transplantation of the assembly lines. All parts were imported from Japan after the necessary processes finished in Japan. The second step was the transplantation of the machining process. Finally, in 1992, the forging process, the most difficult and risky process, was transplanted to the Thai firm. At present the number of workers is 303 persons although it started with only 15.

Table 7-8 The sales of motorcycles by make in Thailand (unit: 1000)

	1984	1985	1986	1987	1988	1989	1990	1991	1992
Honda	78	54	57	70	143	231	289	264	331
Yamaha	126	102	88	106	173	193	251	223	252
Suzuki	87	69	72	99	141	132	167	154	214
Kawasaki	29	30	25	31	41	34	42	23	52
Total	321	254	242	305	498	590	749	664	849

Source: *Thailand Automotive Industry, Directory*, 1994: 61. The sum of columns may be unequal to the column of total because of the rounding of numbers.

The manufacturing of motorcycle's functional parts (gears, shafts, ratchets) requires sophisticated technology, i.e. precision, strength and durability. The Thai staff are diligently learning this high technology including the making of dies and jigs. They are capable of operating all production lines which are composed of forging, heat treatment, machining and assembling. However, it does not mean that they have reached the same level as the Japanese factory. According to the MD who has been in Thailand from the preparation stage to the present, the learning attitude of Thai workers has changed entirely in these years. At first, the local people wanted the "indigenisation" of technology as soon as possible. They wanted Japanese people to go back home as soon as possible. Today, they want "Japanisation" of technology. They want to learn as much as possible. The level of general understanding of the Thai customers is also high now. When J-12 started operation, the customers only cared about prices and did not show any interest in the shop floor. Today, they care about quality and want to see the shop floor. If customers care about quality, the firm's staff also care about quality. Thus, the customers' attitude is important.

The firm has twenty Thai managers, six managers and fourteen section-chiefs. As they tend to only care about their sections, the top management planned to let them experience other sections by job rotations. The top management announced that they have to experience two sections in three years. The policy helped them to have a broader understanding of management. The local staff will hopefully understand that they have to work in effective teams. This firm is successful because it took a gradual method in technology transfer. The MD is now trying to transplant the management concepts little by little.

As already mentioned, J-11 achieved a miraculous development in Thailand. The reasons for their successful development in Thailand are considered to be:

1. No more JV

The founder has four sons. The last son was sent to Hong Kong to seek the possibility of overseas investment where he was trapped in a fake JV project and lost a great deal of money in the project. He decided that he would never trust local partners, never start a JV, because their management concept is totally different. J-11 thus started as a 100 per cent owned subsidiary.

2. The importance of the management philosophy

Prior to the start-up in Thailand, the parent enterprise in Japan employed three Thai students in Japan. They became familiar with Muramoto's business culture and later worked for Muramoto's start-up. In 1987, 10 Thai staff were recruited by J-11 and sent for training in Japan, five for press work for one year, five for die maintenance for two years.

J-11 put great emphasis on the preparation stage which was to teach strict management philosophy and to give the best service to the customers. This attitude has to be based on the bottom-up orientation, not on the top-down orientation. This is exactly the spirit of the Japanese management philosophy. J-11 first taught the Japanese culture and the Japanese management philosophy to create a *team spirit* among Japanese expatriates and local staff. The process technology was taught last. The process technology itself is, according to the president, rather easy in the case of J-11 once the management philosophy is understood.

3. Start from a small scale

J-11 started from the smallest scale of a plant with only 10 persons and seven press machines (Table 7-9). The land and the building were rented in order to minimise the risk. J-11 chose a gradual step approach. It increased machines and lines gradually.

4. A solid management policy and the flexibility

Diversification and expansion of the business lines were achieved in a short period. If the management policy is very well understood and the organisation is functioning flexibly, diversification and expansion will be achieved successfully.

5. Acquisition of new technologies, the customer's education and training

The firm's key point of the success lies in the management system mentioned above. If the firm is trusted by customers, technologies will be introduced from the customers whenever necessary.

Table 7-9 The growth process of Muramoto

	May 87	Nov 87	Dec 87	May 88	Jan 89	Apr 90		Oct 94
Japanese expatriates	3	4	4	8				41
Thai workers	7	36	80	140				*3800
Press machines	7		15					111
Injection machines					2	5		81
total number of employees	10	40	84	148				*3800

Source: Muramoto. *3800 includes 41 expatriates.

A comparison between the "all-at-once method" and "gradualism" show "gradualism" to be more successful. As mentioned, J-11 started from the metal press lines where it was confident. Then, with the assistance of a set maker, it expanded its process to assembly and injection. In contrast, another electric component maker, in the same business, started a full set of processes from the beginning—metal press, injection, assembly, heat treatment and machining (Table 7-10). The large scale investment created financial difficulties. Also, the teaching of all processes at the same time failed. The result of the whole project was found to be unsuccessful.

Table 7-10 A contrast between a scale-up method and a scale-down method

	X Co., Ltd. (in 1993)	Muramoto (in 1993)
Start up	1987	1987
Ownership	Japan 100%	Japan 100%
Capital	60 million baht	130 million baht. (initiated from a small scale → 220 mil B in 1994)
Assets	936 million bahts	460 million bahts
Employment	2156	2800 (→3800 in 1944)
Equipment	Press M/C, Injection moulding M/C, Sintering furnace, Riveting M/C, Tapping M/C, Lathe M/C	Press M/C, Injection moulding M/C
Products	VCR components, Reel and mechanical discs, Clutches, gears and cassette units, Chassis units.	VTR parts, CRT parts, Video camera parts
Sales amount	2413 million bahts (in 1991) → scale-down	2000 million bahts (in 1991) → 4180 million bahts (in 1994)

Source: SEAMICO, 1993

(note) X Co. and Muramoto started similar businesses though X Co. on a larger scale, with a wider range of processes, which required a big amount of investment. X Co. was not so successful. Two main stumbling blocks were: (1) Financial difficulty due to the over-investment and (2) technological problems, i.e. the difficulty in learning of forging, machining and heat treatment all at once. Muramoto avoided these two difficulties by a gradual scale-up method.

7-3-2. Efforts to transplant a management philosophy

Equipment and staffing of qualified staff alone will not lead to a successful technology transfer. Technology transfer will be successful only when the people learn both technology and discipline. If they are not ready to work hard, the management of the firm will not be successful. The cases of J-22 and J-6 show the importance of learning the Japanese discipline and management philosophy.

The holding company of J-22, a leading world enterprise in hydraulic pumps with a long history of technology accumulation, made a license agreement with a renowned Thai auto parts manufacturer, Sammitr Motors Manufacturing. The holding company of J-22 was to provide drawings and samples of dump truck parts to Sammitr Motors Manufacturing for the period of 1964-74. Based on this mutual trust, in 1988, J-22 was set up as a JV between the same two partners. A condition of BOI promotion was to export 80 % of the products. The remaining 20% were allowed to be supplied to the Thai partner.

A full set of equipment was brought into the new factory located next to the Thai partner. The planned production lines were heat treatment, forging, machining, and the assembling of dump truck units (hydraulic cylinders). The Thai partner was one of the oldest and the largest auto parts manufacturers in Thailand.[100] Under these seemingly perfect conditions, J-22 began operations in 1989. Soon after the start-up, at the peak time, the number of workers reached 120 and the number of expatriates, twelve. However, the plant continued losing money. The JV could not reach the expected technological level and the products did not reach the required quality standard from the viewpoint of Japanese expatriates. Delivery times were not met. The following factors explain this failure from the viewpoint of Japanese expatriates.

1. Low levels of learning

Learning levels of technology at J-22 scored very poorly (point 5 each in "operation"). The products are functional parts of dump trucks units, i.e. hydraulic mechanisms. Functional parts need precision, strength and durability. Metalworking technology needs skills and is difficult to learn. There are no firms which are capable of making these kinds of functional parts in Thailand. J-22 challenged this, but the start-up was not smooth.

2. Difficulty in teaching the management concept

In comparison with the Japanese holding company, the Thai staff lack the understanding of the quality of products, do not try to understand the requirements of customers, and do not try to consider the health and safety of workers. Consequently, the workers themselves do not care about the quality of products which they are making. Therefore, the factory and the machines are not maintained properly. Engineers do not want to go to the shop floor, and workers do not clean the machines nor the workshop floor because they think cleaning is a janitor's job. Staff turnover was rampant especially in the machining section and the welding section.

3. Staff problems

Prior to the start-up, 50 persons were sent to Japan for three month training. However, only five remain with the firm now. Every year a large number of workers resigned [It happened unexpectedly for the Japanese management]. At the beginning there were six engineers (university graduates) in the factory. At the time of the survey, only one remained.

Restructuring was started. The machining section had the problem of unstable workforce. Therefore, the machining process was subcontracted to three or four outside firms. Drawings, jigs and the process flow were changed in order to make the operation easier for Thai workers lacking experience and discipline. The manufacturing process was adapted to Thai workers. Differently from Japan, one month's stock of materials are kept for all production processes. This is to allow for workers' absenteeism, sabotage and unexpected resignation. The total number of employees was decreased from the peak of 120 to 85 persons. Workers often resist the request to work hard and answer back, "This is Thailand, not Japan". The situation is far from JIT. However, due to the above restructuring, J-22 was able to make a profit in 1993. NGs (defects) were decreased, sales doubled, and the average wage also doubled. This factory is now on the path to improvement.

Due to the lack of discipline of Thai staff (especially of Thai managers) or due to the over-expectation from the Japanese side, the technology transfer to Thai staff in this case was not smooth. Thai staff felt that Japanese people did not understand the Thai people's nature and failed in management. They felt that responsibility should not be born only by Thai staff. They emphasised that Japanese people do not speak English or Thai. Therefore, the Thai people cannot understand what Japanese people wish to say. The technology supplier could not communicate efficiently with the recipients. Also, the firm was established near the partner's plant site. It is true that Thai and Japanese styles of management are totally different. If the Thai plant has a strong influence on the new enterprise, as probably happened in this case, it may be very difficult to implement the Japanese style of management and discipline. This example shows that a production system needs not only equipment and manpower but also discipline and team work.

Another case is that of J-6, a steel wheel maker. After nearly 20 years' operation in Thailand, the technology level of J-6 is still not satisfactory from the viewpoint of Japanese expatriates. The scoring is 6-7. The number of expatriates is six. Operation, maintenance, QC and production control, all need the assistance, or interference, of Japanese expatriates. Why, even after 20 years of management, has greater success not been achieved?

In July 1994, Central Motor Wheel (the holding company) increased the share of the capital from 4% to 27% and came into the centre of the management of J-6, sending six expatriates to replace the then five management persons. Until then the management of the firm was led by people from steamship or trading companies in Japan. In the past years, Central Motor Wheel sent only one expert to take care of the technical matters of the firm. This big change in the management after 20 years of operation occurred due to the following reasons.

(1) J-6 has been a protected monopolised factory in the production of steel wheels in Thailand.

(2) The recent expansion of the car market in Thailand invited the establishment of an aluminium wheel plant (Enkei, 1988) and a further threat of entry of other manufacturers of steel wheels emerged.

(3) Car assemblers also wanted a better assurance of the quality and the cost reduction of steel wheels.

Thus, Central Motor Wheel made a decision of a deeper commitment in J-6 in 1994. The problem for the new expatriates was the language of management. After the replacement of the management members, the language for the weekly meetings was changed from English to Japanese. Thai managers attend the meetings and listen to a translation.

The number of employees, 450, is comparatively large due to the use of older machines and inefficiency in labour methods. In order to improve the efficiency, the new management emphasised the following.

(1) Human resource development,

(2) Cost reductions,

(3) Environmental considerations,

(4) Good maintenance of dies and equipment,

(5) Avoidance of accidents in the shop.

The goals set are as follows:

(1) Customer's claim ratio, less than 15 pieces per month (PPM) for wheels, 250 PPM for press parts.

(2) Cost reduction, 3%,

(3) Productivity increase 10%, decrease of machine breakdown 30%.

In summary, the present levels of learning in "operation" scored rather low (point 6, 7, 7, and 7 each).

It should be noted that, in the late 1970s and early '80s, many Japanese investors had to work hard to change the Thai workers' attitude to disregard quality, cost and delivery time (QCD). Thai Kawasumi (a manufacturer of medical equipment) was a good example of this. The firm had to persuade the Thai partners to restructure the management. The firm insisted that the workers wear new uniforms before entering the factory site. It helped Thai staff understood that they worked in a factory, not on an agricultural farm. The result largely depends on human efforts and discipline inside the factory. 5S (keeping the shop floor clean and tidy) activity is a later trial of transplanting discipline to workers.

From the above two cases, lessons to learn are summarised as follows:

(1) Incorrect location of the plant. Workers may possibly be influenced by the behaviour of the workers at the partner's plant next to the JV plant. That may affect the learning of discipline.

(2) Too much dependence on elites, i.e. English speaking university graduated engineers. They have no experience in factory management. Whereas Japanese technical experts are very often high-school graduates (not university graduates) and do not speak English, but they know quite a lot about manufacturing.

(3) Neglect of the wide gap between the Japanese factory and the Thai reality.

(4) Misunderstanding by Thai people that a JV will create a success without effort from the Thai side.

7-4. Comparing the Japanese and Western technology

What follows are comparisons between the Japanese and Western technologies by process. The aim of this section is to understand why so many Japanese expatriates came to Thailand and why they stayed for so long.

7-4-1. Defining "easy technology" and "difficult technology"

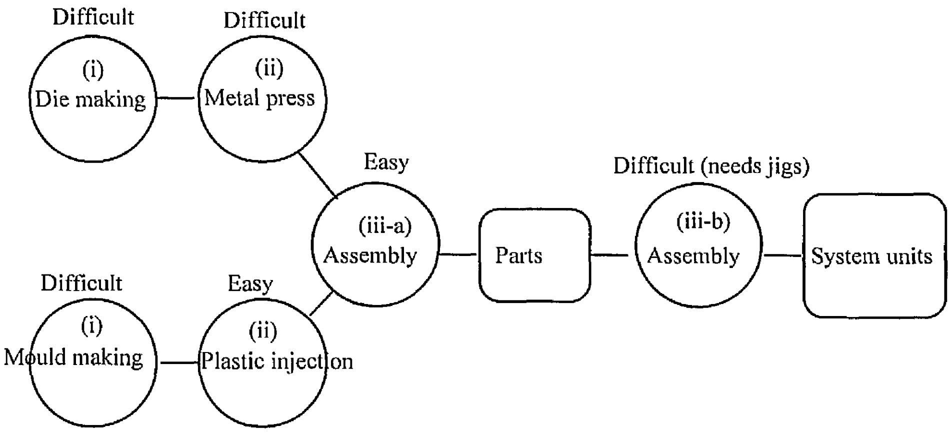
From observations during the survey, the author derived some basic standards for the judgement of "easy" or "difficult" technology as shown in Table 7-11. In short, precision works are more difficult than non-precision works; handling of metal and rubber is more difficult than plastics; assembling requiring jigs and fixtures is more difficult; metalworking which requires change in the nature of metal to obtain the strength (e.g. casting or forging for functional parts such as crankshafts or engine blocks) is more difficult. The above prepositions imply that the more difficult the technology is, the more in number and the longer in time Japanese expatriates tend to stay.

Table 7-11 Standards for judgement of easiness and difficulty (a summary of observation)

	easy technology	**difficult technology**	**more difficult**
scoring	"0"	"1"	"2"
precision		precision works	
material	plastics	rubber, metal	
injection	plastic injection	rubber injection	
assembly	assembling without jigs	assembling with jigs	
metal-working		metalworking (press, sheet work, welding)	metalworking (casting, forging, heat treatment, machining)

Source: The author's survey.

Figure 7-4 Easy technology and difficult technology in the process of parts making



Source: The author's survey. A summary of observations

The surveyed firms are divided by process into two groups, Group A and Group M, and eight categories as shown in Table 6-11.

Group A or assembly group includes:

1. Assembly (plastic/rubber)
2. Injection/assembly (plastic/rubber)
3. Injection (plastic/rubber)
4. Press/assembly (metal).

Group M or metalworking group includes:

1. Sheet works/ welding, press, machining
2. Mould and die
3. Forging, casting, press, machining
4. Other special process

The production process for Group A is normally divided into three steps; (i) making of moulds, dies and jigs (pre-production process), (ii) stamping and injections, and (iii) assembling. As illustrated in Figure 7-4, (i) mould and die making and (ii) metal press are difficult. Whereas, (ii) plastic injection and (iii-a) simple assembly are easy.[101] However, some assembly (iii-b) is considered difficult as it needs sophisticated jigs and fixtures and the preparation process requires know-how. In many cases, especially at the beginning, "moulds, dies and jigs" are supplied by holding companies or customers. Subsidiaries undertake only (ii) stamping and injections and (iii-a) assembly which are considered easy to learn. This is to avoid risks in developing countries where the technology level is generally low. Even in assembly processes, there are easier processes such as assembling of notebook computers, PCBs or ICs and there are more difficult processes such as assembling of cathode ray tubes (CRT) or automobiles which need precision jigs and fixtures. This difference comes from the nature of products. Even in the case of the same product, some firms adopt more advanced systems of production and others less advanced systems.

In general, an easy labour-intensive (manual) assembling process for mass production has the following characteristics.

(1) Normally,[102] it does not need big investment in machines and human training compared to metalworking industries.

(2) Technologies for assembling process are broken down into easy manual processes as compared to the metalworking processes. Even though the whole manufacturing process of the products needs a set of sophisticated technologies (Chapter 3: 3-5-2), the assembly lines are normally simplified and clearly shown in flow process charts, quality control charts, manuals and job descriptions.

(3) Normally, there is no need to study the basic components (or raw materials) for assembling because necessary parts are already processed and checked by suppliers.

(4) Although there are some machines such as insertion machines, ripping machines (of wire edges), winding machines (of wires), testing machines, the operations of machines are designed not to be so difficult.

(5) Workers are not expected to learn technologies about the products or the whole processes. Even if the local staff become able to manage the assembling process, they are not able to learn the whole process of technologies such as R&D, the establishment of new plants. Learning of IE or R&D technologies is totally a different matter.

Group M includes metalworking processes. As regards press processes, there is an easier press work such as a manual single press and also a difficult press work such as an automatic progressive press or a full automatic transfer press. In addition, some press technology has come close to forging (cold forming). A press process sometimes not only punches or blanks metal but also changes the shape considerably without producing waste, for example, the case of multi-V shaped pulleys.[103] This type of press work replaced some tasks done by casting and machining. As regards casting, there is easy technology such as iron casting of lamp stands as well as the most difficult technology such as casting of engine blocks for automobiles.

Based on the above mentioned standard (Table 7-11), the technology of each firm in the survey is scored "0" (easy), "1" (difficult) or "2" (more difficult). The technology judgement was carried out in two ways, method No. 1 and method No. 2. Method No. 1 judged whether the process is "0" or "1". Method No. 2 further classified "1" into two groups, "1" (difficult) and "2" (more difficult). In practice, "metalworking for auto parts" and "precision mould and die making" are considered "more difficult" and scored "2". In addition, in the case of method No. 2, W-13—a JV between the USA, Thailand and Japan where technology is provided from Japan—was reclassified into a Japanese firm. The results of the scoring are shown in the right columns of Table 7-12. What follows are comments on the judgement.

7-4-2. Scoring by process

(1) Assembling process (category 1)

Assembling technology in two Japanese firms (J-3, 9) and four Western firms (W-3, 5, 11, 12) are considered "easy". They are all scored "0". Both J-3 and W-3 were scored "0". In fact, in more detail, J-3 (Japanese capital, 100%) has more advanced systematic technology than W-3 (Western capital, 100%), probably because W-3 aims at large size UPS for smaller markets while J-3 aims at small size UPS for larger markets. J-3 adopts a flow production system while W-3 adopts a job shop system of a low productivity. J-9 (Japan 100%) and W-5 (Taiwan, 44%, West 5%, Thai 51%) both assemble electric wires. J-9 has 1,350 employees and 9 expatriates, while W-5 has 250 employees and no expatriate. It seems the Western investor (W-5) does not provide technology. W-5 assembles OEM products for Philips.

Technology seems to be provided by the Taiwanese partner. W-11 (156 persons, 1 expatriate) assembles electric control board and W-12 (450 persons, 2 expatriates) assembles ICs.

Even in the case of the same product, there are different development stages in the methods of assembling. For example, in Japan, the number of workers on an assembly line is changed frequently depending on the volume of the work. However, in Thailand, the number of workers on a line is fixed regardless of the volume of the work. Japanese workers are trained to change the task any time, whereas Thai workers are not trained in that way (J-2, J-11). In the case of a typical IC assembly at Toshiba[104] in Japan, one line is composed of 10 workers and the line is straight. But the newest design of the assembly line at Toshiba is U-shaped and carried out by seven workers. The working system affects productivity and quality. The ultimate image of the assembling line is to be carried out by one person. The notion is that simple work will not give satisfaction to humans if the training level is upgraded.[105] Thus, assembly lines have to be adapted to the education and training level of the people. Even a simple assembly line experiences technical change continuously as a result of *kaizen* (improvement activity by Japanese concepts) on the shop floor.

(2) Injection/assembly (category 2)

In this group, injection processes are added to the assembly processes. Four Japanese firms (J-10, 13, 14, 19) and a Western firm (W-2) are included here (Table 7-12). Usually, injection moulds are supplied by customers or holding companies. Injection machines automatically and quickly produce plastic parts. The plastic parts made in the injection lines are carried to the assembly lines for the following assembly process. Injection lines do not need so many workers. On the other hand, assembly lines need a large number of workers. W-2 (telephone, capital shares, Thai 98%, West, 2%) has 1,059 workers and 5 expatriates. Technology of W-2 is scored "easy" as is J-9 (electric wires, 1,350 workers, 9 expatriates). In contrast to W-2, technology of J-19 was judged difficult or more difficult. J-19 is equipped not only with the injection/assembly lines but also with mould and die making facilities and metal press lines. This is to manufacture "precision" moulds and dies in-house. The staff for making moulds are being trained. That is why technology of J-19 is scored "difficult" or "more difficult" according to the standard of "precision" in Table 7-11 and the footnote of Table 7-12.

(3) Rubber injection (category 3)

Two firms (W-1, J-5) in the survey have only rubber injection lines. However, the technology level of W-1 is easier than that of J-5. As the result, W-1 learnt technology quickly and has no foreign expatriates. W-1 manufactures rubber parts for windscreen wipers. Moulds are provided by the US holding company. All products are exported back to the holding company in the USA. Rubber parts for wipers are black and precision is not required. W-1 has no expatriates. The Thai manager answered that technology was not difficult and was already learnt by Thai staff. Technology is considered "easy".

In contrast, J-5 holds higher technologies. Firstly, J-5 needs precision works for silicone rubber injection. Silicone rubber parts are used for electrical devices and appliances. In addition, J-5 is going to make moulds and jigs in-house. Therefore, the technology of J-5 is judged "difficult" or "more difficult" (Table 7-12).

(4) Press/assembly (category 4)

Metal press lines are more difficult than plastic injection lines. The difference lies in the nature of metal. Metal has a special bending nature, and are thus different from plastics. Especially in order to form them into accurate shapes, the bending nature of metal has to be understood. This requires accumulation of experience and technology. Therefore, technology of three Japanese firms (J-7, 11, 21) are judged "difficult" (Table 7-12).

J-11, a metal press shop for electrical parts, added assembly lines and injection lines later. The basic metal press technology and the excellent management system enabled the firm to handle a variety of product items, and to process metal press, injection and assembly. The large number of workers in assembly lines is the reason that J-11 has 3,800 workers.

J-11 plans to establish a new plant at Korat in order to avoid labour shortages in the Bangkok area. The new plant will concentrate on assembling processes and will be staffed only by local people including the plant manager. This becomes possible because the labour-intensive assembling technology is easy. Nevertheless, equipment and assembling jigs have

Table 7-12 Scoring technology by product and process

process group code*	firm code	number of expatriate	industry type	major product	process code**	scoring No.1	scoring No.2
1	J-3	2	electrical	UPS	10		
(Assembly)	J-9	9	electrical	Electrical wires	10		
	W-3	2	electrical	UPS	10		
	W-5	0	electrical	Electrical wire	10		
	W-11	1	electrical	Electric control board	10		
	W-12	2	electrical	IC	10		
2	J-10	4	electrical	Precision mould	4,10		
(Injection/	J-13	4	electrical	Timers	4,10		
Assembly)	J-14	6	electrical	VTR parts	4,10		
	J-19	4	electrical	Precision mould and die	3,4, 6,10	1	2
	W-2	5	electrical	Telephone	4,10		
3	J-5	2	electrical	Silicone rubber	5, 6	1	2
(Injection)	W-1	0	auto parts	Rubber parts(auto)	5		
4	J-7	5	electrical	Metal press	3,10	1	1
(Press/	J-11	40	electrical	Components assembly	3,4,10	1	1
Assembly)	J-21	3	electrical	Microwave oven parts	3,6,10	1	2
5	J-2	5	auto parts	Press, assembly(auto)	3,7,10	1	2
(Sheet works-	J-6	6	auto parts	Steel wheel	3,6,10	1	2
welding,	J-20	3	auto parts	Brake hose sockets	3,6,7,8,10	1	2
Press,	W-7	0	electrical	Hermetic compressors	4,6,7,8,9,10	1	1
Machining)	W-9	2	electrical	HDD	6,7,10,11	1	1
	W-10	0	electrical	Electrical appliances	3,4,5,6,7,8,,10	1	1
	W-4	3	general	Aircraft goods	3,6,9,10	1	1
6 (Mould and die)	J-17	7	auto parts	Dies and tools	3, 6	1	2
7	J-1	4	auto parts	Nuts and bolts (auto)	2,3,6,7,9,10	1	2
(Forging,	J-4	5	auto parts	Clutches	1,3,6,10	1	2
Casting	J-12	5	auto parts	Engine parts	2,6,7,10	1	2
Press,	J-22	4	auto parts	Dump trucks units	2,3,6,9,10	1	2
Machining)	J-8	4	general	Valves	1,2,6,10	1	1
	J-16	3	general	Anchor bolts	2, 6,7,8	1	1
	W-13	2	auto parts	Engine valves (auto)	2,6,7,8,9	1	2
	W-8	1	electrical	Electric motor	1,3,6,7,9,10	1	1
8	J-15	1	electrical	Super hard dies	3,6	1	2
(Special	J-18	8	electrical	Condenser	6,10,11	1	1
product/	J-23	5	electrical	Heat treatment	7	1	2
process)	W-6	0	electrical	PCB	8,11	1	1
total						23/36	39/36

Source: The author's survey. *process group code = see Table A-4

(abbreviations): J=Japan, W=West; electrical = electrical parts, general = general parts

(**process code): 1=casting, 2=forging, 3=press/stamping, 4=plastic injection, 5=rubber injection, 6=machining, 7=heat treatment, 8=electro plating, 9=sheet working/ welding, 10=assembly of parts and components, 11=other processes

(standards for judgement):

Method No.1 (according to Table 7-11): "Easy technology"= zero, "difficult technology"=1.

Method No.2 (a modification): "Precision mould and die making" and "heat treatment" are considered "more difficult" and scored "2". In addition, a Western auto parts firm (W-13) is switched to a Japanese technology firm because it is a JV with a Japanese firm and is receiving technology from Japan.

Table 7-13 Comparing the technology levels between Japan and the West

	scores/no. of firms						Average					
	No.1			No.2			No.1			No.2		
	Japan	West	total	Japan	West	total	**Japan**	**West**	total	**Japan**	**West**	total
auto parts	8/8	1/2	9/10	18/9	0/1	18/10	1.00	0.50	0.90	2.00	0.00	1.80
electrical parts	8/13	5/10	13/23	13/13	5/10	18/23	0.62	0.50	0.57	1.00	0.50	0.78
general parts	2/2	1/1	3/3	2/2	1/1	3/3	1.00	1.00	1.00	1.00	1.00	1.00
total	18/23	7/13	25/36	33/24	6/12	39/36	**0.78**	**0.54**	0.69	**1.38**	**0.50**	1.08

Source: The author's survey (*Survey A*). A summary of Table 7-12

to be designed and manufactured by Japanese experts. This is a matter of equipment technology, not a matter of "operation" or "maintenance" technologies.

(5) Sheet works/welding, press, machining (category 5)

Three Japanese firms (J-2, 6, 20) and four Western firms (W-4, 7, 9, 10) are in this category. Technologies for sheet works/ welding, press and machining are considered "difficult" (Table 7-12). BEW (J-2) is a specialist of sheet works and press works for automobiles, a Mitsubishi subcontractor. Kallawis (J-6), which makes steel wheels by stamping, is a Toyota subcontractor in Japan, and a monopoly in Thailand. Thai Okawa (J-20) makes brake-hose-sockets for automobiles. W-7 manufactures hermetic compressors, W-9 manufactures HDD, and W-10 manufactures electrical appliances such as toasters, hot pots, etc. Technology of the above six firms' involves metalworking and the tasks will not be learnt in a day or two as is the case of simple assembly or plastic injection. Careful maintenance of machines, dies, jigs and tools is indispensable. It should be noted that the Japanese firms engage in auto parts, while the Western firms engage in electrical appliances which are considered quite conventional. That seems to be a reason why the three Japanese firms send more expatriates (14 in all) than the four Western firms (5 in all).

The above observations suggest that a smaller number of expatriates is not always the result of a successful technology transfer. If the level of technology aimed for is high, the number of expatriates will increase and they will stay for longer. It is necessary to take into account the content of technology which the firm is trying to acquire.

(6) Mould and die (category 6)

As mentioned, today's mould and die technology is highly sophisticated, and it plays a critical role in mass production in the machine industry. A mould and die industry requires not only a big investment in equipment but also the accumulation of skills and high technology. Previous sections in this chapter discussed this issue. Precision mould and die technology is thus considered a "difficult" technology. For example, SNN (J-17) is a die and mould specialist for automobiles. Following the standard, the technology of J-17 is scored "1" (method No. 1) and "2" (method No. 2). There are many other Japanese firms which make moulds and dies in-house, although they are electrical parts suppliers (J-19, 5, 21, 15). They too are considered firms engaging in "difficult technology" and thus scored the same as J-17.

(7) Forging and casting (category 7)

Six Japanese firms (J-1, 4, 8, 12, 16, 22) and two Western firm (W-8, 13) are in this category. Forging and heat treatment are necessary to produce strength, durability, tensile of metal. The complicated concave shapes of engine rooms are formed properly only by casting. Valves, nuts and bolts are made by forging and heat treatment, or by cold forming. Functional parts of automobiles and motorcycles mostly need forging, casting, and finishing by precision machining. These technologies are thought to be one of the most sophisticated metalworking technologies and scored as such. In this field, firms in developing countries cannot yet compete with advanced countries.

As already referred to, W-13 is a JV between the USA (51%), Japan (24.5%) and Thailand (24.5%). In this firm, the technology is taught by the Japanese partner not by the US firm as explained (see page 196). Taking this into consideration (according to method No. 2), W-13 is classified as a Japanese one. Consequently, technologies of seven firms among eight become Japanese in this category.

(8) Special processes (category 8)

Three Japanese firms, super hard dies (J-15), condensers (miniature aluminium electric capacitors, J-18) and heat treatment (J-23), all need difficult technologies. The technology for PCB (a Western firm, W-6) is also considered "difficult" or "more difficult" as shown in Table 7-12.

In this category, J-23 is a specialist in the heat treatment. Heat treatment technology is one of the least developed metalworking technologies in Thailand. J-23 still relies heavily on Japanese experts. Because the heat treatment process for J-23 still relies heavily on experience. The process data are not yet accumulated nor codified into systematic data as seen in the case of the steel industry and the mould and die industry. Therefore, local staff need many years to learn the technology. This is the reason that J-23 has the highest worker-expatriate ratio (7.4 persons) among the surveyed firms. The average worker-expatriate ratio for Japanese subsidiaries is 86.3 persons. A further discussion on the worker-expatriate ratio will be given in Chapter 9.

In general, heat treatment needs furnaces with gas, oil or vacuum. The furnace developed in Europe was the salt bath type which uses liquid composed of Barium Chloride. Barium Chloride from the salt bath pollutes the environment and offers bad labour conditions. Then, the US firms invented the vacuum furnace which later became popular in Japan. The vacuum type furnace is free from pollution and preferred these days. In any of these furnaces *heat* will be transferred via gas or oil. The atmospheric pressure in the room will be "10" (ten times the normal air pressure at sea level)[106] if the furnace is new. The high pressured air will cool materials in the room faster. These are conditions for satisfactory equipment. In Thailand, only a few local firms have satisfactory equipment.

Even if the equipment is satisfactorily new, most Thai firms lack the understanding of technologies. Heat treatment needs a good understanding of materials and an accumulation of experience. First, there are many kinds of steel. Each steel dealer supplies different steels. Then, the setting-up of materials and the setting of temperature need accumulated experience. In Japan 10 atmospheric pressure is adopted, while in Thailand 1.5 atmospheric pressure is very often adopted. Quenching and tempering are repeated according to the specification of the product quality. The above is a complex set of technologies to learn.

Problems in heat treatment observed in the case of local firms are as follows.

(1) Witness A (J-21): heat treatment of punching dies

The firm subcontracts the heat treatment of punching dies to J-23 as local firms have no vacuum furnace. Oil or gas furnaces at local firms tend to de-carbonise the surface of the punching dies. If the surface is de-carbonised, the dies could not work properly.

(2) Witness B (J-16): heat treatment of anchor bolts

J-16 has no heat treatment equipment and the work is subcontracted. J-16 reported repeated failures in finding satisfactory subcontractors. After the heat treatment is processed at local firms, the products of J-16 (anchor bolts) are inspected for their hardness. Sampling ratio is 250 pieces per each lot. If the hardness of the 250 samples ranges within the tolerance, the bolts will be accepted. If the hardness range exceeds the tolerance, the lot will be rejected. The local firms had difficulty in keeping the bolts within the designated range of hardness. J-16 finally reached the conclusion that J-16 should not rely on existing local firms in Thailand. Thus, J-16 acquired technology by itself and fostered a local Taiwanese subsidiary as its subcontractor in Thailand.

It should be noted that educational background of staff in heat treatment plants is different in Japan and Thailand:

(1) In Japan

The holding company of J-23 in Japan employed three university graduates in *metallurgy* when it established a heat treatment plant in 1970. Three employees were sent for OJT at heat treatment factories for a month. They acquired a full grasp of technologies through experience in about two years.

(2) Thailand

Key local staff of J-23 are *vocational school graduates*. At the beginning, J-23 employed three persons from a five year course and three persons from a three year course. However, one left the firm recently. They are learning fast but their educational background is lower than in Japan and staff turnover is obstructing technology transfer. They are now able to operate the whole process although they still need Japanese experts. The customers bring in many different types of steel materials. It needs experience to identify the composition of the steels. Different steels need different formulas of heat treatment. It is expected that these workers will be able to handle the process in three years if they do not quit.

The learning of heat treatment technology may take time, the MD of J-23 has a hope for the future. Thai staff are found to be creative. They have invented a jig to avoid bending. With this jig, J-23 is now capable of handling the heat treatment of cutting blades for slitting machines. These jigs solved the problem of bending effects. That has been done by an invention of a special jig by Thai staff.

Technology holders of the subsidiaries in Japan all have a long history of technology development dating from before WW2. Their technologies are now advanced and difficult to learn. It was frequently recognised in the survey that the Japanese expatriates are proud and determined in their task of teaching technologies in Thailand. There was no hint of intention to hide technology.

7-4-3. Evaluation

As far as the surveyed firms are concerned, Japanese firms in Thailand are attempting to transfer more difficult technologies than Western firms. What follows is an overview.

Firstly, the scoring of technology levels was carried out by the eight process groups. As shown in Table 7-12, the average score of "Group A" (easy technology) was 0.31 (5/16), whereas the average score of "Group M" (difficult technology) was 1.00 (20/20). The scores of Group A by the No. 2 method was 0.50 (8/16), whereas that of Group M was 1.55 (31/20). Scores of Group A were lower than Group M in both methods because the task of Group A is composed basically of assembling processes, which was easier to understand than metalworking, and the measuring followed the standard set as such.

Secondly, as shown in Table 7-13, the average figures classified by country showed that technology levels in Japanese subsidiary firms are higher (more difficult) than in Western firms. By No. 1 method, technology levels of Japanese firms scored 0.78, whereas that of

Western firms scored 0.54. By No. 2 method, the Japanese firms scored 1.38 and the Western firms scored 0.50. The gap between scores of Japan and the West becomes wider in the case of No. 2 method, partly due to the reclassification of a company from a Western firm to a Japanese firm. As mentioned, this reclassification followed the real technology supplier although the majority holder of the company is the US firm.

In conclusion, Japanese firms in the survey engage in more difficult tasks than the Western firms in the survey. In principle, the difference in figures shows the distribution difference of Japanese and Western firms in process and sector. That seems to be the major reason why Japanese firms send more expatriates and why they stay longer.

Chapter 8:
Efforts by Local Firms:
The Parent-Child Relationship is the Fastest Way

Introduction

In this chapter I intend to survey the various forms of technology transfer in local firms from quasi-internal borrowing (QIB), technical agreement (TA) to "learning-by-doing" and "reverse engineering". Among these forms, QIB is the most effective form of technology transfer in Thailand.

Before WW2, commercial businesses were in the hands of foreigners, especially in Chinese hands. Later, through the Thai-ification policy during Pibul's governments, Chinese immigrants were naturalised and assimilated into Thai societies. Since the 1960s, following the industrialisation policy, Chinese immigrants and their sons have played the major role of technology recipients in Thailand, first in the textile industries and later in the machine industries.

The first section will examine the general background of the local entrepreneurs in this survey. At first, the survey will focus on their ethnic background and languages as the cultural interaction (hybrid society in Veblen's term) is one of this thesis' concerns. Then, their opinions on technology source and the prospect of catching-up will be examined. According to our survey, these entrepreneurs (technology recipients in Thailand) consider their major technology suppliers to be Japanese firms. For them, Japanese firms and experts are considered the most important source of acquiring technology.

The latter part of this chapter will examine the practice of their borrowing. For the acquisition of technology, there are a variety of routes such as true internal borrowing inside subsidiaries (TIB), quasi-internal borrowing between parent enterprises and subcontractors (QIB), learning from foreign firms and technical experts on contract bases (TA). There are also the cases of "diffusion" (the second step spread of technology) and "indigenous development efforts". These routes also seem to play a great role because they spread technology to the mass who lack direct access to foreign technology.

8-1. Entrepreneurs' background and the concepts

8-1-1. Entrepreneurs' background

The Thai manufacturers in this survey are mainly Chinese immigrants or their sons. Some originated from local farmers. Many of them speak English, but some speak only Thai or only a Chinese dialect and Thai. Japanese is also learnt by some manufacturers because Japan is considered to have the most advanced technologies in the world. They are all keen to acquire technologies from foreign countries.

Among the 20 Thai firms, 13 (65%) are founded and owned by Chinese immigrants or their sons (Table 8-1). Three firms (15%) are founded by local farmers or farmers' sons. All these 3 firms are in the agricultural machinery sector or a die maker which diversified from the sector. The other four firms (20%) are excluded from this question because T-10, T-17 and T-18 belong to the Siam Cement group which were originally founded by the King and no information was available from the other firm.

Table 8-1 Managing director's background (local firms)

	number of firm	%
Immigrant or immigrant's son	13	65
Farmer or farmer's son	3	15
others/unknown	4	20
total (20 firms)	20	100

Source: The author's survey

Table 8-2 Managing director's language capability (local firms)

	in single answer	in two answers	in three answers	total
Thai	2	13	5	20
Chinese		4	2	6
English		8	5	13
Japanese		1	3	4
others				
total (20 firms)	2	26	15	43

Source: The author's survey

The language of the managing directors (MDs) was also asked (Table 8-2). All MDs speak Thai. Among them, two MDs (10%) speak only Thai and four (20%) speak only Thai and Chinese. English is spoken by 13 MDs (65%) and Japanese is spoken by four MDs (20%). The number of Japanese speakers are few, but knowledge of the Japanese language helps their business because most technologies come from Japan and Japanese experts rarely speak English or Thai. Some of the MDs or founders sent their sons to study not only to English speaking countries but also to Japan for acquiring technology in the future.

In the 1970s the antagonism towards Japanese investment in Thailand culminated in the boycott of Japanese products. In the early 1980s local people still wished to maintain "indigenousness (Thai-iness)" and wished to exclude Japanese influence as much as, and as soon as, possible. In the 1990s, in contrast, many Thai firms wish to "Japanise" their firms by adopting Japanese technologies and management philosophy. They consider that machine operations alone were not enough to make competitive products, but the management system also had to be improved. Experience with Japanese firms led them to recognise that, at least for the moment, learning is still more important than "indigenousness". This is the thinking of practical businessmen, but not a common understanding among the public.

This survey asked the following question to Thai firms, "Which countries (regions) have the most advanced technologies in the manufacturing of your products?" As shown in Table 8-3, 19 firms (95%) answered "Japan" and one firm (5%) "Europe". Two firms answered that Europe has the most advanced technologies in injection moulds. One firm which makes hydraulic machines answered that the firm has to learn not only from Japan but also from NIEs and ASEAN. One firm in the spare parts for agricultural machinery sector answered that the firm has to learn both from firms in Japan and Thailand. In sum, it is widely recognised among Thai industrialists that Japan has the most advanced technologies.

This survey then asked, "How many years will it take for your firm to become able to produce the same level of products with the most advanced countries?" (Table 8-4). Three firms answered "1-3 years". They engage in slitting, nuts and bolts, and guide pins and guide bushes for moulds. Four firms answered "3-10 years". These engage in casting, forging, radiators and auto bodies. Another three firms answered "over 10 years" and five firms answered "perhaps never". These eight firms (40%) are making moulds and dies, or auto parts. These technologies are truly difficult. The remaining five firms (25%) gave no answer (Table 8-4).

In summary, about one third seek to catch-up within 10 years, but it seems that the technology questioned did not cover "creative" technologies. Therefore, if they do not learn "improving" and "creative" technologies, several years after the catch-up they will be forced to borrowing technology again. Probably, interviewees who answered "perhaps never" or gave "no answer" took into account this point.

Table 8-3 The most advanced countries in technologies (local firms' viewpoint)

	in single answer	in multiple answers	total	%
Thailand		1	1	5
Japan	16	3	19	95
USA				
Europe	1	1	2	10
NIEs		1	1	5
ASEAN		1	1	5
others				
total (20 firms)	17	7	24	17 = 100

Source: The author's survey

Table 8-4 Years for catching-up (local firms' viewpoint)

	number of answers	%
1-3 years	3	15
3-10 years	4	20
over 10 years	3	15
perhaps never	5	25
answers not available	5	25
total firms	20	100

Source: The author's survey

Table 8-5 Technology levels of Thai mould and die firms

	type of firm		technology level	the number of firms (%)
1	JV between Thailand and Japan	advanced technology although the equipment is less advanced as compared to that of Japan	high	5 %
2	100% owned by Thai local	orders from Japanese firms technical assistance from Japanese firms	reasonable	15 %
3	100% owned by Thai local	works only for local customers not for Japanese firms	low	80 %

Source: Sang Charoen Tools Center

In the case of mould and die firms, a Thai MD classified foreign subsidiaries and local firms into three groups according to the access to foreign technology. He considers that the access to foreign technology determines the technology levels of the local firms in the case of mould and die making as follows (Table 8-5):

(1) JVs with Japan (*high levels*)

Thai-Japanese JVs have the most advanced technologies because of their abilities to access the highly developed Japanese technologies and the teaching by Japanese partners is the most serious. However, the equipment found in these factories is usually less modern and the staff's technology levels are also lower than in Japan. The 16 Japanese JVs in the survey correspond to this category.

(2) Local firms with technical assistance (*reasonable levels*)

The firms getting orders and technical assistance from Japanese firms have reasonable levels of technologies because of the technical assistance. The nine Thai firms in the survey (QIB/TA) and six firms in the "diffusion route" in Table 8-6 fit this category.

(3) Local firms (*low levels*)

Local firms providing for the local customers have low level technologies because the technology levels of local customers do not require high technology such as precision, durability or strength. Their products, e.g. plastic basins, buckets, do not need high technologies or vice versa. They lack technology sources to upgrade technologies. Recently, they have opportunities to acquire new technologies through the activities of the government agencies and associations, text books and lectures, but those sources are not comparable to the direct borrowing from Japanese industrialists. The five firms of the categories in "indigenous efforts" in the survey fit this category (Table 8-6).

Mr. Paibool of Metalworking and Machinery Industries Development Institute (MIDI)[107] commented that, generally speaking, the access to foreign technology depends on the size of the firm:

(1) Advantages for comparatively large size firms

Normally large size firms with abundant resources such as renowned Thai business groups can afford to conclude technology agreements or employ technical advisors.

(2) The case of medium size firms

For medium size firms, it is difficult to get foreign technical advisors. The size is too small to have foreign advisors for many months in the factory. Therefore, firms in this category send staff to training courses by MIDI, Technology Promotion Association (TPA) and so on. Also, they send staff on overseas study tours organised by the government or by the private sector.

(3) The case of small size firms (household size)

The smallest size firms cannot afford even to send staff on training courses or study tours organised by the above institutions. Thus, they have to rely only on self-study and learning-by-doing.

Despite difficulties of access to foreign technologies, technology information is spreading into local firms through the activities of MIDI, TPA or Thai Tool and Die Association (TTDA). As a result, most *entrepreneurs* now understand the importance of quality, cost and delivery time (QCD). As equipment and process alone cannot improve the Thai firms' technological capability, the next step is to spread the understanding QCD to the *employee* level. Although this task seems not to be easy, it is indispensable for the strengthening of the industrial base. New management concepts such as 5S (to keep the shop floor clean and tidy), SS (suggestion system) and QC circles must be understood from this viewpoint (Mr. Paibool).

8-1-2. Outlines of major routes for borrowing

The survey found a variety of routes to borrow technology (Table 8-6). What follows are major routes for borrowing:

(1) internal borrowing within the same company group (QIB),

(2) technical assistance (TA),

(3) technology diffusion,

(4) indigenous efforts.

Twenty Thai firms in the survey are classified into one of the above four categories according to their main borrowing routes. It does not mean that these firms use only one route. They use other routes at the same time.

Table 8-6 Technology source of the surveyed firms (local firms)

sources (routes)		firms' code numbers	no. of firms
Quasi Internal Borrowing (QIB)		2, 13, 15, 19	4
Technical Assistance (TA)		1, 7, 16, 17, 18	5
Diffusion	Spin-off	6, 9, 14	3
	Customer (subcontracting)	12	1
	JVs	3, 10	2
Indigenous efforts	Self learning	5, 8, 11,	3
	Reverse Engineering	4, 20	2
	total		20

Source: The author's survey

Before the analysis of the case studies below, the concepts of the routes for borrowing shown in Table 8-6 must be clarified.

(1) Quasi-internal borrowing (QIB)

All Japanese firms discussed in Chapter 7 are principally examples of TIB (borrowing from the holding company in Japan). However, some rely more on the parent enterprises in Thailand, e.g. the cases of QIB. BEW and Muramoto are good examples in that they acquired new technologies from the parent enterprises in Thailand. Whether it is a TIB or a QIB, whether the subsidiary in the host country is majority or minority owned, the borrowing is undertaken seriously both by the holding company and the expatriates abroad. As mentioned, the technology supplier does not have a capital stake in QIB, but the relationship between the technology supplier and recipient is tight. A strong tie is necessary from the viewpoint of the parent enterprise. Otherwise, the parent enterprise would be susceptible to the problems of defective products, low quality, late delivery, or high costs.

This strong relationship supported the development of the Japanese machine industry. However, it is a new experience in Thailand. Through this relationship, local firms are expected to acquire, not only new machines and documents, but also new technology and management concepts. In other words, transplanting the Japanese management concept on QCD is indispensable (J-6, 22, T-2, 17, 18).

(2) Technical assistance (TA)

Apart from TIB and QIB, there are also examples of technical assistance (TA) by foreign technical advisors. In this case, technical advisors are not sent by a parent enterprise or by a holding company. This is the case of an individual contract with independent technical advisors for a set period of time. It is often difficult for a Thai firm to find and employ technical advisors from overseas. This survey encountered cases where Japanese government schemes facilitate the finding of technical advisors for local firms. Requests for advisors are increasing because local firms now consider that technology is effectively learnt through human contacts and human stimulation. Learning-by-doing or learning from the public domain alone is no longer considered enough.

(3) Indirect technological diffusion

Spin-off enterprises, subcontracting and joint ventures diffuse technology.

(i) Spin-off means diffusion of technology by a person who has accumulated technology in a company, probably in a foreign subsidiary. After acquiring technology, he becomes an independent businessman; then he starts to spread technology independently.

(ii) Subcontracting is another route for diffusion. If a foreign subsidiary (or a local firm) subcontracts, and if it involves technical assistance, it also diffuses technology. Education by the subsidiary firm provides opportunities for local firms to get orders regularly. If the orders become regular, the relationship will become another parent-child relationship. However, it should be noted that *subcontracting* here is defined as a type of "diffusion", separately from *QIB*, because it is a second step of technology spread as illustrated below ("⇒" denotes teaching).

QIB (international relation):

a parent enterprise ⇒ a supplier (*shitauke*)

Subcontracting (domestic relation):

any technology source, QIB or TA → a firm in Thailand ⇒ another local firm

(iii) A JV becomes another route for diffusion. One example is a fully Thai owned firm (T-100), that established a Thai-Japanese JV (T-J). T-J acquires technology from the JV partner in Japan. Then, T-100 acquires technology from T-J of which technology was obtained from Japan through the JV. This is a diffusion of technology, a side effect or a by-product of the JV as shown below.

JV as a route for diffusion:

a technology supplier → a JV (T-J) ⇒ a technology recipient (T-100)

(4) Indigenous development efforts

Without direct contact with foreigners, some local firms make efforts to develop their technology. Learning-by-doing and learning from the public domain (publicly available sources) are sources for them. Overseas business trips organised by government agencies have also stimulated local firm's entrepreneurship.

T-4 (agricultural machinery) and T-20 (hydraulic machines) make machines by their own efforts. Their sources of technologies are the public domain and reverse engineering (imitation). Namely, they import one machine, and then dismantle and analyse it. After that, they design and plan the copy production. This seems to be the beginning of the indigenous technological development. In Thailand this activity is called "R&D version two" (Reproduction & Duplication).

Local firms do not consider these forms of learning ideal, but they have little choice. For many Thai firms, it is difficult to find JV partners even if many of them desire one. It is also difficult to get individual foreign advisors (TA). They have no personal relationship with foreign firms or foreign technical advisors. Some of the owners have sent their children to Japan or to Western countries for study. If their sons come back, it is hoped that they may help in getting foreign technical advisors through their human relationships and language ability.

At the end of this chapter, the comparison between different routes will be discussed. According to the observation, QIB showed the highest level of achievement. While, indigenous efforts without foreign contact showed the lowest level of achievement.

The next section will present the way the surveyed 20 firms are borrowing and technological levels they acquired.

8-2. The case of quasi-internal borrowing (QIB)

In the following case studies of QIB, the CH group, the SAS group and Thairung acquire technologies from Toyota, Mitsubishi or Isuzu. Although QIB is not based on capital relationship, these are the cases of a very tight relationship just as *shitauke* in Japan. Their learning is very serious and effective.

8-2-1. Considerable advancement through direct human contact

The CH group (T-2 and T-3) was founded by Mr. Chalit in 1968. It is composed of five radiator companies and managed by Mr. Chalit's family. Mr. Chalit, a Chinese immigrant, started a radiator workshop first by a partnership in the 1940s, and then in 1968 set up a new firm, CH Vatanayont (Phrakanong), separate from the partnership. CH Vatanayont began supplying radiators to Toyota Thailand in 1971 and to Thai Hino in 1972. In 1974, he set up a second factory at Samrongtai, T-2, with 35 employees to, expand the production capacity of radiators. T-2 has received technical assistance in radiator production from Nippon Denso Japan (an MNC of the Toyota group) since its establishment to the present.

The management of the group was shared by the founder's sons. The first son is the MD of T-2. The second son is the deputy MD of T-2 and in charge of the factory management. The fourth son, the general manager of T-2, graduated from a university in Japan and speaks Japanese fluently. He is the general manager of T-2. The third son educated in England is now in charge of the radiator making at CH Vatanayont and T-3.

A radiator is composed of tubes (brass, copper or aluminium), fins (copper or aluminium), core plates (copper), tanks (brass or plastics). Each part is manufactured separately, and put together, soldered to avoid leakage, and finally makes a radiator. As leakage becomes the most probable and frequent trouble in the future, it is tested twice in the case of T-3 before packaging. Work is divided amongst the group as follows:

- CH Vatanayont (established in 1968) is the oldest factory among the CH group and now specialises in radiators for after market service (spare parts).
- T-3 manufactures about 340 types of radiators (larger sizes) in a year by the batch production system, and the products are exported; 95% to the USA (e.g. Go/Dan Industry) and 5% to other countries.
- On the other hand, CH Watanayont (established in 1994) manufactures only 10 types of radiators (smaller sizes) for domestic market (for Toyota) by a mass production system using high quality dies and jigs under the Japanese QC system.

The CH group has received technical assistance continuously in radiator technology from Nippon Denso and in die making from TK Corporation (a Toyota supplier). Meanwhile, the CH group planned to manufacture radiator tanks from plastics. For this purpose, T-2 sent the factory manager and two key workers to Nippon Denso Japan for two years to be trained in plastic moulding.

(1) Training began in 1968. The technology acquired at that time must have been one of the lower levels.

(2) A new factory, T-2, was established in 1974 and received another wave of technical assistance from Nippon Denso.

(3) In 1985 TK Corporation began technical assistance in die making with T-2. Mr. Onouchi, was sent to Thailand. The plan was to obtain high level technologies including QC and other management concepts, which will be explained further in the following section.

(4) The establishment of CH Watanayont in 1994 is aimed at supplying radiators to Toyota. This involved another wave of technology transfer from Nippon Denso.

Technology levels are uneven across the plants of the CH group. The oldest factory (CH Vatanayont) has the oldest technology. T-3 has medium level technology for the US market. T-2 and CH Watanayont aim at the most advanced technologies. The unevenness is reasonable for the CH group which has a policy to supply different markets. That is the reason of adding new factories, while keeping the old factories as they were.

In 1985 Toyota decided to order stamping dies for its Kijan vehicles in Indonesia from three manufacturers in Thailand; (1) Thai Hino Industry, (2) Sammitr Motors Manufacturing and (3) T-2. Then, Toyota requested Toyota Auto Body to assist Sammitr Motors Manufacturing, and TK Corporation Japan to assist T-2. This was the start of TK Corporation's TA in die making with T-2. The construction of the die factory of T-2 was completed in 1987 under the supervision of TK Corporation.

While Toyota Auto Body sent three experts (die production control, die designing, machining and assembling) to Sammitr Motors Manufacturing, TK Corporation sent one expert (Mr. Onouchi) to T-2. T-2 is now capable of making stamping dies. In 1986 T-2 made its first shipment of Kijan. Since then T-2 has exported dies to Japan, Australia, China and Taiwan, for Toyota, Mazda or Honda.

Mr. Onouchi gave technical assistance to T-2 in the following ways:

(1) Manuals

First, Mr. Onouchi made die making manuals for T-2 using the manuals of TK Corporation and let the staff translate the manuals into Thai. Following the manuals, Thai workers drew designs. The chief of the designing section was trained at TK Corporation in Japan. Machining and finishing processes follow the drawing of die designs. He made manuals for machining and finishing as well.

(2) QC

From 1985 Mr. Onouchi started QC and *kaizen* (a suggestion system for technical improvement by employees). For example, the number of *kaizen* suggestions in 1993 at the die section alone reached nearly 200.

(3) Equipment

Stimulated by the expanding car market in Thailand, T-2 made capital investment in machines such as press machines (second-hand in 1988), NC milling machines (1989-90), a welding robot (1992), CAD (1988), CAM (1992), Toyota K Ram (a software for die making, 1994).

(4) Technical training

Since 1990 T-2 has been regularly sending trainees to TK Corporation in Japan; 6-8 persons for three months each year. They are learning the technologies of NC machine operations, the machine tools maintenance and process control. On the other hand, since 1985, TK Corporation has been sending technical experts to T-2 for a 3-6 month period every year. At present two technical experts, one for die making and the other for press work, remain at T-2.

The recent development of die making technology in T-2 is marvellous. T-2 has eight CAD computers and eight CAM computers; among eight CAM computers two are for the Toyota K Ram programme. CAD is for drawing die designs by computer. Staff are able to make die designs depending on the data accumulated in the computer. CAM is to make the NC data for die making. K Ram is the system used for Toyota car manufacturing. Therefore, if T-2 receives orders from Toyota by way of K Ram data, T-2 can manufacture dies for Toyota cars by using NC machines directly from the data given by Toyota. It is not necessary to draw designs or make master models or blind face models which are indispensable for the traditional mould making process. However, it should be noted that, although T-2's machines are new, the management concept is still in the style of an old family business. The financial status of the group is not disclosed to the employees. Therefore, it is far from the employees' participation. The scoring of technology levels by Mr. Onouchi is not high.

From 1985 to 1990 Mr. Onouchi worked for T-2. In 1990 he retired from TK Corporation to become an employee of T-2. Mr. Onouchi devoted his last years to the die shop of T-2. Mr. Onouchi and his wife live at Mr. Verasak's house, the fourth son of the founder, who graduated from a university in Japan. Mr. Onouchi is thus accepted as a family member by Mr. Chalit's family.

8-2-2. Teaching based on long established mutual trust

The SAS group was founded by Mr. Sunsurn, a Chinese immigrant's son. He started business as a street vendor. The group is now composed of eight brother companies including

SAS (T-15) and SAB (T-13). The total number of employees of these eight companies is nearly 10,000. The Japanese automobile industry supported this remarkable growth. This section treats the borrowing at T-15 and T-13. This case is a typical example of QIB. The relationship stands on strong mutual trust as if they were a parent and a child or *shitauke* in Japan.

T-15 was set up at Yanawa in 1972 with about 100 employees. T-15 then made auto seats and door panels for Hino trucks. T-15 grew to a company of 300 employees in 1978. At the survey time (1995), T-15 had nearly 1,700 employees and three factories:

- Yanawa (945 persons) for the poly-urethane-foam plant, seat cutting and sawing, door panels, seat slides;
- Bangplee (525 persons, set up in 1991) for seat assembly; and
- Kingkaew (269 persons, set up in 1993) for sun visors, seat belts, head linings and under fenders.

The interviewee made the following three points as the main driving force of the firm's development. (1) the support of customers (and good service to customers), (2) the owner's strong interest in the technical problems of customers and the wish to develop technical capability in order to meet the customers' problems, and (3) the government policies to support local industries such as BOI tax exemptions and reductions.

The history of the firm shows that the founder earnestly and laboriously absorbed technologies from foreign firms, especially from Japanese firms. What follows are selected examples of technology agreements of the SAS group since its establishment (Table 8-7).

In 1973, soon after the establishment of T-15, Mr. Namba (now 75 years old) visited Thailand. He was introduced to Mr. Sunsurn (now 53 years old) by United Development Motor Industry (UDMI, the former name of MMC Sithipon Co., Ltd.). They became good friends. Mr. Namba began giving technical advice to Mr. Sunsurn as a friend. Mr. Sunsurn once explained that Mr. Namba's technical assistance had been more than a business agreement, and had been more like the relationship between a school teacher and a pupil, or a father and a son. Mr. Namba was an excellent instructor and Mr. Sunsurn a diligent apprentice. Mr. Sunsurn says that Mr. Namba taught him everything.[108]

Table 8-7 History of borrowing at the SAS group

	borrowed technology	technology supplier
1973	auto seats	Namba Press Co., Ltd.
1976	seat reclining mechanism	Imasen Electric Industrial Co., Ltd.
1979	window regulators	Imasen Electric Industrial Co., Ltd.
1980	the Taumel type seat reclining mechanism	Keiper Recaro GMBH
1981	sun visors	GEBR Happich GMBH
1985	seat belt exhaust system	Takata Corporation J. Eberspacher
1986	stamping dies (SAB)	Mitsubishi Motors Corporation
1987	auto seats and moulded foam seat slides exhaust and muffler systems door panels	Namba Press Co., Ltd. Imasen Electric Industrial Co., Ltd. Sankei Industry Co., Ltd. Suiryo Plastics Co., Ltd.
1994	jeep seats for Chrysler door sashes	Johnson Control Inc. USA Shiroki Corporation

Source: SAS

In 1976, following technical assistance from Namba Press, Mr. Sunsurn concluded a technology agreement with Imasen to receive technical assistance for the seat reclining mechanism. In 1994, T-15 received the order for jeep seats from Thai Chrysler. As the original design for the jeep seat was made by Johnson Control Inc., T-15 had to make the license agreement with Johnson Control Inc. for this production. Because T-15 was already capable of making auto seats, this agreement was more like a patent agreement. Johnson Control Inc. will provide drawings and technical assistance upon request. Also in 1994, another license agreement was concluded with Shiroki Corporation in Japan to obtain technologies for door sash, including cold roll forming. T-15 was importing door sashes from Japan and assembled them into complete door panels in Thailand. This license agreement was to replace the import with the in-house production. Shiroki Corporation is a noted sash supplier in Japan which supplies to Toyota and Mitsubishi.

The above observations demonstrate that there are two types of license agreements. One is to acquire new technologies (technology type) and the other is to buy patents or brands (patent type). Sometimes a license agreement brings in drawings, technical experts, technical training and manuals, and in some other cases it brings in only patents and brands, not manufacturing technology. Western technologies today are more likely to be transferred as patents, while Japanese technologies are in the form of QIB or TA. Mr. Sunsurn emphasised that the firm's development owes much to Japanese assistance.

In 1986, Mr. Sunsurn established T-13 to concentrate on stamping and auto body assembly. The staff and production lines were separated from T-15. Its main products are pick-ups (small size) and large size trucks for MMC (Mitsubishi) Thailand. T-13 is an indispensable supplier (*shitauke*) of MMC. MMC had three alternatives to (i) foster a local supplier, (ii) let a Japanese subcontractor invest or (iii) invest by itself. For Mitsubishi it was a big decision to expand its capacity in Thailand depending on a local supplier which was then at a very low level of technology. At the same time, it was also a big decision for the SAS group to invest. This is really a parent-child relationship similar to the subcontracting system in Japan.

MMC first provided technical assistance to T-15 in stamping in the middle of the 1980s. Mitsubishi sent two or three technical experts to T-15. As a result, the production lines of T-15 achieved considerable progress with their assistance in the middle of the 1980s, when the author visited the factory a few times. At present there are five Mitsubishi technical experts at T-13.

8-2-3. Efforts towards independent R&D

This is the case of borrowing from Isuzu. In 1960 Thairung (T-19) was established by Mr. Vichien, a Chinese immigrant, now aged over 80. Initially, the firm was established as a major dealer of Isuzu. It then started manufacturing pick-up trucks in 1967. Since then T-19 has developed to a car manufacturer with design and assembling capability although it depends on Isuzu's technology. T-19 now manufactures double-cab pick-ups and station wagons. The manufactured cars are sold through Tripetch Isuzu under the brand name of Isuzu.

At present Mr. Vichien's wife is the managing director of the company. They have three children. The first son was educated at Keio University in Japan, the second in Australia and the third in the UK. With sons educated in Japan and Western countries, the family is ready to acquire further technologies globally. Recently, T-19 started learning Isuzu Production Systems (IPS, similar to JIT in Toyota) and the 5S activity around 1988.

Through orders from Isuzu, T-19 has accumulated technical capability and now has a small R&D group in the engineering section. Furthermore, with the introduction of a digitiser in 1990, T-19 changed its method of die making. In order to achieve this improvement, T-19 has been getting technical assistance in die making from Shatai Kogyo (auto body maker in Japan) and Isuzu (Fujisawa plant in Japan). For example, six workers were trained in Japan for 2 to 6 months studying die designing, die making and stamping technologies. At present, the engineering section has 15 designers, 40 R&D staff, with 3 work stations and 2 PCs for CAD/CAM. The engineering section of T-19 first introduced the CAD/CAM system in 1992. Staff are learning manual drawing of designs and some are learning to operate CAD/CAM.

Having its own R&D group, T-19 has developed a station wagon by itself and put it into the domestic market from 1989. It is claimed that this station wagon is the first car developed by a Thai company. However, the chassis, the wind shield, the engine and the transmission come from Isuzu. T-19 designed the whole body and the inside except the chassis, windshield and engine parts. The cars are sold under Isuzu brand through Isuzu's channels.

In order to improve the quality, T-19 had Isuzu Technical Center Thailand (ITCT) check the station wagon for durability in 1993. Following the test results (the recommendations), the manufacturing processes such as the dies and jigs were corrected to decrease the weakness and to strengthen the durability. The minor errors in the size of mating parts, the pipe setting, the positioning of fuel tank were also corrected.

It is true that Japanese firms such as Isuzu came to Thailand for their own interests, but it is also true that technological development of Thai auto parts manufacturers such as T-19 has strongly been supported by Isuzu or other Japanese firms. The staff of T-19 now has a strong wish and potential for developing their own cars although the present situation is still far from independent R&D. Nevertheless, this case presents that QIB has truly been an efficient way of technology development for Thai firms.

8-3. The case of technical assistance (TA)

TA is often provided outside a parent-child relationship. BPS (T-1), MAP (T-7), Siam Technic (T-16), SNF (T-17) and TEP (T-18) are examples of this type of TA. They took actions actively or by good luck to obtain TA from Japan.

The case of T-1 is an example of borrowing technologies from a Japanese (virtual) immigrant who lives in Thailand extending working visas repeatedly. T-1 developed the manufacturing technologies relying on Mr. Nishida who had been working for T-1 since 1983. The case of T-7 is also an example of borrowing from Japan. The MD of T-7 graduated from a Japanese university, and trained in Japanese factories. T-7 concluded technology agreements and JVs with Japanese firms. The other three firms also borrow technology from Japan.

8-3-1. Immigrant type

Mr. Nishida, a Japanese expert at T-1, worked in Thailand for more than ten years and further wished to devote his life to Thailand. The case is called an immigrant type.

T-1 has been a dealer in silicon steel coils. It began as a partnership in 1974 and changed its legal status to a company in 1981. In 1983, T-1 employed a Japanese die specialist, Mr. Nishida. As the founders (MD and assistant MD) were both traders and had no technology in die making, Mr. Nishida played a great role in the development of manufacturing technologies at T-1. T-1 started diversifying into die making with Mr. Nishda's assistance. At present, T-1 has become a competent manufacturer with three production lines:

(1) slitting machines for silicon coil (14 machines);

(2) punching machines for silicon cores (37 machines);

(3) machine tools for die making.

When Mr. Nishida was working for a die maker in Osaka (Ikedakogyo), he met the MD of T-1. They became good friends at that time. Mr. Nishida later started a restaurant business but failed. When he became unemployed, the MD of T-1 invited him to come and work for T-1. Mr. Nishida's start was based on a friendship, not a legal contract. T-1 was lucky because

Mr. Nishida proved that he was a skilled technician in slitting and die making of tungsten carbide steel.

The die making section of T-1 was started by Mr. Nishida in 1983. At first Mr. Nishida drew designs and subcontracted the making of dies from local die makers. However, the result was not satisfactory. Therefore, Mr. Nishida began making dies by himself at T-1. Four years later T-1 had achieved the grade of making dies sufficient to supply for Japanese customers.

The increase in FDI after 1985 brought better opportunities. At first, T-1 succeeded in receiving orders of die making and stamping of silicon cores (EI cores and motor cores) from Thai Tabuchi Electric. Thai Tabuchi Electric (established in 1987) makes power supplies and transformers. Silicon cores are the main parts of power supplies and transformers. In addition, there were many new investments from Japan in the late 1980s. T-1 received orders from these newcomers. For example, T-1 received orders of slitting and stamping from Melco Consumer Products Co., Ltd. (1989), Toshiba Consumer Products Co., Ltd. (1989), Hitachi Consumer Products Ltd. (1970), Sharp Appliances Ltd. (1987), Minebea Thai Ltd. (1981). In these cases of stamping, dies are normally supplied by customers.

Making stamping dies of tungsten carbide material needs a special technology because tungsten carbide is exceptionally hard and the die making requires great precision. Silicon steel has a natural bending nature so that the die is called a "freak die" (Mr. Nishida). Furthermore, in the case of EI core making, the die must be designed to produce no scrap portions when the silicon steel is cut into EI cores. Mr. Nishida has trained five designers in the past 12 years at T-1, but they all left. At present T-1 has only Mr. Nishida and another half trained designer. This is a difficult problem to solve in Thailand. In Mr. Nishida's opinion, the only way to keep the trained person in the company is to train a family member or a relative of the owner.

According to Mr. Nishida, the technology level of T-1 in die making is higher than normal core makers in Japan. Mr. Nishida estimates, there are about 500 core makers in Japan. They have no grasp of the technology of die making because core makers and die makers are separate there. In Thailand, however, there were no die makers for tungsten carbide materials prior to 1983. Thus, being a core maker, T-1 had to learn making tungsten carbide dies by itself. In that sense, T-1 has a higher technology than the normal core makers in Japan.

The technology level of slitting is also high enough to supply the products to Japanese manufacturers in Thailand. In addition to Mr. Nishida, T-1 has obtained the technical assistance of a Japanese expert for the slitting technology since 1993 through the Japan Overseas Development Corporation (JODC). Mr. Nishida was also approved as a JODC expert from 1993. JODC operates a scheme to subsidise the expenditure for a private company to have technical assistants from Japan. Mr. Nishida devoted ten years to a Thai firm. However, he is not yet sure whether there are local staff who could carry on his technological capability without him.

8-3-2. Relay type

In the following cases, technical assistance was provided by Japanese firms outside a customer-supplier relationship. Japanese firms sent different technical experts by turn and received trainees in Japan upon request according to necessity.

The first is the case of Mahajak Autoparts (T-7), a company of the Mahajak group which originated as a hardware trading firm in 1958, and expanded its business to manufacturing of nuts and bolts for construction in 1969. The Mahajak group is keen on the introduction of technologies from foreign countries and has JVs with Japan and Korea as follows:

- Mahajak International Electric Co., Ltd. (Fuji Denki Japan 20%, Gold Star Korea 20%, Mahajak 80%) in 1979,
- MHI Mahajak Air Conditioners Co., Ltd. (Mitsubishi Heavy Industry 51%, Mahajak 49%) in 1988,
- Mahajak Fuji Technology Co., Ltd. (Ryokami Fuji Co., Ltd. Japan 45%, Mahajak 55%) in 1991.

Apart from the above JVs, T-7 was set up as a fully owned firm of the group in 1989 to diversify into auto parts (nuts and bolts). Making of nuts and bolts requires technology in forging (cold forming), heat treatment and electroplating. The MD, a son of the founder of the Mahajak group, Mr. Chalum, studied chemical engineering at a university in Osaka. Later he studied heat treatment technology for a year at Oriental Engineering in Japan. However, the technology in hand was not good enough for auto parts. The firm sought technical assistance through Mr. Chalum's channels. So far, the firm has concluded the following technology agreements:

(1) Tonantanko Co., Ltd. at Yamato-shi, Kanagawa (forging)

(2) Jidosha Buhin Kogyo (quality assurance and 5S)

(3) Shinko Bolt Industry Co., Ltd. at Funabashi-shi, Chiba (bolt)

(4) Kobe Seiko Co., Ltd. (production management)

T-7 was newly designed with new machines. But the technology level of workers is low because they are new and young. The average age of workers is about 25 years old and their educational background is mostly just primary school. J-7 sent five persons to a Japanese SMI, Tonantanko, for six month training and Japanese experts came from Tonantanko to continue OJT for short periods. The first contract with Tonantanko was for five years from 1990 to 1995 and a further extension is in process. Furthermore, from 1995, the firm has a technical expert on production management from Kobe Seiko under the scheme of JODC. The firm is thus very keen on acquiring technology from Japan.

Although the firm is keen on learning Japanese technology including Japanese management concepts, the task is not so easy. T-7 started the operation in 1991 with 50 workers. The general manager (Mr. Prason) joined the firm to assist the new plant. The management policy proposed by the owners (the president and the MD Mr. Chalum) to the general manager was to make a new style of firm with newly recruited employees. The general manager studied civil engineering at Chulalongkorn University, and then worked for government agencies and for the Siam Cement group (1 year). His background is excellent.

First of all, the firm tried to make the shop floor clean to prepare good working conditions for workers. The canteen was designed to have a modern image with a seven million baht budget. It was a big change from the dirty eating place more common in Thai factories. As for the management system, the general manager proposed a pyramid style structure of responsibilities and Japanese style motivation systems (5S, Safety First, QC circle, Suggestion System, *kaizen*) drawing on his past experience. Probably, a pyramid style structure is necessary to construct order and discipline. However, the Japanese management system which he proposes is "bottom-up participation", not a top-down management. From the viewpoint of Japanese experts, there is a difference between a pyramid style top-down management and the Japanese motivation system.

Machines in the factory are quite modern and advanced. They are mostly imported from Japan or Germany except the four electroplating lines from Taiwan and Hong Kong. However, the machines are not fully operated. The machine utilisation is around 50% (Table 8-8).

Table 8-8 Forging performance of Mahajak Autoparts and its technology supplier

	performance	capacity
Tonantanko (technology supplier)	3000 tons / month	n.a.
Mahajak Autoparts	120 tons / month	240 tons / month

Source: Mahajak Autoparts

Although the firm has orders in hand, shops are often unable to keep to the delivery times. The efficiency of workers is not satisfactory. According to the general manager, if the technology level of the firm is compared with that of Japanese factories, the firm's level should be rated half of the Japanese level. Firstly, the educational background of workers is lower than in Japan and they lack a basic knowledge of industry. Secondly, the history of the firm itself is shorter than Tonantanko which has more than 50 years experience in the hard competition of Japan. Thirdly, the workers' accumulated technology is not yet very great because the firm was only established in 1989.

The management group of the firm is, nevertheless, trying hard to catch-up with the technology level of Japan. While the industries in Japan were declining, Thai industries grew rapidly. Supported by this favourable economic environment, T-7 invested in the production lines every year in the past. So far, the firm achieved the target every year. The case of T-7, borrowing technology by means of TA, shows Thai entrepreneurs' aggressive efforts to learn foreign technology. It also shows Thailand's potential and hope for the future. TA from Japan has become easier than before due to the increased flow of information and the support of the Japanese and Thai governments (e.g. JODC). That will further accelerate the speed of technological development in Thailand.

The next case of the relay type TA is T-16, a firm which engages in forging auto parts and agricultural machinery parts. T-16 was established in 1977 to produce connecting rods (tei rod ends and eye links) for the spare parts market, mainly for agricultural machinery. Around 1986 this firm faced a crisis because of many rejects by customers due to the low quality of the products.[109] When Mr. Sama, the plant manager, entered the firm in 1986 to assist its restructuring, it was producing only 18 tons a month losing money.

As a plant manager, Mr. Sama started to learn forging technology by reading English books. At the same time, he fired the workers in the firm to replace them with newly recruited employees. He tried to improve the forging process little by little. In 1986, Mr. Sama visited Japan to study technology in Japan and encountered a Japanese SMI (Shimizu Iron) in Tokyo. Since then, T-16 has received technical assistance from Shimizu Iron. Shimizu Iron has been sending advisors every year to give advice although the period of stay is short.

Experts from Shimizu Iron gave advice on improving the shop floor. One example of the improvement is the decrease of the number of workers at each process (e. g. from 7 to 5 persons). The firm developed a belt conveyer system by in-house activity. The quality of the products is checked by five members of the QC section. Productivity increased from 18 tons a month in 1986 to 250-300 tons a month in 1994.

Comparing the Japanese machines with German machines, Mr. Sama says that German machines are tougher and longer lasting than the Japanese ones. The firm has German, not Japanese, forging machines. Nevertheless, the firm is learning technologies from Japan. He believes that Japan has the most advanced manufacturing and management technologies. He thinks the firm may be able to catch-up with Japanese firms if advisors come and teach. Otherwise, the firm will never catch-up with Japan in technology.

The firm supplies 65% of the sales amount to OEM customers such as Thai Engineering Products (axle parts for ten-wheels trucks), Koyo Manufacturing Thailand (spiders), Nakatan Thailand (under-brackets for motorcycles). The other 35% are supplied to the spare parts market. The forging section has 40 employees, with four forging hammers (0.75 - 2.0 tons), two eccentric presses (100 tons and 150 tons) and four oil furnaces. The die making section has 28 members of staff, with an EDM, copy milling machines (5 units), milling machines (3 units), shapers, lathes, drilling, and grinding machines. Most of the machines are new machines replaced in 1993. The firm's recent growth was greatly supported by orders from the increased Japanese FDI since the late 1980s.

The last case of the relay type TA is three firms in the Siam Cement group. The Siam Cement group is composed of 35 subsidiaries and 33 associated firms (in 1993). T-17, T-18 and T-10 belong to the Siam Cement group.

The first foundry workshop of the group was established as a division in Siam Iron and Steel Co., Ltd. in 1966. Later the foundry division was split to make a new firm, T-17, in 1977. Then, the group established T-18 in 1985 and T-10 in 1990 to expand the capacity of the group. T-10 is the second foundry to follow T-17. On the other hand, T-18 is the factory to process the machining and finishing of the cast products produced by T-17 and T-10.

For the operation of the foundry workshop, at first, the Siam Cement group received technical assistance from a Danish company (F. L. Smidth & Co.) from 1942. Later the Siam Cement group received technical assistance in steel casting for big cement machines from Warder, Denmark, in 1965. Some foundry men were sent to Denmark for training. However, the transferred technology was not maintained or upgraded. Worse, the transferred technology soon deteriorated and faded out. From 1978, T-17 started the manufacturing of casting parts for Siam Kubota Industry (SKI) which was set up in 1978 to manufacture diesel engines for agricultural machines. At first SKI tried to start the casting of parts for diesel engines by itself. However, it suffered from a very high defect ratio.[110]

After receiving technical assistance from Aishin Takaoka, T-17 successfully achieved technical change from job shopping production to a batch production system, and, as a consequence, improved productivity in a great deal. At the same time the material/method was changed from iron cast to ductile iron cast. T-17 started receiving technical assistance not only from Aishin Takaoka (general technology) but also from IHI (general technology), Kubota (flywheel, crank shaft), Hino and Isuzu, although assistance had been obtained piecemeal. For training, some workers were sent to Japan and in turn some experts came to Thailand for a short period (from two weeks to one month on average). For example, the plant manager of T-10 was sent to IHI for two months and to Kubota. In 1994, T-17 made an agreement to receive technical assistance in full scale for the coming five years, not in a piecemeal fashion as in the past. This policy change complies with the TQC activity of the Siam Cement group initiated in 1993.

From 1993 the Siam Cement group started TQC activity. The group requested Dr. Kano (University of Tokyo Rika, a student of Dr. Ishikawa) to train the senior staff of the group. Komatsu Career Creation Co., Ltd. (KCC) is also working for the training in accordance with the team of Dr. Kano. In 1994 six Japanese experts came to T-17 twice, each time for two months. At the survey time (early 1995) it was reported that in 1995 about 12 to 15 Japanese experts were supposed to come to T-17 twice, each time for two months. From 1996 to 1999 two or three Japanese experts are to stay at T-17. Concerning the TQC activity at the Siam Cement group, Mr. Inoue[111] emphasised that the most critical point for Thai people to recognise is that TQC is not an idea for top-down management but rather for bottom-up management.

8-4. The case of diffusion

8-4-1. Spin-off

Many spin-off entrepreneurs are found in the survey. They acquired technologies through their working experience and then became independent. Most of them were trained in Japanese firms, either in Thailand or in Japan. Because they understand Japanese businesses and have many friends in Japanese firms, they are likely to receive orders from Japanese firms.

T-14 is a die and press specialist with 65 employees. Mr. Prasertsilp, the MD of T-14, had worked at Isuzu for 17 years from 1973 to 1990. Then, he established his own factory in 1990 with his working experience. He was born to a farmer's family at Ubon, north-eastern Thailand, and educated at a technical high school (MS6) at Ubon and then at a technical college (diploma) in Bangkok. In 1973 he began working at Isuzu. Isuzu sent him to Japan for seven months, two months for Japanese language and five for technical training. Since 1977, he had worked at the die making and press section of Isuzu and accumulated experience and technology of die and press work. He mentioned that he knew most of the people in the die sections of automobile firms such as Isuzu, Summitr Motors Manufacturing, SAB and Thairung. He has established two more factories other than T-14. One is a factory for CNC lathe process (6 CNC lathe machines and 24 employees at Thonburi). The other is a factory for pressed parts for air conditioners at Cholburi.

Because he is capable of making designs for moulds and dies due to his 17 years of working experience, he himself trains all his staff. Two are now capable of designing moulds and dies at his firm. The firm is busy with orders and completes about five or six dies every month, spending two or three months for one die on average. However, in order to deal with these orders in time his firm needs to improve design capability. Recently his firm bought two CADs and a CAM. Therefore, the process will proceed as follows.

Drawing $\Rightarrow$ 2 CADs $\Rightarrow$ 1 CAM $\Rightarrow$ 3 CNCs

Staff are being trained by outside specialists (local software companies) to operate these CAD/CAM computers. Because he speaks Thai, English and Japanese and his wife speaks Chinese, his firm is able to speak with customers from a variety of countries.

The MD assesses the technology level of his firm to be around 5 point. He, however, thinks that his firm is able to improve the technology level to 7 or 8 points in three years or so. Production control including stock control is already computerised. He believes that his firm would be able to upgrade the production control technology in the near future.

For the training of his working staff, he allocates 100,000 baht each year. He sends staff to seminars by MIDI and the Technology Promotion Association (TPA). His firm lacks design staff because of the firm's short history. The training at institutes is not adequate for real business. Secondly, in Thailand, the lot size of orders are very small. Therefore, the firm cannot invest in expensive new machines to improve efficiency and productivity. In Japan an order exceeds 100,000 while in Thailand an order is only thousands.

The next is the case of T-6, a mould and die maker of 50 employees. In 1978, Thai Kawasaki (established in 1966, 100% Thai owned) established a die maintenance section composed of four persons, where the MD of T-6 (Mr. Banpot) was the chief of the section from the beginning. Mr. Banpot and his staff were trained as the staff of Thai Kawasaki and received technical training in mould making. In the late 1980s, mould and die making orders had increased so much that Thai Kawasaki split the die section to make it an independent die and tool factory in 1990. That is the start of T-6. T-6 received technical assistance from Tatsuno Chemical in Kobe when it was still a section of Thai Kawasaki.

T-6 makes injection moulds and aluminium die cast moulds for motorcycles (e.g. dust covers), sanitary units (toilet lids) or chairs (seat parts made of plastics). The largest customer is Thai Kawasaki. T-6 is equipped with modern machines necessary for mould making of high quality injection moulds and aluminium die casts. There are two designers, excluding the MD who is also capable of drawing designs. From 1985 to 1988, ten people were trained in Japan for one or two months each. Among the trained ten staff, eight still remain with the firm. This is a very low training loss ratio. The low ratio probably comes from the split of the firm from Thai Kawasaki. The new company is small and has to stand on its own feet. All staff are conscious that the future of the firm is in their hands.

The firm installed Japanese machine tools because it received technical assistance from Japan. It was convenient for the staff to handle the machine tools with which they had become familiar through the training. Probably the staff received good training. However, technological development depends greatly on the customers' requirement. It seems that the customers have not demanded high technologies from this firm, and, thus far, the firm has failed to push up the technology level.

Although a few Japanese customers are seen in the customer list, the main customers are local Thai firms including Thai Kawasaki. The final products of moulds are chairs, sanitary units and dust covers. Therefore, it could be said that the technological level needed for this factory is not so high as that of engineering plastics. Design capability is also at a low level, but it is enough for the local market.

Due to the nature of the mould making job, it is difficult to predict exactly the processing time for each manufacturing job. The firm often delays the expected delivery time. Another problem it faces is the difficulty in catching-up with the rapid changes in models. This is a very difficult job for Thai local firms. The MD argues that the Thai local market is so small that T-6 has to take any orders coming, and cannot select jobs. In contrast, the market in Japan is so large that firms are specialised in specific fields. Therefore, a mould maker in Japan has already grown up as a specialist, and has been able to deepen their technologies in each of their specific fields. It is true that Thai companies have also accumulated their technologies through experience, but their opportunities for technological development are limited compared to those of Japanese companies.

T-9, a mould base maker, is also a case of spin-off. Mr. Verasak, the MD of T-9, worked for a Japanese firm in Thailand and was trained in Japan. He established T-9 with his working experience at a Japanese firm. The MD's father was a dealer of plastic injection machinery. Two sons, the MD and his brother, helped their father when they were young. Later the MD worked for Kawaguchi Co. in Thailand (two years of office work in Thailand, three years of training in Japan, five years of factory work in Thailand). Upon the death of the father in 1986, the two sons inherited the business and set up a trading company with the assets of the father's company.

In 1990, the MD set up a JV with a Japanese company from Kakegawa, Shizuoka. As the products of the JV were for the international market, not for the domestic market, the MD established a new factory, T-9, for the domestic market in 1994. T-9 produces guide pins and guide bushes for moulds, of which technology was acquired at the JV by the MD. The largest customer is Srithai Miyagawa (8%). T-9 has 17 employees including three vocational-school-graduates. They are not trained yet. Machines are newly bought and expensive, two CNC injection machines of Mori Seiki and a Toshiba grinding machine. The seller of the machines, Yamazen Co., Ltd. a top class Japanese machine tools dealer in Bangkok, gives training and maintenance service.

J-16, an anker bolts manufacturer earlier mentioned, also introduced an example of technology diffusion by spin-off. Among three engineers (university graduates) employed by J-16, an engineer quit the firm and started his own business making bolts and nails. The number of employees of the spin-off firm is about 50.

8-4-2. Sub-contracting

Metalworking jobs are likely to be subcontracted and tend to produce spin-off entrepreneurs. In the case of J-1 and J-8, the firms subcontract to spin-off entrepreneurs who used to work for the firms. Another two firms subcontract to local firms. What follows are examples of the diffusion of technologies by subcontracting from FDI to local people.

In the case of J-1, subcontracting started when the government changed its policy. As the government banned the J-1's operation of the electroplating to stop the emission of pollution, J-1 helped the electroplating section become an independent local firm in 1967. The chief of the electroplating section started a small firm (EZP Co., Ltd.) and became a subcontractor to J-1. The owner of the subcontracting firm was one of the first 50 trainees sent to Japan. President Aoyama says that EZP has been achieving satisfactory results in the past 20 years.

In the case of the machining process at J-8, a worker who received training in Japan wanted to start his own business. He now has a factory of 10 workers. J-8 subcontracts the machining of brass rods to his factory. J-16 subcontracts the heat treatment and die making processes. In the case of the subcontracting to the local firm (a Taiwanese capital), the treatment data are provided and the process is controlled by J-16's specification. Heat treatment technology was transferred to Taiwan from Japan, and then from Taiwan to Thailand via a Japanese firm as explained in the previous chapter. J-16 also subcontracts die making locally—to Japanese subsidiaries and to Thai firms. In the case of J-22, the machining section had a problem of continuous job hopping. Therefore, the firm decided to subcontract the machining process to three or four local firms. These are all cases of technological diffusion.

8-4-3. Joint ventures

Among the 23 Japanese subsidiary firms in this survey, 16 firms are Thai-Japanese JVs, and among 20 Thai firms, one firm is a Thai-Japanese JV (Table A-1, Table A-3). From the viewpoint of local partners, these JVs are means of acquiring technology. Firstly, the JV itself is the subject which acquires technology. Secondly, the JV is a route through which technology is acquired. In the latter case, the final technology users can be any firm or person other than the JV. This section will introduce a case of the former—JV as a technology recipient (the cases of J-18) and a case of the latter—a JV as a route for technology diffusion (T-17).

At the establishment of J-18, the acquisition of a new technology looked so easy that the Thai side maintained management responsibility. However, the acquisition of technology proved to be very difficult and the JV became unprofitable. Consequently, the technology supplier invested an additional amount of capital and took over the management and technology responsibility afterwards. In most cases in this survey, Thai JVs with Japanese capital let the Japanese side take the whole management responsibility. The details will be reported in the next chapter.

T-17 is a JV with a Japanese firm, while T-10 is a 100 per cent Thai owned firm. Both T-17 and T-10 are owned by the Siam Cement group. Therefore, technologies acquired in the left hand (T-17) may possibly be transferred to the right hand (T-10). For example, before the start of T-10, about 90 young people were newly recruited and trained at T-17 where the technology was provided from Japan. When the training was completed, the plant manager and two senior technicians were transferred to lead T-10's operation. The R&D section of 20 members at T-17 covers the technology issues both of T-17 and T-10 at the same time. This is a way to absorb technology through a JV. As explained, T-9 is also in the same position in which T-9 absorbs technology from a separate JV with Japan.

8-5. The case of indigenous development

Lardkrabang Tools and Die (T-5), Mana Lohakij (T-8), CMT (T-4) and TMC Industry (T-20) are cases of indigenous development of technology. They all work hard to upgrade their technological capability. They are gradually recognising that the time to work with foreign firms is coming.

8-5-1. Learning-by-doing

T-5 is a case of "learning-by-doing", indigenous technological development. A Chinese immigrant started a trading business in agricultural products. The immigrant's son, Mr. Tanapol, the MD of T-5, was also in the same business and in 1971 established a factory to make agricultural machinery with several simple press machines. Later, in 1991, stimulated by MIDI's technical training and seminars, the MD decided to set up a separate factory for tools and dies making. The MD visited many factories in Thailand and in Japan, and observed how they were operated in order to collect data for the design of his tools and dies factory. This factory is a typical case of learning-by-doing as shown below.

The firm invested in equipment, a mixture of second hand and new machines, a CNC lathe, a W/C EDM, an MC and a CAD. However, due to the lack of experience and the lack of skilled technical staff, the managerial and technical capability of the firm is still low. The design capability of the firm is especially weak. In addition, the flow of production lines lags behind the scheduled time. The firm is very often unable to complete the products in the requested delivery time.

The MD recognises that his firm has to improve the management system of production. The high turnover of workers and the delays in delivery time must be improved. T-5's staff, especially university graduates, do not have discipline. University graduate engineers do not want to go down to the shop floor and are lazy in learning manual tasks. Once the MD is away from the factory, the workers stop working hard and the manufacturing process slows.

The number of employees was 42 at the time of the survey. The MD confessed that this firm faces a serious problem of a high staff turnover. For example, in 1993 ten workers resigned and in 1994 four resigned. Consequently, this firm has to train newly employed workers continuously. For a small-sized firm like this, the recruitment of new workers is not easy. It recruits young workers mostly from the Northeast region and provides them with a dormitory. But the salaries are not high enough to keep workers. They prefer working with famous big companies like SONY or Toshiba. As the firm has difficulty in recruiting and keeping technical staff, it organises training courses in order to recruit new workers. The course comprises five days training. The trainees are usually young people who have finished nine years of compulsory education. These trainees are paid 60 or 70 baht (US$ 2-3) a day. If some of them wish to work in the firm, they are welcomed.

In addition to the above training courses, the firm uses outside training courses for the improvement of the staff's technological capability. Firstly, the firm sends staff to training courses by MIDI, TPA and the Thai Tool and Die Industry Association. The firm also sends the staff on study tours organised by these organisations. However, these courses alone do not suffice. The technology level will never reach that of Japanese firms if firms rely on this training alone. Recognising these drawbacks, the MD sought a technical advisor through JODC. At the survey time (the end of 1994) he said he was expecting an advisor from Japan in 1995.

T-11, a mould maker, is the second case of "learning-by-doing" and at the same time an example of a "spin-off". Mr. Prasit, the MD, developed his technology by self-learning at foreign firms during the age of 16 to 22. He thus accumulated knowledge and experience in mould making at four firms.

- A Thai firm, Imperial Thai Toys, for 2 years;
- A Hong Kong firm, Ying Mee, for 1 year;
- A Taiwanese firm, Power Mould, for 1 year;
- A Japanese firm, Bandai, for 2 years.

After that, in 1991, at the age of 22, he established a small injection mould shop at Sukhumvit with his father's financial assistance. His firm has 12 employees, seven for mould making and five for injection. The firm works for 15 customers, among which are two Japanese firms. Examples are a part for electric fans (cores), a part for lifts (plastic cases).

Equipment in his firm is not new because he had to began with a limited budget. Nevertheless, his firm has an EDM which enables it to make high quality moulds. In case he needs CNC machines he goes to his friend's firm to borrow the machines because they are too expensive for T-11 to buy. The MD of T-11 says that Bandai, a Japanese firm, had the most advanced technology and management system among the four firms he experienced. He experiences difficulty in getting technological information on mould making although he exchanges business information on moulds with friends in the same business.

T-8 at Cholburi is the third case of "learning-by-doing". Born to a Thai farmer, Mr. Mana, the MD of T-8, opened a retail shop to sell agricultural equipment and later started repairing agricultural equipment. The workshop has 25 workers with several machine tools including five lathes, 10 welding machines and 10 milling machines. The firm also constructs steel-built warehouses and steel-built factories for customers. His wife and a daughter also work for the retail shop and the workshop. This is a typical family size business. The firm repairs tractor parts, caterpillars, bulldozer blades and other metal spare parts.

This firm remains at the initial stage of industrial development. The firm has several machine tools to repair metal parts of agricultural equipment. However, the technology level is still low and only good for repairing agricultural machinery or other metal parts. The owner intends to enter a new field of industrial activity but is not sure what to make or how to start.

8-5-2. Reverse engineering

T-4 is a case of "reverse engineering". The founder was born to a Thai farmer at Cholburi in the late 1920s. The firm is also a case of a manager of local origin, not a Chinese immigrant. After WW2 he engaged in sugarcane and cassava plantations. The farmers at that time had to rely on man power or animal power using simple farm equipment. After coming back from a study tour to see the manufacturing of agricultural machinery in Europe, the founder started the production of Thai-made "disc ploughs" in 1958.

Being an agricultural country, Thailand uses many types of agricultural machinery. Machines made by Massey Ferguson, Ford, John Deere and Kubota are popular. These machines need spare parts such as "disc ploughs" and "front blades". The demand for spare parts has increased due to the expansion of agricultural production. At present, T-4 has over 400 dealers in Thailand and occupies 30% of the after market for agricultural machines' spare parts such as disc ploughs.

Machining, welding, painting and assembling are the production processes in the firm. Spare parts for agricultural equipment do not need high precision. T-4 has developed some original brand products by reverse engineering. T-4 is able to reproduce copies of a sample if it gets one original to disassemble and analyse. The MD says that it may take about a year or two to start commercial production of a new product after importing a sample model. The consumer price becomes low (less than half or one third) compared to the original price of the imported part or equipment. Thus, reverse engineering helps a developing country to accumulate not only capital but also technological capability.

This is the starting point of industrial development in the case of a developing country like Thailand. Nevertheless, reverse engineering alone is not enough for the further upgrading of the technology level. The MD says that T-4 has never made license agreements for the production of spare parts or for the development of copy products. This seems to be the case in most developing countries at the initial stage of development, not only of Thailand. However, if Thai firms remain at this stage, it is difficult to obtain more sophisticated technologies (precision technology or mass production technology). They cannot supply international firms in Thailand.

T-20 is also a case of "reverse engineering". The founder was born to a Chinese immigrant at Cholburi and established a small workshop at the age of 27 in 1972 with only three people. Observing the potential markets for hydraulic pumps the founder worked hard to acquire technologies to manufacture hydraulic systems. His firm shows a case of successful indigenous in-house technology development. He has not made any specific technical license agreements so far. However, he has obtained useful technical advice from many friends and acquired necessary technologies. R&D activities with a scholarship from

Ministry of Science and Technology was one of the sources of technology acquisition. He has developed a variety of new products mainly by reverse engineering for the domestic markets, and some even for neighbouring countries.

The products of T-20 depends on hydraulic systems. The firm manufactures a variety of products which use hydraulic power systems. Its main products are hydraulic cranes (30%), press machines (30%), hand pallet trucks and other hydraulic products. The production share of press machines is increasing and may reach 70% in three years. The firm purchases materials such as steels, hydraulic mechanical parts, and processes and assembles them into a variety of hydraulic machines. The main processes are machining, sheet works, welding, and painting. The manufacturing is done by batch system because the range of products is wide and each product is manufactured in small quantities. The operation of the factory is maintained by two shifts. Some machines are operated 24 hours a day in order to recoup their high investment costs.

Recently, T-20 made a contract with a Japanese SMI, Sanki, which manufactures similar products at higher cost in Japan. Under the contract, T-20 will manufacture hydraulic machines (hydraulic presses and die spotting machines) on behalf of Sanki. The machines will have a joint brand name of Sanki and T-20, but will be purchased by Sanki. Sanki will sell the products to its customers through the world-wide network of Marubeni. Marubeni will take a fixed rate of commission. T-20 is now capable of making products for the international market.

It is very important for a developing country to become capable of making machines by itself. T-20 is a good example of indigenous machine making in Thailand. That is why T-20 has received government prizes several times. The products are mainly large equipment and manufactured by the batch production system. This firm's strength lies in its design capability and marketing. However, the range of the metalworking technologies is limited. The firm does not use moulds and dies which are effective in the production of a large quantity of high quality products. The firm does not process casting, forging or heat-treatment which are technologically very important and difficult to acquire. If the range of technologies is limited to this level, the firm has to purchase critical parts from outside or import them from foreign countries. This is the limit of indigenous efforts.

The founder of T-20 sent his sons to study overseas. One is studying in the USA and the other in Japan for the future development of the firm. They will hopefully challenge higher technologies to strengthen the industrial base of Thailand.

Summary and conclusion

As shown in Table 8-9, QIB firms show the highest technology levels in operational technologies on average (point 6.9). Next, TA firms showed the second highest technology levels (point 6.6). Firms which acquired technology through the "diffusion route" seem to remain at low levels (point 5.1). Indigenous development of technologies is effective only for a limited market and the levels of technologies are found to be the lowest (point 4.5). These figures demonstrate that the parent-child relationship or *shitauke* (QIB) provides the highest levels of technology. QIB in Thailand seems to be practised in the same manner as in Japan. They have no capital relationship except in some cases of major suppliers. However, they co-operate for their common aim to upgrade technological capability, based on mutual trust and interest.

The lowest level of technology in indigenous development suggests that learning by human contact is important. Especially, what is learnt from competitors in industrialised countries proves indispensable to enable a firm to compete in international markets. Thailand developed a three-wheeled car (*tuktuk*), a four-wheeled car (*see-lo*), a country car (*ee-than*) and a long-tail boat (*rua-harn-yao*). However, these products cannot earn foreign currencies as the international market prefers more sophisticated products. This is the reason why FDI is considered the best way to develop modern industrial technology, which enables access to the international technology and the market. For example, an MD, who relies on indigenous efforts and lacks English or Japanese language capability, has sent his sons to foreign countries, one to the USA and the other to Japan, hoping for direct access to foreign technology in the future.

Table 8-9 Learning levels of technologies at local firms

	present (1994, at the survey time)						future (3 years later)				
	no. of firms	operation	maintenance	QC	PC	average	operation	maintenance	QC	PC	average
QIB	4	7.3	6.5	6.8	6.8	6.9	8.3	8.3	8.8	8.5	8.6
TA	5	6.8	7.2	6.4	6.0	6.6	8.1	8.4	7.6	7.6	7.9
Diffusion	6	5.7	4.2	4.8	5.5	5.1	7.8	6.0	6.8	7.8	7.1
Indigenous	5	5.2	4.2	4.4	4.2	4.5	6.2	6.0	5.4	5.6	5.8
total	20	6.2	5.4	5.5	5.6	5.7	7.6	7.1	7.1	7.4	7.3

Source: The author's survey

QC = quality control, PC = production control. average = average of operation, maintenance, QC and PC.

Chapter 9: High Levels of Achievement in the Acquisition of Operational Technologies

Introduction

The focus of this chapter is the issue of the interaction of two or more nationalities in Thai industries. This issue is sensitive because it is linked with national pride and antagonism against all things foreign.

The first section explains why Japanese firms have invested in Thailand. They have invested to seek a chance for survival in Thailand as private companies. Whatever the original motives may be, if a decision is made to start a manufacturing plant, successful start-up and survival become imperative. In order to put projects on a profit making line as soon as possible, training local staff is unavoidable. Japanese firms do not use resources as given. Japanese firms try to educate and train people, believing in the success of the flying-geese pattern of development for Thailand. The second section is a discussion of the issue of training, together with the staff turnover problem. If a firm aims to transfer not only easy (Group A) technologies but also difficult (Group M) technologies (see Table 6-11), the high turnover is detrimental. Discipline and team work are indispensable for technology transfer.

The third section will examine the achievement levels of local staff. Firstly, overall evaluation of product quality will be discussed. The survey showed that the quality levels of Japanese subsidiary firms almost reached those of the holding companies in Japan. In addition, the learning levels of local staff are measured (i) by the ten point method (from 1 to 10 point) and (ii) by the rating of staff's responsibility (from 0 to 4 point; Table 9-17). This measurement will be carried out for each of the three strata and ten categories classification of this survey method.

9-1 The importance of survival regardless of the ownership

9-1-1 A desideratum for survival

The survey showed that Japanese FDI has been fragile, unstable and risky, especially in the case of metalworking which requires large capital investment. Profits are not guaranteed. This finding complies with the argument that Japanese FDI has not been aimed at exploiting monopolistic profit, but occurred as a *desideratum* for its own survival, linked with the policy of the "changing and abandoning of jobs" (see Chapter 3: 3-1-3).

As shown in Table 9-1, the 23 Japanese firms invested in Thailand for many reasons. Labour costs were (14 firms, 60.9%), the high yen (8 firms, 34.8%), the Thai government's incentives (5 firms, 21.7%) and high land prices in Japan (2 firms, 8.7%). In total 19 firms raised cost issues. On the other hand, four firms did not raise any issue about production costs. Their answers comply with the fact that their investment decisions were made in order to follow their parent enterprises or customers (J-2, 4, 6, 23).

Table 9-1 Questions and answers on the motives of investment (23 Japanese firms)

	No. of firms	%	(note)
1 Raw materials and energy in Thailand	0		
2 Followed other related companies	10	43.5	Domestic market (8), export (2)
3 Difficulty in obtaining a suitable land in the home country (Japan)	2	8.7	
4 Abundant and cheap labour in Thailand as compared to other places	14	60.9	
5 The local market expansion in Thailand	6	26.1	Followed parent firms (4), self decision (2)
6 Export back to the home country	6	26.1	
7 Export to other countries such as US or Europe	6	26.1	
8 Avoid the high yen currency in Japan	8	34.8	
9 Attractive promotional policies in Thailand	5	21.7	
total	23 firms (57 answers)	100 (247.8)	

Source: The author's survey. Multiple answers within 3.

The survey shows that, wherever the market may exist, Japanese FDI was planned as (1) the relocation of industrial bases and/or (2) to follow the parent enterprises or customers (J-1, 2, 4, 6, 12, 23, W-13). Investment was not planned as monopolistic exploitation. Investment emerged only as a survival game shifted to a new front line, which seemed to offer a better opportunity than in Japan (J-2, 5, 7, 8, 11, 16, 17, 20). The most important implication of the finding is that FDI for survival inevitably brings technological development to the recipient countries [Thailand] as a result, even if this is not intended by the [Japanese] investors.

FDI is a type of expansion or relocation, as the survey shows (Table 9-2). The nature of investment is basically the same as domestic investment aimed at the local market or the cheap local labour. Especially, the major motive has been to solve the problems of labour or land shortages. At first, relocation was achieved inside Honshu (mainland of Japan), and then industry spread to Kyushu. For example, as Kyushu was an agricultural island and labour/land cost was cheap, Honda established its plant in Kyushu to manufacture for export. In the early 1980s, Honda's suppliers such as FCC and others followed Honda to Kyushu. In the 1990s, Honda relocated to Asia and the West in order to avoid the problems associated with the high yen and to gain access to local markets. Musashi and FCC followed Honda both in Asia and the West although relocation abroad affects the domestic market which is now declining.

It should be noted that relocation to Thailand becomes feasible only if the cost there is low enough both in terms of equipment and labour to make the investment project sustainable. According to the survey, the yearly sales per employee in Thailand was on average 4.3 million yen (£26,900), nine per cent of the corresponding figure in Japan which was, on average, 49.9 million yen (£311,800). The difference comes from the gap in the sales amount. The scales in terms of the number of employees are on average similar (Table 9-3). This means that the gap in labour and other costs makes the Thai operation possible despite the existence of the wide gap in labour productivity between the two countries.

Table 9-2 Relocation of 20 Japanese firms by region/ period

	holding company	relocation					
	the year of the start-up	in Honshu (mainland)	in Kyushu (southern)	in **Thailand**	in Asia	in the West	total
1991-96		**1**	1	3	**9**	3	17
1986-90		1		**18**	5	5	29
1974-85	2	3	**2**	2	1		8
1950-73	2	**13**	1	1	1		16
1885-1949	16						
total	20	18	4	24	16	8	70

Source: The author's survey (*Survey C*). Based on the information from 20 holding companies in Japan.

Table 9-3 Yearly sales per employee by location (unit: million yen)

	Main			Honshu			Kyushu			Thailand		
firm	S	E	S/E	S	E	S/E	S	E	S/E	S	E	S/E
No. 1	2,638	115	22.9	2,789	100	27.9	2,756	42	65.6	2,023	300	6.7
No. 1				4,564	80	57.1						
No. 1				5,624	79	71.2						
No. 1				10,306	178	57.9						
No. 2	30,000	1,000	30.0	3,400	129	26.4				760	358	2.1
No. 3	38,356	81	473.5	9,420	157	60.0	6,268	141	44.5	7,044	272	25.9
No. 4	3,200	150	21.3							250	100	2.5
No. 5	6,000	211	28.4							400	80	5.0
No. 6	60,721	1,635	37.1							3,000	300	10.0
No. 7	300,000	4,400	68.2							8,000	4,200	1.9
No. 7										9,000	1,500	6.0
No. 7										5,000	1,800	2.8
No. 8	5,366	100	53.7							831	1,600	0.5
No. 9	22,675	594	38.2							24,190	4,646	5.2
No. 10	29,000	900	32.2				10,000	500	20.0	3,000	400	7.5
No. 11	27,895	300	93.0	3,733	57	65.5				4,206	600	7.0
No. 12	5,443	320	17.0	4,890	260	18.8				567	70	8.1
No. 13	109,900	3,038	36.2							1,123	100	11.2
total	641,194	12,844	**49.9**	44,726	1,040	**43.0**	19,024	683	**27.9**	69,394	16,326	**4.3**
average	49,323	988								4,626	1,088	

Source: The author's survey (*Survey C*). Based on the information from 13 holding companies and their subsidiaries.
S = yearly sales, E = number of employees, S/E = yearly sales per employee

Table 9-4 shows the lapse of time needed before a profit is made. In the case of seven firms engaged in assembly/injection processes (categories 1 to 3), the average time lapse for the first profit was 1.9 years. The seven firms include two high technology firms, J-5 and J-19; J-5 took three years and J-19 two years. If the two firms of the higher technology are excluded, the average years become only 1.6 years. This shows that the assembly/injection process took the least time to make profits. This corresponds to the general observation that the assembly/injection process is easy and quickly learnt.

In contrast, other firms took longer to make profits; six firms in categories 4 to 6 took 2.5 years, six other firms in category 7 took 4.3 years, and three firms in category 8 took 5.3 years on average. These processes need a large capital investment, and the technologies are difficult to learn. Consequently, the time required to begin turning profits is longer.

Table 9-4 Time lapsed to make a profit (by process)

	0 / 1 year	2 years	3 years	4 years	5 years or more	total years	no. of firms	average years
Assembly/Injection	9, 10, 14	13, 19	3, 5			13	7	1.9
Metal (shape)	17	11, 21	7	2, 20		15	6	2.5
Metal (nature)	12	4		16, 22	1, 8	26	6	4.3
Special			23	18	15	16	3	5.3
number of firms	5	5	4	5	3	70	22	3.2

Source: The author's survey (*Survey A*). Figures denote code numbers of 22 Japanese firms. The number of firms is 22 because J-6 is excluded due to lack of information.

9-1-2 Two nationalities in a firm

This section treats the most sensitive and controversial issue of nationalities. At first, it is necessary to understand that ownership and management are different issues. Once a firm is established, management comes first, not ownership. Management requires co-operation between the holding company in Japan and the Thai partner(s). Management intends to achieve the best for the firm, and not just for personal promotion. Nevertheless, it is also true that local people feel ambivalence towards what they receive as Japanese domination. It is argued that Japanese expatriates dominate the management of subsidiaries even in the case of minority ownership. This survey also found that this argument is correct. Local people strongly wish to manage or to become independent although they need Japanese assistance at the same time. This section intends to focus on the problems of the existence of two nationalities in a firm. The first issue concerns the management sharing between Japanese and Thai shareholders, and the second, sharing between Japan's HQs and the local management sides.

The first question to the 16 JVs was:

"Which side takes the responsibility of the following management matters, the Japanese investor or the Thai partner?"(Table 9-5)

Table 9-5 Which side takes the responsibility of the following management? (in the case of six JVs)

firm code	J-2	J-6	J-12	J-15	J-17	J-18
(Japanese capital share: %)	(62)	(27)	(49)	(49)	(49)	(58)
Manufacturing	Japan	Japan	Japan	Japan	Japan	Japan
Sales	Japan	Japan	Japan	**Thai**	Japan	Japan
Finance	Japan	Japan	Japan	Japan	**Thai**	Japan
Labour management	Japan	Japan	**Thai**	**Thai**	**Thai**	**Thai**
R & D	Japan	Japan	Japan	Japan	Japan	Japan
Government procedures	**Thai**	**Thai**	**Thai**	**Thai**	**Thai**	**Thai**

Source: The author's survey (*Survey A*). In the case of other ten JV firms, all matters are managed by the Japanese side alone.

This question is in fact improper because management is carried out in co-operation, not separately by the two sides in the six categories. However, at least, the understanding of the Japanese expatriates is expressed. In ten JVs, the Japanese side bears full responsibility in all management matters. In six other JVs (shown in Table 9-5), some tasks are shared by the Thai side; in six firms, "government procedures" are carried out by the Thai side; in one firm each, "sales" and "financing" by the Thai side. In four firms, "labour management" is carried out by the Thai side. On average, the number of tasks carried out by the Thai side is limited. The Japanese side mostly undertakes management responsibility regardless of the capital shares, majority or minority.

The second issue is the transfer of responsibility from HQ to the local management side. This point is important from the viewpoint of technology transfer. If the local management is entrusted with a wider range of management matters, Thai staff have a chance to learn a wider range. Management by a Japanese minority occurs due to the government restrictions of foreign capital shares. Very often, Japanese firms accept these restrictions and work under their majority (yet silent) share holders. The silent share holders maintain the right to take over the management. However, they usually lack the experience and capability due to their short history of industrialisation.

Table 9-6 Which side has the real authority regarding the following matters, the parent company or the local management? Or, is it planned to transfer to the local management?

		no. of firms			%		
		HQ	Local	Planned	HQ	Local	Planned
1	Directors appointment/ personnel	**20**	3		87	13	0
2	Staff's personnel	2	**21**	2	9	91	9
3	Volume of stocks and productions	1	**22**	4	4	96	17
4	The purchase of parts and raw materials	5	**22**	1	22	96	4
5	Methods of manufacturing	10	14	1	43	61	4
6	Planning of equipment investments	14	10	3	61	43	13
7	Products items and composition	11	11	1	48	48	4
8	R & D	**15**	6	3	65	26	13
9	Marketing	13	10	3	57	43	13
10	Financing	**17**	7		74	30	0
11	Settlements of yearly accounts	5	**17**	1	22	74	4
	average per firm (total exceeds 23)*	10.3	13.0	1.7	44.7	56.5	7.5

Source: The author's survey.
*A few firms answered two answers dividing each category into several parts.

As shown in Table 9-6, the second issue was questioned concerning the eleven categories of management matters such as "directors' appointment/ personnel", etc.:

> "Which side has the real authority, the parent company (HQ) or the local management side which includes both expatriates and local staff?"

In most cases, the HQ maintains the tasks of "directors' appointment and personnel (20 firms)", "R&D (15 firms)" and "financing (17 firms)" in its hands. Whereas, the tasks of "staff's personnel (21 firms)", "volume of stocks and productions (22 firms)", "the purchase of parts and raw materials (22 firms)" and "settlements of yearly accounts (17 firms)" are mostly passed to the hands of the local management. Regarding the remaining four categories, i.e. "methods of manufacturing", "planning of equipment investment", "products items and composition" and "marketing", about half the firms entrusted the responsibility to the local side. It should be considered that, if the responsibility is in the hands of the local management side, the Thai staff are provided a chance to learn according to their efforts.

What follows are the most advanced cases of entrusting the responsibility with the local side including expatriates.

(1) J-17 (dies and tools)

In the case of J-17, the management responsibility is fully on the subsidiary firm (expatriates and Thai staff). The Siam group (Siam Motors and Nissan) has the 51 per cent majority and Nissan's two subsidiaries have the Japanese stakes of 49 per cent. The casting vote on the board is held by the Thai side. However, the technology of die making for automobiles is in the hands of Nissan, not in the hands of Siam Motors and Nissan. The Thai side is a silent partner for the moment. The president of J-17 is the former plant manager of Nissan's tools and dies plant in Japan. All management responsibility is in the hands of local company including the 17 Japanese expatriates sent from the Nissan's side (seven long term expatriates and 10 short term expatriates).

It is noteworthy that the Siam group (the majority share holders of J-17) has a strong wish to manage the Nissan car business in Thailand. The story goes back to the inception of the Siam group. In 1962 Siam Motors and Nissan (founded and owned by Thaworn Phornprapha) started the assembly of Nissan cars with technological and financial assistance from Nissan. The Siam group managed the Nissan car business for about two and a half decades. However, the group faced management trouble from the mid-1980s. The market share of Nissan cars in Thailand declined and financial trouble was rumoured. Before his retirement Thaworn restructured the management of the Siam group. In 1990 the Siam group sold a part of the capital of the *Siam Motors and Nissan* (the assembler of passenger cars) and the *Siam Nissan Automotive* (the assembler of trucks) to Nissan Japan, 25 per cent each. The market share of Nissan cars turned upwards in the 1990s.

The future of the Siam group, including J-17, depends on the directors' and staff's capability, not on the nominal ratio of capital.

Table 9-7 Entrusting the management authority to the local side (conspicuous cases)

		J-17	J-6	J-1	J-5	J-8	J-12	J-7	J-14	J-20
1	directors'	x	x							
2	staff's	x	x	x	x	x	x		x	x
3	stocks	x	x	x	x	x	x		x	x
4	purchase	x	x	x	x	x	x			
5	manufacturing	x	x	x	x	x	x			
6	investment	x	x	x		x	x			
7	products	x	x	x	x	x	x			
8	R & D	x	x	x	x		x			
9	marketing	x	x	x	x					
10	financing	x	x	x		x				
11	accounts	x	x		x	x	x			
		11	11	9	8	8	8	0	2	2

Source: The author's survey. x denotes entrusting to the local side (and planning of entrusting). See the note of Table 9-6

(2) J-6 (steel wheels)

CMW, the holding company of J-6, is a first tier subcontractor in Japan with 1,200 employees. J-6 is another case where full responsibility is in the hands of the local management (Japanese expatriates and Thai staff). CMW has only 27 per cent of the capital share of J-6. However, all six expatriates are from CMW in Japan. This means that CMW entrusted full responsibility to the six expatriates. Such cases are rare and seen only in the case of LIs such as CMW, not amongst SMIs. If the company is large, it may have enough staff to allocate for FDI. However, SMIs normally lack human resources for such ventures. SMIs are not able to send a full set of staff capable enough to manage independently from the holding companies.

(3) The other four firms

The following four firms also have already passed management responsibility for eight or nine categories to the local management side (Table 9-7).

J-1 (nuts and bolts) is fully owned by Japanese capital, and has the longest history of operation in Thailand (30 years) among the 23 surveyed firms. The holding company has already entrusted to the local side nine categories except "directors' appointment" and "settlements of yearly accounting". J-5 (silicone rubber) is a comparatively new firm. In this firm, eight categories except "directors' appointment", "settlements of accounting" and "planning of equipment" are entrusted to the local side due to the policy of the holding company. The holding company has a policy to encourage each subsidiary (Thailand, Hong Kong, the USA) to become strong enough to stand on its own feet. J-8 (valves) started its operation in 1988. Again, the holding company has policy to make each subsidiary (Taiwan, Thailand, Spain, Mexico) become competitive. Thus, eight categories are entrusted to the local side with the exception of "directors' appointment", "R&D" and "marketing". Marketing is not entrusted in order to avoid competition in the same geographical areas, especially Japan. J-12 (motorcycle engine parts) was entrusted eight categories except "directors' appointment", "marketing" and "financing". The holding company of J-12 is also determined to make each subsidiary (Thailand, the USA, the UK) independent and competitive.

In the above cases, Thai staff are all provided a chance to learn a wide range of technologies including management know-how.

What follows are the least advanced cases of entrusting the responsibility to the local side. In the cases of three firms (J-7, 14, 20), the management responsibility is not entrusted to the local management at all. The management is still in the hands of holding companies. The reasons are:

(i) The first overseas investment

They are all SMIs in Japan and investments in Thailand have been the first FDI for all companies. Therefore, expatriates lack experience and know-how in overseas manufacturing. For example, in the case of J-7, the post of managing director (MD) is held by the deputy MD in Japan and he makes decisions as a Japanese, not as a resident of Thailand. The senior expatriates are technicians in press works and mould making. They do not speak English or Thai. They are skilled workers, but they are not trained as managers. An advisor who speaks English is a retired ex-salaried man from a *sogoshosha* (general trading company). He has just started working for the firm and does not have full knowledge of the firm's business and technology. Therefore, all eleven categories depend on HQ. The other two firms also lack capable staff due to their short history in overseas operation. This results in the holding companies' deep and direct involvement in the FDI's operation, at least until they begin to make profits.

(ii) A production base for the parent, no marketing function

They are defined as production bases and the marketing function is not attached. All products are sold to the holding companies (J-7, 14, 20), or both to the holding company and a set maker in the case of J-7. The holding company of J-7 is a second tier auto parts supplier of Nissan and does not supply assemblers in Thailand. The holding company of J-20 is also an SMI. J-20 does not supply directly to assemblers in Thailand. The holding company of J-14 is also an SMI as a plastic injection factory (although the firm is a large enterprise by definition as a dealer because its main business is dealing in industrial materials).

(iii) No chance for R&D learning, dies and moulds are provided

As the subsidiary is defined to carry on easy processes such as manual assembly tasks, moulds and dies are provided by holding companies or customers, the level of technology is still low. The chance for acquisition of improvement and R&D technologies is scarce. In the case of J-20, the process is complicated. The process covers not only press works but also machining, heat treatment, electroplating and assembly. But they concentrate on a single item of "brake hose sockets", 150,000 pieces per month. There is no time to teach the improvement and R&D technologies yet.

In the above three cases, Thai staff are not provided with a chance to learn a whole process of technology and management know-how because the HQ holds the greatest part of the responsibility. The subsidiary firms are only partial production bases of the holding companies. In this type of subsidiary firms, the replacement of expatriates as a result of learning by local staff seems to be easier, except some difficult technological matters. As seen in the previous section (Table 9-6), on average, more than half the categories (56.5%) were entrusted (transferred) to the local sides.

The next question is about the localisation to the Thai staff. The survey tried two ways to approach this issue. One is "the worker-expatriate ratio" from the viewpoint of management and the other is "the staff localisation" on the shop floor. At first, "the expatriate worker ratio" will be discussed below. The issue of staff replacement will be examined later in 9-3-2 (staff localisation by five point evaluation).

The number of employees per expatriate (worker-expatriate ratio) is calculated for 23 Japanese firms and 13 Western firms (Table 9-8, 9, 10, 11). These tables show that Japanese firms have more expatriates than Western firms both in number and ratio on average. At the time of start-up, a Japanese firm had 4.1 expatriates on average and the worker-expatriate ratio was 23.3, i.e. one expatriate existed in 23.3 persons. At present, a Japanese firm has 6.0 expatriates (d) and the worker-expatriate ratio (c/d) is 86.3 (Table 9-8, Table 9-10). Meanwhile, a Western firm has 1.4 persons per firm (d) and the worker-expatriate ratio (c/d) is 235.2 (Table 9-9, Table 9-11). The reasons for this are as follows:

(1) The claims are that Japanese expatriates normally do not speak English or local language while Western expatriates and many local staff in developing countries speak English. Consequently, Japanese expatriates are less efficient in technology transfer because of the language barrier in comparison with Western expatriates. As a result, they have to stay in larger numbers and have to stay longer in Thailand.

(2) Japanese firms normally do not have good systems of technology transfer such as job descriptions and manuals. Consequently Japanese firms are less efficient in technology transfer and have to send more staff for longer periods.

(3) Japanese firms pay lower salaries to expatriates, hence Japanese firms can afford to send more staff for a longer period.

(4) Japanese firms are investing in a riskier, more competitive market. Therefore, they have to stay longer and send more staff to struggle and to survive, taking all responsibility.

(5) Japanese firms are investing in more difficult processes than Western firms. Therefore, technology transfer takes more energy and a longer time.

The above reasons (1), (2) and (3) seem to be all true to a great extent. (4) comes from the issue of *desideratum* mentioned. Concerning the issue of (5), the sample does show that Western firms do concentrate on assembly. Even in the case that they are involved in metalworking, the sample shows that Western firms seem to tackle easier tasks than Japanese firms (Chapter 7: 7-4-2).

Table 9-8 Worker-expatriate ratio (a/b, c/d) by firm size (Japanese firms)

	number of firms	start-up year employee a	start-up year expatriate b	present(1994) employee c	present(1994) expatriate d	ratio a/b	ratio c/d	years of operation	average growth rate
Small-medium industry	8	55.6	4.3	98.4	3.4	13.1	29.1	6.1	1.1
Large industry (201-500)	10	63.8	3.7	270.0	4.5	21.5	65.9	8.7	1.19
Large industry (over 500)	5	215.4	4.6	1703.0	13.4	46.8	127.1	7.0	1.57
total	23	95.3	4.1	521.8	6.0	23.3	86.3	7.4	1.36

Source: Table A-1. average growth rate = compound (geometric) average yearly growth rates of employees.

Table 9-9 Worker-expatriate ratio (c/d) by firm size (Western firms)

	number of firms	present (1994) employees c	present (1994) expatriates d	ratio c/d	years of operation
Small-medium industry	4	156.5	1.5	104.3	5.8
Large industry (201-500)	8	318.5	0.9	364.0	6.4
Large industry (over 500)	1	1,059.0	5.0	211.8	6.0
total	13	325.6	1.4	235.2	6.2
(over 30% share)	(9)	(252.7)	(1.3)	(194.4)	(6.6)

Source: Table A-2. (over 30% share) = firms with capital shares 30% and over.

Table 9-10 Worker-expatriate ratio (a/b; c/d) by process (Japanese firms)

	number of firms	start-up year employee a	start-up year expatriate b	present(1994) employee c	present(1994) expatriate d	ratio a/b	ratio c/d	years of operation	average growth rate
assembly/ injection	7	104.7	3.3	610.7	4.4	31.9	137.9	4.4	1.49
metal (shape)	7	59.8	3.8	726.4	9.9	15.6	73.7	12.5	1.22
metal (nature)	6	106.6	7.3	971.1	12.5	14.6	77.8	9.0	1.28
special	3	90.4	4.8	769.4	8.9	53.8	95.9	11.3	1.09
total	23	95.3	4.1	521.8	6.0	23.3	86.3	7.4	1.36

Source: Table A-1. average growth rate = compound(geometric) average yearly growth rates of employees.

Table 9-11 Worker-expatriate ratio (c/d) by process (Western firms)

	number of firms	present (1994) employees c	present (1994) expatriates d	ratio c/d	years of operation
assembly/injection	6	380.8	1.7	228.5	5.8
metal (shape)	4	267.5	1.3	214.0	5.3
metal (nature)	2	214.0	1.5	142.7	10.0
special	1	450.0	0.0	/	4.0
total	13	325.6	1.4	235.2	6.2

Source: Table A-2

For example, Western firms make aircraft goods, electric motors, electric appliances such as toasters, cookers, hot pots. As a Western plant manager said,[112] these processes are normally easier than engineering plastics (J-10, 14, 19) or precision press parts for microwave ovens, VTRs or air conditioners (J-7, 11, 13). Another case is rubber injection (Chapter: 7: 7-4-2). In the surveyed samples there are two rubber injection firms, one is a Japanese and the other a US firm. The former makes silicone rubber parts (defect ratio 5 - 10%, claim ratio 0%) and the latter windshield wipers (defect ratio 2.5%). The former has two expatriates and plans to add another soon, while the latter has no expatriate. The Japanese president is teaching technologies for making moulds, dies and machines to Thai staff (J-5). In contrast, at the Western firm, the local managing staff says that they can manage without expatriates. Moulds are supplied by the holding company in the USA and the technologies are not so difficult for them (W-1).

9-2 The importance of the teamwork concept

9-2-1 High turnover ratios

The training loss (the high turnover ratio) is a serious problem both for Japanese and Thai firms. The causes were not discussed, yet how seriously it affects technology transfer is discussed. For example, at J-1, the training loss is as high as 49/50. J-1 sent 50 workers to Japan each for 2-3 years. At present only one remains with the firm and the other 49 have all

Table 9-12 Training loss at manufacturing firms in Thailand

(year of start)	loss ratio	training	
J-1 (1966)	49/50 ?/20	50 persons for 2-3 years. 20 persons for less than a year (in Japan)	The period of training in Japan was changed to less than 1 year.
J-5 (1990)	3/4	4 persons for 1 year 2-8 months (in Japan)	They said they resigned to help their family businesses.
J-7 (1991)	2/11	7 person for 1 year, 4 persons for 6 months (in Japan)	A low loss ratio because of the location (Cholburi)
J-14 (1988)	8/10	10 persons trained in injection, assembly, QC, etc. (in Japan)	Only 2 remain at present.
J-19 (1992)	4/8	8 persons for 3-6 months (in Japan)	4 resigned because they recognised that they could not master the technologies
J-22 (1989)	45/50	50 persons trained for 3 months (in Japan)	Among 50 trained in Japan only 5 remain. Every year about 50 persons quit.
T-6 (1990)	2/10	10 persons for 2 months in die making (in Japan)	The loss ratio is very low as compared to other firms.
T-1 (1981)	4/5	5 persons in die designing by a Japanese expert	4 resigned in the past 12 years. The best way is to train a family of the owner.
T-5 (1991)	14/42	14 persons in die making resigned in the past 2 years	It is necessary to employ and train new persons continuously.
T-19 (1967)	16-20/200	200 persons work for die making and engineering section	Every year 8-10 % quit. It is regrettable that they quit after learning technologies.

Source: The author's survey (*Survey A*). 49/50 means that 49 persons resigned among 50 persons trained.

left. The president of J-1 regretted that the periods the firm had sent them to Japan for training were too long. Because they learnt to understand Japanese, they left to utilise their ability better at other firms. Therefore, the firm changed policy and now sends them to Japan for less than one year. Following the new policy, the firm has so far sent about 20 workers to Japan, each for less than one year. Many other firms also raised the problem of the high turnover ratio in the interviews (Table 9-12).

Even in the case of a large Thai firm, 8-10 per cent quit every year (T-19). In the case of a small firm, over 30 per cent quit in two years (T-5, J-22). This means that possibly the trained staff may be totally replaced in 6-10 years. For a small firm (T-5), it is a hard job to recruit workers. As mentioned, T-5 regularly opens a five day technical training course to recruit new workers.

Mr. Kamon (T-19) deplores the fact that many trained staff resign to change their jobs. That is a complete loss for the firm and, in case where they change to a new kind of job, that is a loss even for the whole country. Learning lessons from the high turnover ratios, the president of J-5 changed the policy to employ graduates of vocational schools who are not university graduates from the business owners' families.

9-2-2 Towards good teamwork

The holding company of J-23 (heat treatment) employed three university graduates of metallurgy before it opened the heat treatment shops in Japan. In Thailand there are not enough university graduates to work for manufacturing industries, especially for SMIs. Therefore, most Japanese firms, including J-23, have decided to employ graduates of vocational schools, junior high schools or high schools. For example, the MD of J-17, a Thai, is a high school graduate. Graduates of universities do not have a good reputation. It is said that they do not go to the shop floor to work with workers (T-5). They do not take responsibility when problems occur on the shop floor (J-22). In addition, they often quit after training (J-5).

There are some successful cases of local staff leadership. After two years of unsuccessful management, J-21 changed the management method from direct control to indirect control. Japanese expatriates explained the management policies and targets only to Mr. A, a graduate from a university in Japan, and asked him to implement them. Japanese expatriates trusted him (J-21), which resulted in successful management. In the preparation stage, the holding company of J-11 recruited three Thai students in Kobe who, after returning to Thailand, worked for J-11 in Thailand. They formed the core of the Thai staff and helped the successful start-up in Thailand. In some cases, the leadership of the MDs succeeded in forming the strong teamwork among the whole staff (J-8, 12, 16). Mr. Prasartsilp (T-14) was born to a farmer in the Northeast (*Isarn*), educated at a technical college and worked for Isuzu for 13 years including training in Japan. With this background, he also succeeded in bringing about good teamwork by employing many people from his native area. They speak the same language called *Isarn*. These firms present typical examples of the Japanese management philosophy of teamwork spirit. The concept is different from the elitism of Thai university graduates.

9-3 A satisfactory achievement by Thai firms

9-3-1 The quality of products

According to the survey, the quality level of products in the 23 surveyed Japanese firms is satisfactory. Only one firm described that its own quality is not as good as that of Japan (J-6), the other 22 firms (95.7%) named at least one product item of which quality is equal to that of Japan (Table 9-13). However, expatriates expressed that the overall level is still lower than the Japanese counterparts and further improvement is necessary.

Table 9-13 Product quality comparison between the subsidiary and the holding company (23 Japanese firms)

	firms which named at least 1 item applicable to the left column	items which were named applicable to the left column
not good as that of Japan	5 firms (21.7%)	7 items, 13.2% (bolts, final assembly of a car, wheels, press parts, stamping dies, bites)
equal	22 firms (95.7%)	44 items, 83.0%
better than that of Japan	1 firm (4.3%)	2 items, 3.8% (silicon rubber products)
total	23 firms (100%)	53 items (100%)

Source: The author's survey

(1) The case that a Thai firm produces better quality products

It should be noted that one firm answered that the quality of some items are better than that of Japan (J-5). Why does it happen that the Thai firm's quality is better than that of the technology supplier? In the Thai firm, more people are allocated for inspections. As a result, the products have fewer defects. The reject rates are lower. Another firm also explained in an interview that the Thai subsidiary achieves lower defect ratios in some products because the Thai firm exercises either complete checks or higher ratios of sampling checks at more points than in Japan, while the Japanese holding company exercises lower ratios of sampling checks at minimum points (J-16).

(2) The case that Thai firms produce inferior quality products

The possible causes of lower quality are as follows. Firstly, the equipment is inferior to that of Japan. Secondly, levels of skills and technological knowledge as a whole do not reach that of the Japanese holding company. Thirdly, the management system (routines) as a whole is still incomplete, unstable and fragmented.

9-3-2 Learning levels of Thai staff

Questions were designed to measure the learning levels of Thai staff at the 23 Japanese subsidiary firms on three strata and ten categories of technology (Chapter 6-1-1; Table 6-1). The first is the measuring of technology levels (by ten point evaluation for ten categories). In the case of the 23 Japanese firms (Table 9-14), the first stratum technologies (operational technologies) already reached near-high levels (7.7, 6.9, 6.0, 5.8) although QC and production control technologies are still not satisfactory (6.0 and 5.8). In the future, the first stratum technologies are expected to reach 8 or 9 points. In contrast, the second stratum technologies (improvement technologies) are at very low levels (4.4, 3.6, 2.7) and the third stratum technologies (creative technologies) are at the lowest levels (2.1, 1.8, 1.2). In sum, the learning of technology will be satisfactorily achieved in the first stratum in the near future. However, the second and the third stratum technologies are far from achieving full localisation.

In the case of the 20 Thai firms (Table 9-15), the situation is similar as far as it is concerned with the technology in ten categories. The first stratum technologies (operational technologies) of 20 Thai firms showed a little over 5 points (6.2, 5.4, 5.5, 5.6) on average, and these figures are expected to reach satisfactory levels (7.6, 7.1, 7.1, 7.4) in the near future (three years later). In contrast, the second stratum technologies (improvement technologies) are at very low levels (4.0, 4.5, 2.7) and the third stratum technologies (creating technologies) are at the lowest levels (2.3, 3.9, 1.7).

It is interesting to note that improvement technologies and creating technologies of Thai firms scored often higher than those of Japanese firms. First, measuring standards are different (see Table 6-7). Second, Thai firms which supply local markets engage in improvement and creating activities suitable for the local markets. Thirdly, however, this does not mean that Thai firms have higher levels of improvement and creating technologies. There is the third dimension to consider. As mentioned earlier, in the case of unsophisticated technology, learning of "improvement" and "creative" technologies are not so difficult as in the case of sophisticated technologies (see Figure 6-1; page 161).

The most obvious finding from the survey is that the levels of technology acquisition mainly depend on access to foreign technology. For example, in the case of "operational technology", as Table 9-16 shows, the achievement levels in "QIB" and "TA" routes (7.3 and 6.8) are higher than the "diffusion" route or "indigenous" efforts (5.7 and 5.2). This result corresponds to the preposition that borrowing by direct human contact is the most effective, as observed in the cases discussed in Chapter 8.

Next is the measuring of staff localisation (by five point evaluation). Focusing on the shop floor, this survey examined the levels of staff localisation for each ten categories of technology. The figures in the columns of Table 9-17 show the staff localisation. The figure "4" denotes that the technology is already in the hands of Thai staff. They no longer need Japanese assistance. The figure "3" denotes that Thai staff carry out the tasks (technology) with Japanese assistance. The figure "2" denotes that Japanese expatriates carry out the tasks with the assistance of Thai staff. The figure "1" denotes that the tasks (technology) are carried out by Japanese staff alone without the assistance of Thai staff. Figure "0" denotes that teaching of the technology is not planned.

Table 9-14 Learning and development levels of technology (23 Japanese firms)

3 strata		1st stratum **operational**				2nd stratum **improvement**			3rd stratum **creative**		
10 categories		1	2	3	4	5	6	7	8	9	10
scores	present	7.7	6.9	6.0	5.8	4.4	3.6	2.7	2.1	1.8	1.2
	future (3 years later)	9.1	8.5	8.0	8.0	6.0	5.7	4.3	3.8	4.2	2.5

Source: The author's survey. The contents of 10 categories are shown below.

Operational
1. operation
2. maintenance
3. QC
4. production control

Improvement
5. technology improvement
6. development of mould/ die/ jig
7. development of equipment

Creative (-ing, -tion)
8. new technology
9. engineering design
10. R&D of new products

Table 9-15 Learning and development levels of technology (20 Thai firms)

3 strata		1st stratum **operational**				2nd stratum **improvement**			3rd stratum **creative**		
10 categories		1	2	3	4	5	6	7	8	9	10
scores	present	6.2	5.4	5.5	5.6	4.0	4.5	2.7	2.3	3.9	1.7
	future (3 years later)	7.6	7.1	7.1	7.4	5.3	5.3	3.5	2.8	4.7	2.1

Source: The author's survey. See the note of Table 9-14

Table 9-16 Learning and development levels of technology by "route"(20 Thai firms)

	operational				**improvement**			**creative**		
Present	1	2	3	4	5	6	7	8	9	**10**
QIB	7.3	6.5	6.8	6.8	3.8	7.0	2.8	3.8	7.3	1.8
TA	6.8	7.2	6.4	6.0	5.8	6.5	5.5	2.0	2.8	2.8
Diffusion	5.7	4.2	4.8	5.5	5.0	3.3	1.8	2.2	3.2	0.2
Indigenous	5.2	4.2	4.4	4.2	1.6	2.4	1.6	1.4	3.0	2.8
total	6.2	5.4	5.5	5.6	4.0	4.5	2.7	2.3	3.9	1.7
Future	1	2	3	4	5	6	7	8	9	**10**
QIB	8.3	8.3	8.8	8.5	4.5	8.3	3.8	4.5	8.8	2.0
TA	8.1	8.4	7.6	7.6	6.3	7.0	5.8	2.0	3.0	3.0
Diffusion	7.8	6.0	6.8	7.8	7.2	4.5	2.8	3.2	4.3	0.2
Indigenous	6.2	6.0	5.4	5.6	2.8	2.6	2.4	1.6	3.4	3.8
total	7.6	7.1	7.1	7.4	5.3	5.3	3.5	2.8	4.7	2.1

Source: The author's survey. See the note of Table 9-14

Table 9-17 The staff localisation (23 Japanese firms)

	1st stratum **operational**				2nd stratum **improvement**			3rd stratum **creative**		
10 categories	1	2	3	4	5	6	7	8	9	10
Staff localisation (present)	3.4	3.2	2.8	2.8	2.0	1.9	1.5	1.2	1.1	0.7
(future = 3 years later)	3.7	3.6	3.5	3.5	2.7	2.3	1.9	1.6	1.6	1.0

Source: The author's survey. See the note of Table 9-14

(1) The first stratum (operational) technologies

"The operational technologies" are in the range of 3.4-2.8. In the future the figures are expected to reach 3.7-3.5. This means that the Thai staff will become capable of managing the operational technologies independently although they may need the assistance of Japanese expatriates sometimes.

(2) The second stratum (improvement) technologies

On the other hand, "the improvement technologies" are mostly carried out by Japanese expatriates (2.0, 1.9, 1.5) although Thai staff are given the opportunity to learn the technologies by assisting Japanese experts.

(3) The third stratum (creative) technologies

The creative technologies ("new technologies", "engineering designs" and "R&D of new products") are almost all done by Japanese expatriates or not carried out in Thailand (1.2, 1.1, 0.7). Exceptions are J-5 and J-11. In the case of these two firms, development of moulds, dies and jigs are considered to be "creative technologies". These technologies are already carried out by Thai staff with or without the assistance of Japanese expatriates. It should be noted that "creative technologies" for supporting industries are different from that for set makers or assemblers. In case of set makers and assemblers, R&D means creation of new models or new products. In the case of suppliers like J-5 and J-11, R&D means R&D on processes which they handle. J-5 is a silicone rubber moulder. The creative activity exists in the process technology for moulds and jigs, not for new materials. J-11 is a component supplier. R&D activity exists in the creative activity for new jigs. Their function is not to make new materials or new products. The concept of R&D is thus a relative one.

In conclusion, Thai staff are learning technology slowly but steadily from Japanese expatriates and also through training in Japan. As technology forms strata, it is indispensable to learn and accumulate it step-by-step.

9-3-3 R&D technologies in Thailand

As mentioned, people in developing countries desire to acquire technological capability not only of simple assembly but also of higher technology, especially R&D capability. In Thailand, many Japanese firms have been transferring not only assembling processes but also metalworking processes which are considered difficult. More than that, many Japanese firms plan to transfer "improvement technologies" and "creative technologies" to subsidiaries in Thailand. Among the surveyed 23 Japanese firms, five answered that they carry out R&D in Thailand (Table 9-18) and three answered that they plan to start R&D in Thailand in three years.

Many Japanese subcontractors that specialise in specific engineering processes such as metalworking or injection usually cannot afford to carry out independent R&D activities. However, most of the 23 Japanese firms are technologically advanced and can conduct technological activities for "improvement" or indeed for "creating new products or new processes". Although the demarcation between "improvement" and "creative" technologies is blurred and a matter of degree, the following examples show development of new equipment or processes on a minor scale.

Table 9-18 R&D activity in Thailand by Japanese subsidiaries (23 Japanese firms)

		by Holding Enterprise	by Local Management	Planned to transfer to Local Management	total number of firms
1	Methods of manufacturing	8	13	2	23
2	Planning of equipment investments	11	10	2	23
3	Products items and composition	11	11	1	23
4	R & D of new products	15	5	3	23
5	Marketing	11	9	3	23

(1) J-1

The holding company in Japan is specialist in nuts and bolts, whereas J-1 has diversified into automobile/motor cyc ccessories and press parts in Thailand. This happened because the market in Thailand was too small when J-1 started operation in 1966. The diversification was a means to avoid losing money. As the holding company does not have full technology in accessories and press parts, J-1 has conducted R&D and marketing activity in Thailand. The firm now intends to strengthen the R&D activity in Thailand as the Thai market is expanding.

(2) J-5

The president of J-5 plans to make J-5 (fully owned) an excellent, independent maker, not a mere dependent on the holding company. The secret of rubber injection lies in moulds, jigs and tools. Technologies to develop moulds, jigs and tools define the competitiveness of rubber injection makers. The president does not mean the R&D of the basic technologies such as the development of new materials to replace silicone rubber. He wishes to make the subsidiary the most creative company under the given technological conditions. He thus strongly wishes to teach all the available technologies.

(3) J-16

The holding company of J-16 is located in Tokyo, an industrial district. It is a typical Japanese SMI in the sense that it co-operates with other SMIs. Japan has abundant SMIs in all types of engineering processes. Therefore, Sanko in Tokyo could rely on other SMIs for heat treatment and electroplating. When Sanko invested in Thailand, it had to consider how to process heat treatment and electroplating. Thailand is lacking this type of supporting industry. That is the reason why J-16 carried out an R&D activity in Thailand for the development of new processes.

(4) J-6 and J-12

Two firms consider that as their markets exist in Thailand they must be cautious about the change in the market and the development of technologies. They do not intend to have large R&D sections. They only want to seek continuously the improvement of the process technologies to keep competitive edges in the local market.

(5) J-2, J-9 and J-11

These firms consider that the Thai subsidiary firms have to be strong, competitive, independent companies as much as possible. Therefore, if the company wants to become technologically more advanced, investments in R&D facilities and human resources are in order. In the case of J-11, Thai staff are working for the improvement of process and development of moulds and jigs. This is understood as "creative technologies" and "R&D".

In conclusion, "improvement technologies" and "creative technologies" are acquired only through the accumulation of knowledge and experience (tested knowledge). Therefore, the first thing to learn is "operational technologies". They were already learnt to satisfactory levels. This means Thai people are provided a chance to learn "improvement" and "creative" technologies in more sophisticated technologies with the assistance of expatriates. Learning from expatriates is different from conducting "improvement" and "creative" activities in less sophisticated technologies (see the third dimension of technologies in page 161).

9-3-4 Towards a hybrid technology and culture

The first section is a discussion of the possible reasons of delayed industrialisation in Thailand from the viewpoint of local entrepreneurs. A local entrepreneur emphasised the importance of technological accumulation. In the past, Thai people could not accumulate technology, but lost what they had learnt (Figure 4-1). Many Thai firms now strongly wish to improve their technological capability in practice, not in words. This thesis emphasises the importance of direct human contact in the borrowing of technology. Human contact inevitably involves not only technology learning but also cultural interaction. The most important thing is to work together as a good team, local and foreign, hand in hand. As Veblen said, co-operation among different nationals will make a new hybrid society for an industrialising country such as Thailand. Borrowing thus creates a hybrid society. Relocation and immigration facilitate the industrialisation of Thailand. A flying-geese pattern of development of less developed countries thus proceeds, at least in Asia.

As seen in Chapter 4, Thailand had been defined as an agricultural country until WW2 by both external powers and the Kingdom. Thailand did not intend to industrialise. Only recently, Thailand began the process of industrialisation, first from textile industries after the war, and then heavy and chemical industries from the late 1970s. The serious start of industrialisation was planned only in the 1980s. However, education for industrialisation is still at an initial stage, and is not yet aimed at fostering a complete industrial culture. The layers of technology accumulation are still very thin. Technologies have to be piled up from the low to the high, step-by-step. This is the basic argument of this thesis.

Mr. Alongkot, the chairman of the Thai Auto Parts Manufacturers Association (TAMA), describes the cause of the backwardness as follows.

> For the maintenance and development of technology, it is important to foster the habit of reading and writing. The habit enables us to accumulate written records. Westerners and the Chinese both have the habit of reading and writing. Japanese and Koreans also have the habit. On the contrary, Thai, Indonesian, Malaysian people and the Filipinos do not have that type of habit. We don't have the habit of (1) reading the records, (2) filing the records and (3) reviewing the records such as seen in *the Book of Marco Polo* or *Shih Chi* ["Records of the Historian" in China]. That means we are not good at technology improvement [*kaizen*]. It is the time for us to learn these practices. Our company has decided to do it. I should like to tell an extreme example of technology stealing by the Japanese from Germany. A Japanese acquired technical know-how in chemical industry, wrote down the know-how in his own body by tattoo, and committed suicide so that the body would be sent back to Japan.

Mr. Alongkot further continues.

> Thai people have been less anxious to learn new things. They seem to have little curiosity to do research to develop things even though technologies are transferred and transplanted to them. As the result, they have had little chance to grow and develop in the past. Nevertheless, in terms of technology maintenance or minor incremental technology improvement, Thailand seems to be a country that has some advantage because the technology suppliers don't have to worry about or fear technology leap-frog [counterattack by the technology recipient] due to the nature of Thai people. This is why Thailand has become one of the most "suitable" production bases for many industries [a cynical comment by Mr. Alongkot].
>
> In Thailand there has been a belief that once we had a joint venture in Thailand, Thai people would automatically acquire technological capability. We should know that this is completely a misunderstanding. If not only the technology suppliers but also the recipients don't make strong efforts, the technology transfer will never be achieved. Mitsubishi rendered Korea and Thailand technical assistance in car manufacturing, however, Thailand has not become able to produce national brand cars while Hyundai and Daiwoo have already started the manufacturing of national brand cars.
>
> R&D in Thailand is now budding out, but there is still a long way for Thai researchers to go, to reach the state-of-the-arts of the developed countries. The number of scholars with PhDs is growing quite fast. However, I wonder how the Thai government will manage or exploit these precious resources.
>
> The TQC activity in our company aims to change our past behaviours which have obstructed the development of our technological capability.

Veblen emphasised that the European peoples were formed through the long history of interaction, not by the purification of the blood. The development of technology and culture was also achieved by interaction, and a hybrid society was formed. This is exactly what happened in Thailand and is going to happen in Thailand. What happened was the hybrid with Chinese culture, what is going to happen is the hybrid with Japanese technology and business culture.

This time, the scale of immigration is far less significant. Only a few examples are observed. Mr. Nishida came to Thailand in 1983 and helped the technological diversification of T-1. Mr. Onouchi came to Thailand in 1985 and assisted the development of die and stamping at T-2. Both are working for local firms, and have lived in Thailand more than 10 years, and perhaps will stay longer just like other immigrants. J-5 and J-16, typical Japanese SMIs, have a shorter history in Thailand, only four to five years from the start-up until now. Expatriates of the two firms tried to foster young successors in Thailand. As they have accumulated their technologies over almost three decades in Japan, they argue that four to five years is not enough to complete teaching. Among the 23 MDs of Japanese firms, 65 % are at the age of 50 or more, they are all experienced experts from Japan. Nearly half of them expect that they will stay five years or more even if they have to live separately from their families.

Many Thai people are also absorbing Japanese technologies actively. Mr. Chalum, the MD of T-7, Mr. Suchart, the MD of T-2, Mr. Prasartsilp, the MD of T-14, Mr. Ajarin, the MD of J-17, all speak Japanese fluently. They studied in Japan or received technical training in Japan. The number of Japanese language speakers is very few as compared to that of English speakers, although the small number of Japanese speakers play an important role in the learning of technologies from Japan.

T-15 and T-13 are learning Mitsubishi's management, T-19 is learning Isuzu management, the CH group is learning from Toyota group. The way of learning is QIB. Both Mr. Ajarin and Mr. Prasartsilp were trained at Isuzu Motors Thailand. They understand the Japanese "management concept".

The above all cases are examples of cultural interaction through direct human contact. Many confessed that without direct learning by human contact, catching-up may not be achieved. That is the reason why T-17 and T-18, the Siam Cement group, decided to learn the Japanese TQC as a whole, not by a piecemeal method.

Chapter 10:
Summary and Conclusion

A Summary of the Previous Chapters

This thesis discusses technology transfer in developing countries questioning how developing countries have encouraged industrialisation through international interaction, with the West in the centre, the rest in periphery. Basically, the author followed historical views and evolutionary theories. In both cases, the focus was upon *the production system* which is influenced by cultural and institutional frameworks.

Technology spreads in a *flying geese* pattern involving all countries hand in hand through international trade, investment and immigration. Learning technology is not an easy matter because it is complex and dynamic. Technology covers everything related to production, i.e. the transfer of inputs into outputs. Hence, it is equal to the whole system of production which is inseparable from the social and cultural frameworks.

In the case of today's manufacturing industry in the market economy, a production system is composed of (1) manufacturing technology (product/process, improvement, etc.), (2) management technology of labour and equipment and (3) marketing technology. A production system can survive only with competitiveness in the market. In other words, quality, cost and delivery (QCD) are crucial elements of today's production system unless the industry is monopolised by marketing or political power.

A production system inevitably involves country-and-time-specific factors, i.e., it depends on the country of its location and on the timing of its historical development. The Japanese production system is not an exception. In this context, the Japanese production system is characterised by co-operation between the government and the private sector, management and workers, as well as co-operation between large industries (LI) and small medium industries (SMI). The LI-SMI co-operation refers to (1) SMI's exports which supported LI's capital and technology imports and (2) the subcontracting system called *shitauke* which was formulated between the 1930s and the 1950s. Recently, English literature began to analyse the specific nature of Japanese firms and industrial relations with special reference to the co-operative structures[113].

The notion of co-operation is not limited to Japan itself, but extends globally, especially to the neighbouring countries. This notion formulates another specific nature of Japanese capitalism or management philosophy. This notion was coined as the *flying geese* pattern of development by Akamatsu. He observed the due course of Japanese industrialisation in the international interaction among the West, Japan and the rest of the world. Firstly, Japan imported industrial products mainly from Britain after the opening of the country and gradually developed domestic industrial production to replace the imports. Later Japan began exporting light industry goods and capital goods to neighbouring countries competing with Britain and the US. As a result, the course of industrialisation and the international trade between the West and Japan developed into a cut-throat trade competition and finally ended up in a political, military clash involving China and the Pacific-rim area.

The post-war international trade order provided Japan and the neighbouring countries with a chance for the industrial development, which again basically followed the line of the so-called flying geese pattern development. However, because China was excluded from the trade circle until the late 1970s, China's industrial development was retarded. Instead, the industrialisation of NIEs and ASEAN was considerably accelerated by the interaction with the West and Japan. NIEs completed industrialisation through international interaction especially with Japan, first in light industries and later in heavy industries. They were followed by ASEAN countries.

Thailand has never been a colony. However, whether *a colony or not* is unimportant. The point is that Thailand did not begin industrialisation even after the opening of the country in 1855; this was different from Japan. There might have been two possible courses after this opening, one was to compete with the West (to start industrialisation as Japan did), the other was to co-operate peacefully with the West (to remain un-industrialised and follow where a comparative advantage existed as did most tropical colonial territories). The course not to industrialise was selected on the ground of specific historical, geopolitical, domestic and international factors. Probably, it was an unavoidable best choice.

Thailand then had no agent, no will, for industrialisation. It lacked the cultural and institutional frameworks to begin industrialisation. The situation and resources given were quite different from the case of Japan. Thailand had no choice but to co-operate with the West. Consequently, it had to remain un-industrialised, importing industrial goods from the West and exporting rice to the West and Western colonies. It was not until the Democratic Revolution in 1932 that Thailand began industrialisation; at that time, Thailand had no industrial base. It had to borrow capital and technology from abroad. However, the environment was unfavourable. All it could manage was the incorporation of Western and Chinese capital into state enterprises. Industrialisation was thus begun in light industries. In order to push indigenous industrialisation, Ministry of Industry (MOI) was established in 1942. Nevertheless, the fostering of heavy (capital goods) industries was an overly ambitions, and not included in its programme. Thailand had a clear intention to industrialise nearly 90 years later than Japan.

Despite her strong wish for economic development by state intervention, the result was not so satisfactory. The Korean War in 1950 changed the situation. The United States and the World Bank began investment in Thailand, mainly in the physical infrastructure, advising that industrial investment be carried out by the private sector including FDI. According to the US and the World Bank's advice, the Board of Investment (BOI) was set up, at first within MOI, later separated from MOI. Since then, BOI's promotional policies and the MOI's local content policy have played a critical role in Thailand's industrialisation, coupled with the infrastructure built by foreign aid.

As for the private sector, Western capital was invested in Thailand earlier than Japanese capital was. Examples of this includes Unilever, Byer, BASF in the 1930s, Shell, Caltex, IBM in the 1940s, Philips, Hoechst in the 1950s. However, since the 1960s, Japan has also emerged as a key player on the scene of Thailand's international trade and industry. This occurred because the US changed the direction of the policy to support the Japanese industrial development in order to counteract communist power after the 1950s. Supported by the US, high technology industry in Japan started developing and the diffusion to Asia in the flying geese pattern began. At this time, NIEs and ASEAN played a very important role in the trade circle.

As mentioned, Japan became a major investor in Thai textile industries in the 1960s and '70s and, as a result, has played an important role in the development of the technological capability of Thai entrepreneurs. As regards the machine industry in Thailand, the first CKD automobiles were assembled only by Western firms (Ford, Benz and Fiat) in 1961. Later, these companies were followed by Nissan, Suzuki, Toyota, GM, etc. However, discouraged by the local content policy and also by the loss of competitiveness in the market against Japanese cars, Ford terminated its operation in 1976 and GM in 1978. Since then, the Thai car market has been dominated mainly by Japanese cars; consequently, parts industries in Thailand have been fostered mainly by Japanese firms.

The accurate grasp of the real situation of the Thai machine industry is crucial for a better choice in the policy implementation. Thailand began its industrialisation very late compared with the West and Japan. Therefore, an industrial base, especially that of the machine industry, had been almost non-existent. Thailand began assembly of CKD cars, electrical machines and agricultural machines in the 1960s. However, assembly of the imported CKD parts did not upgrade the indigenous technological capability significantly. In the case of the machine industry, the most important thing is to learn technologies necessary to manufacture parts, especially engineering processes. Capital and technology in this field had to be imported entirely from abroad. While the Western firms were not particularly interested in the development of parts manufacturing industries in Thailand, this task was taken up mainly by Japanese FDI following the course of the flying geese pattern development. It is important for the leaders in the government and the private sector in developing countries, including Thailand, to understand that capital and technology have to be imported from abroad, and be accumulated step-by-step. Concerning this point, Landes, Rosenberg, Ogawa, Shingo, Suzuki, etc. explained how to understand technology correctly as shown in the literature survey of this thesis. Until recently, being more a technology importer than an exporter, Japan has been the world largest technology importer.

Although the role of FDI has become widely accepted, a wrong understanding about FDI and technology transfer still widely exists in Thailand and in other ASEAN countries. Typical arguments against Japanese FDI are as follows. Japanese expatriates dominate subsidiary firms, sending comparatively more expatriates for longer periods to hide technology rather than transfer it. Japanese firms usually do not have a comprehensive plan to transfer technology to local staff as compared to the Western firms. They do not provide clear job descriptions or manuals. In addition, the working conditions in Japanese firms are often inferior. Job assignment is also not clear and promotion is slow.

As was explained, Japanese firms have played the role of tutor in the case of textile industries, and also in the machine industries. The clever, flexible implementation of the local content policy facilitated the development of technological capability in the machine industry. A brief summary of the empirical survey in Thailand will be given below.

The number of surveyed firms was 56; 23 Japanese firms, 20 Thai firms and 13 Western firms. Most firms were interviewed by the author except 11 Western firms. Concerning the 11 Western firms, information was collected by mail and telephone in addition to the SEAMICO directory[114]. Therefore, it should be noted that this survey did not intend to compare Japanese and Western firms in general on an equal basis. The comparison was limited to the selected firms.

The case study showed that technology is complex and dynamic. Learning technologies is not as easy as purchasing machines. Technology can be best acquired through human contact. The role of expatriates and OJT is important. Also, technological development will be achieved only when accumulated step-by-step. The case of mould and die industries illustrated how technology is complex and dynamic. This dynamism of technology influences the real process of borrowing. Technology is dynamic and never stands still. Once introduced, it becomes obsolete unless maintained and developed constantly by local staff. Another thing which affects the smooth process of technology transfer is the acquisition of a new management concept such as the Japanese industrial engineering (IE) and quality control (QC). Learning the Japanese management style is important for cost, quality and delivery (QCD). QCD request disciplines and the participation of the shop floor, a slightly unfamiliar business culture both for the West and most developing countries. Nevertheless, from the viewpoint of Japanese management, QCD is indispensable for the establishment of an industry in a competitive market.

In this survey, 56 surveyed firms are classified into four categories according to capital shares, (1) 100 per cent foreign owned, (2) joint ventures (JVs) under foreign management, (3) JVs under Thai management, and (4) 100 per cent Thai owned. In the case of Japanese subsidiary firms [100 per cent Japanese owned firms (6 firms) and Japan-Thai JVs (17 firms)] and Thai firms in QIB[115] (4 firms), TA (5 firms) and Diffusion (6 firms), the learning methods and contents are quite similar. Most firms benchmarked the best practice of Japanese firms. In addition, they have a good understanding of technology. At least, they have an intention to emulate the Japanese best practice. A typical example was the Siam Cement group which has JV, QIB and TA relationships with Japanese firms.

In contrast, some firms in TA and Diffusion still have a long way to go. Decoding the Japanese management style and receiving regular orders from them seem to be difficult. These local firms still need to make considerable efforts to accumulate knowledge and experience in order to reach the standard of the Japanese top class parts manufacturers in the engineering industries. The lack of human resources and the high turnover of employees are also preventing them from reaching these targets.

Firms classified in *Indigenous efforts* have difficulty in accessing Japanese technology. As indigenous firms in an agricultural country like Thailand, they began repairing imported machines and parts by reverse engineering. They lack education and experience in industry. The support by the government agencies has been scattered and thin compared to that in the West and Japan. This is inevitable because Thailand began its industrialisation in the machine industry in the 1960s relying on FDI. Technology then was almost non-existent, whereas Japan began industrialisation in the 1850s by establishing higher education institutes and schools, sending students abroad to learn technology, inviting teachers and engineers to their country according to their need.

The survey found that the major motive of Japanese FDI is *labour shortage*, especially in the so-called 3K industries[116]. Labour shortage is the push factor to relocate industries, first to rural areas in Japan, and then later to neighbouring countries involving the multi-tier subcontracting system and requesting sacrifice of the second and third-tier subcontractors. Coupled with the second major motive, the market expansion, FDI is likely to spread technology from high to low, from developed to developing countries[117] as this thesis repeatedly argues.

The process of technology transfer is not an easy matter both for investors and for local staff. Japanese firms and expatriates tend to push the Japanese business culture which may not be popular in developing countries. Local people, especially who were educated in English speaking countries, are not familiar with the Japanese business culture. They tend to judge the Japanese operation by the standard of the West, such as, the employment agreement with job descriptions, training manuals, and so on. Although Japanese firms originally borrowed the management system from the West, Japanese firms have adapted the Western system into the Japanese way. Therefore, both Japanese expatriates and local staff often face stresses and conflicts, probably more than in the case of Western firms which tend to conduct *arms-length* management in Asia, as Sedgwick[118] observed. The empirical survey presented in this survey concludes that Japanese firms will be successful only if they manage to implement the Japanese management concept and establish disciplines for QCD. The disciplines and the team spirit are the starting point for QCD. Learning difficult skills and higher level technologies, i.e., *improvement* and *creative technologies,* also needs strong efforts and disciplines.

In many Japanese subsidiary firms, R&D activity has been carried out as yet on a very minor scale as compared to the scale of the facility and human resources in Japan. As many Japanese expatriates pointed out, a more important thing for local staff is to learn and accumulate *operational technologies* first. Through daily operations, local staff may learn *improvement* and *creative technologies* as seen in some surveyed firms. As mentioned, industrialisation in the machine industry in Thailand was begun in the 1960s, whereas in Japan it was begun in the 1850s. The 110 years gap has to be considered seriously. It is not wise to complain as quoted in Chapter 5 that "the Japanese do not teach, we need R&D, not a simple operation".

Finally, in order to clarify the reason for the comparatively large number of Japanese expatriates and their longer stay in Thailand in comparison with Western firms, this thesis compared the technology adopted between 23 Japanese firms and 13 Western firms. The methodology was as follows. The author collected lists of firms in the machine industry from the Department of Industrial Promotion (DIP), chambers of commerce and industry of Japan, the US, and the UK. With the lists in hand, the author started contacting firms, trying to get a wider and deeper view of the machine industry in Thailand, in addition to the author's accumulated knowledge as an advisor for SMI promotion—at DIP from 1984 to 1988 and at the Overseas Investment Advisory Service Section at the Shoko Chukin Bank from 1988 to 1992. The author visited firms in the category of the machine industry basically in the order of "the first come, the first visit" basis. Partly because of less samples in Western firms and partly because of the different natures in Japanese investment and Western investment in the machine industry, the Japanese samples included many machine industries engaging in more difficult engineering technologies, whereas the Western samples included mostly electrical industries which adopted rather easier technologies.

Conclusions

This survey, thus, suggests following recommendations for a more effective industrialisation.

(1) State leadership and encouragement are necessary

Development of industrial technology needs state leadership and encouragement. Experience in Thailand showed that a free trade policy, based on a comparative advantage, had retarded the industrialisation of Thailand until the 1930s. Industrial promotion, especially the establishment of technological education and practical training on the shop floor, have played an important role in the industrial development in Japan.

(2) Direct human contact is indispensable

Borrowing technology is the best way to develop industrial technology. Because technology is composed, not only of machines and manuals, but also of acquired *human skills* and *memorised routines*[119], it is indispensable to learn directly through human contact.

(3) Replacement of foreign expatriates does not mean technology transfer

A popular claim in ASEAN countries that Japanese expatriates dominate subsidiary firms and do not transfer technology is misleading. Replacement of expatriates with local staff does not mean technology transfer. Neither majority, or full ownership or a national brand equal technology transfer. Technological capability is not nominal, but it exists on the shop floor.

(4) Emphasis on the shop floor is important

Local staff with high education are often reluctant to practice on the shop floor. Theory without practice is not able to make a competitive industry. More emphasis needs to be placed on practical education and training. The value system, to disregard practice on the shop floor, seems to retard learning of industrial technologies.

(5) Step-by-step learning is the best way to accumulate technologies

Continuous efforts in learning *operational* and *improvement technologies* through experience on the shop floor is the best way to accumulate technologies. Assembly of CKD parts is only a first step. The next step is to acquire parts manufacturing technologies.

(6) A careful attention to R&D is necessary

R&D capability will be accumulated on the basis of learning *operational* and *improvement* technologies. It seems futile to request *creative* technologies until *operational* and *improvement* technologies are accumulated to a considerable extent. R&D activity requires a huge amount of investment both in facility and human resources, which only highly industrialised countries can afford today. In the case of developing counties with a lower per capita GNP, a balance between investment in the physical infrastructure, hospitals, basic education, technical training on the shop floor, etc. and R&D has to be considered carefully.

(7) Cultural interaction and awareness

What follows are lessons for Japanese firms. Firstly, Japanese expatriates are advised to learn, or at least to try, to understand local language and culture before they go to Thailand or to any other country. Provision of language and culture courses would help a smooth cultural interaction and technology transfer. This author believes that local language is more important than English from the viewpoint of keeping a balance among plural cultures. To ensure a smooth technology transfer, interaction between cultures on equal base is paramount. Both the Thai and the Japanese firms need to pay more attention to the cultural aspect. Furthermore, in order to facilitate a smooth technology transfer, manuals in local language for local staff seem to be beneficial although it may be difficult to arrange them in the same manner as the Western MNCs. In any case, a careful attention has to be paid to avoid misunderstanding between expatriates and local staff. In sum, warm care for cultural values will be beneficial for all parties concerned.

Lessons for the recipient countries are as follows. The most successful policy for Thailand has been the assimilation of Chinese into Thai, in language, culture, commerce and industry, which created a hybrid society in Veblen's term. This multi-culture atmosphere forms a favourable investment opportunity for foreign investors. The encouragement of the private sector and the flexible policy adjustment to let foreign investors survive are further welcome. A serious problem for investors, foreign or domestic, is the high turnover ratios in local staff. More practical education and training to bring in *practice over theory* and *getting your hand dirty attitude* on the shop floor have to be conducted. This new industrial attitude will be followed by a serious search for knowledge of science and technology. A common belief that technology transfer will be achieved if local staff are given managers posts, replacing expatriates, will gradually disappear according to the accumulation of knowledge and experience in industry. Local entrepreneurs and staff have many things to learn from expatriates. It should be noted that after a failure in the indigenous technological development during the 19th and the early 20th century, Japanese electrical firms changed their policy to learn technologies through JVs before the war[120]. It is important to understand the dynamism of technology and foster a co-operative culture inside the firm, the country and also globally. This is a way to help the development of technology and, as a result, to serve for the welfare of the people.

In conclusion, this thesis contends that technology will spread in a co-operative way of a flying geese pattern of economic development and facilitate the technological development of developing countries. In this course of a development passage, Japan has played and will further play the role of tutors until when developing countries catch up with Japan. The leading goose in the twenty first century can be any country according to the course of development to follow; that assumption being included in the premises[121]. Until then, borrowing technology is indispensable.

Notes

[1]Akamatsu called the pattern of development the "wild-geese-flying pattern" or *ganko keitai* in 1962 (Akamatsu, 1962: 11). Howe briefly called it "flying-geese" pattern (Howe, 1996: 409).

[2]Narrow and blurred distinctions of technology and technique do not distinguish the difference between technology and technique (Ahiakpor, 1990: 31-2).

[3]Some persons stress the managerial aspect (Chong, 1983) or the marketing aspect (Rugman, 1986) rather than the technical aspect.

[4]Veblen used both the term "an industrial system"(e.g., Veblen, 1939: 32, 129) and "the system of production"(Veblen, 1939: 136).

[5]The case the author observed at a village in the Northeast of Thailand during the work at the Department of Industrial Promotion around the year 1985-6.

[6]Fransman recognised that from the late 1970s some literature (e.g., Baranson and Roark, 1985; Stewart, 1990) on Third World technology began to distinguish six different technological capabilities. They are:

> (i) search for and selection of technology, (ii) mastering of technology, (iii) adaptation, (iv) minor innovations, (v) R&D, (vi) basic research (Fransman, 1984: 10).

For example, Stewart classified technology transfer in developing countries into four levels; basic level (operational technology), intermediate level (duplicative technology), technological self-reliance (adaptive technology) and advanced design (innovative technology) (Stewart, 1990: 309). On the other hand, TDRI classified technological capability into four categories; acquisitive, operative, adaptive and innovative (TDRI, 1989: (3)-31-2; Sumeth, 1992: 41-5).

[7]Ogawa's "three strata of technology accumulation" appeared first in his analysis of Korean and Thai textile industries in *Ajia Keizai* (November 1976: 49-50). This concept was clearly expressed in his later works (1992; 1993a; 1993b).

[8]It is suggested to place "the theory of the multinational corporations" within the framework of "the theory of the firm" (Ahiakpor, 1990: 5-6; Casson, 1987: 1).

[9]The nature of Japanese firms is discussed by Nakatani (1988: 16-7) and Sakakibara (1993: 158-9).

[10]The concept of "routine" was first brought in by Schumpeter. If innovation spreads, it loses its competitive edge, and is reduced to "routine". (Heertje, 1988: 79).

[11]Kaplinsky (1990) and Stewart *et al* (1990) introduced the history of the AT movement and AT institutions. The names referred to are Intermediate Technology Development Group (ITDG) in London (1964), Appropriate Technology International (ATI) in Washington, Groupe de Recherche et d'Echanges Technologiques (GRET) in France, German Appropriate Technology Exchange (GATE) in Germany, and existence in Canada, India, Ghana. These organisations worked with local non-governmental organisations or, in some cases, with governmental organisations in DCs.

[12]Maruti Udyog Ltd.(MUL) is a JV state enterprise with Suzuki Motor Co. of Japan, established in 1982. Suzuki's investment was 26 percent in 1982, 40 percent in 1987, and 50 percent in 1992 (Takahashi, 1995: 34-5).

[13]The Marco Polo Bridge Incident was a fight between Japanese army and the Chinese National garrison near the Marco Polo Bridge outside Beijing, which marks the beginning of the Sino-Japanese War (1937-45).

[14]*shitauke* refers to the system of subcontracting or an individual firm (s) in the system.

[15]Howe introduced the case of the textile industry in China in the 1920s and presented how a Japanese business leader understood technology transfer at that time. According to Howe, the leader expressed that technology transfer was for "the mutual benefit of Japan and the recipient country":

> We (Japan Cotton Mill-owners' association) exist to improve the industry, to develop the finest friendship between our competitors of other nationalities and ourselves, to maintain the most cordial relations between the management and the labourers, and to provide for the labourer as favourable conditions as the production of the industry will permit (Howe, 1996: 411).

[16]In the Tokugawa era preceding the Meiji, Japanese people are classified into four classes; i) *samurai* (*shi*), i.e. warriors and bureaucrats, ii) farmer (*no*), iii) craftsman (*ko*), and iv) merchant (*sho*).

[17]Sometimes, large industry (LI) and small-medium industry (SMI) are used as collective nouns to represent plural numbers of LI and SMI.

[18]*Kogyo Iken* (Recommendations on Industry) by Maeda Masana, 30 volumes, 1884.

[19]It was reported that, by February 1940 the Ministry of Industry had decided the relocation of 21 factories to Manchuko, and planned to relocate about 50 factories by March 1941. In addition, it was reported that Taiwan and North Korea as well were requesting SMI from Japan (Yamanaka, 1948: 200). On the other hand, in October 1940, as a means of SMI's "tengyo (change of jobs)" policy, the government decided to promote relocation of SMI to Manchuko as agricultural settlers, not as industrialists. Under this scheme, from December 1940 to March 1941 1,780 families went to Manchuko as settlers (Toyoda, 1941: 426-7). In 1939, among all factory establishment in the colonies, 18.4 per cent in Taiwan and 41.6 per cent in Korea were of Japanese investments. As regards size of factory, large size factories with 200 or over employees were mostly of Japanese investments (96.5 per cent in Taiwan and 92.0 per cent in Korea). As regards small-medium size factories, a large portion (employment size 50-99; 46.0 % in Taiwan, 57.6 % in Korea) were shared by Japanese investments (Yamamoto, 1992: 171). The spread of industries was thus achieved by Japanese SMI before and during WW2.

[20]Rates of subcontracting (= 1 - rate of in-house production) by automobile assemblers were as follows: Toyota (Japan), Nissan (Japan) and Kiat (Korea) 70% each; GM (US) 30%; Ford (US) 50%; Benz (Germany) 57%; Peugeot (France) and Renault (France) 40-50% (National Association for Subcontracting Promotion, March 1993, quoted in JICA/UNICO, 1994b: 1-3-6).

[21]LE and SME refer to large enterprises and small-medium enterprises, including commerce and service industries. Sometimes, LE and SME are used as collective nouns. At first in the Meiji period, the term "*small* industry (*sho-kogyo*)" appeared. Around the 1920s, the term "*small-medium* commerce and industry (*chusho sho kogyo*)" became popular together with the term "*small-medium* commerce (*chusho shogyo*)" and "*small-medium* industry (*chusho kogyo*). After WW2 the term "small-medium enterprise (SME, *chusho kigyo*)" which covers both manufacturing industries and other industries such as commerce has been widely used (Yamanaka, 1963: 8) especially after the enactment of the SME Basic Law in 1963. In fact the term SME very often refers to SMI as seen in the following discussion.

[22]As mentioned in the earlier footnote, during the war time the relocation programmes of small-medium enterprises (SME) to Manchuria were planned and implemented (Yamanaka, 1948: 20; Toyoda, 1941: 426-7).

[23]*SME White Paper* (*Chusho Kigyo Hakusho*, Tokyo: MOF Printing Bureau, each year for 1963-1995) is the report on SME by MITI to the parliament following the assignment by the SME Basic Law (1963).

[24]Special agencies for SME, i.e. Small Business Corporation, Shoko Chukin Bank and Small Business Finance Corporation, have been sending advisors since the late 1980s.

[25]Source: Shoko Chukin Bank, Overseas Investment Advisory Service Department, 20, July, 1994, not published. General information on the government schemes and statistics on FDI by SME are included in the yearly *Chusho Kigyo Hakusho* (SME White Paper).

[26]Chrysler Corporation acquired control of Rootes Motors in 1966-7 (*The New Encyclopaedia Britanica, Vol. 3,* 1994: 290)

[27]The number of the approval of "A type" technology license agreements from 1949 to 1959. Original data is in *Gaishi Donyu Nenkan* (1962), quoted by Nihon Kikaikogyo Rengo (1982: 89).

[28]Casting for higher strength and ductility with the processing advantage of iron and the engineering advantage of steel (Morris, 1992: 1472). Ductile iron casting is also called nodular graphite cast iron or spheroidal cast iron. Its production technology was invented first in the UK in 1947 (based on the letter from Mr. Shibata Koichiro, Japan Society for the Promotion of Machine Industry, April, 1996).

[29]A production method of spheroidal graphite cast iron was invented by Meehan, an American company, in 1926. This method provided strength to cast iron (Sogo Imono Sentaa, 1976: 108; Nihon Imono Kyokai (ed.), *Imono Benran, Kaitei 4-pan*: 495).

[30]*Manufacture* of needles is a case of synchronised production (Marx, 1990: 464)

[31]The term *automation* was used by Marx for German paper-mill and British fabrication. According to him, "automation is the most developed form of production by machinery" (Marx, 1990: 503).

[32]NS Chemicals Co. in Tokyo, a Honda's subcontractor, engages in plastic injections, and use second tier subcontractors. The jobs subcontracted out are product items of a lot size less than 1,000 or items which need demanding 3K tasks or simple manual tasks. 3K tasks, for example, include a process which emits poisonous gas and pollution (interviewed by the author on 12 January 1996).

[33]See Imai, Masaaki, *Kaizen,* (New York: McGraw-Hill, 1986)

[34] See Takahashi, Yoshikazu and Osada, Takashi, *TPM: Total Productive Management,* (Tokyo: APO, 1990)

[35] In Toyota, *poka-yoke* was called *baka-yoke*, a direct translation of an English word 'fool-proof'. Shingo theorised Toyota's baka-yoke, but avoided the sound of *baka* (stupid) because human workers are not infallible. Instead he used the word poka-yoke (Shingo, 1986: 45). *poka* means a normal mistake which happens to every body.

[36] A new production system called "scientific management" based on motion study and time study, which was theorised by Frederick Taylor, an American engineer (Morris, 1992: 2174). The production system at Ford was a typical example of this scientific management or Taylorism.

[37] Machines used for military purposes during the war time were distributed at lower prices (Morris-Suzuki, 1994: 174)

[38] From the fiscal year 1956 to 1970, total loans of 33.7 billion yen were advanced to 529 auto parts firms by the Japan Development Bank (*Kaihatsu Ginko*) and the Small Business Finance Corporation (*Chusho Koko*) (Oshima, 1987: 34)

[39] The author's survey in Thailand (August 1993, November 1994, March 1995).

[40] Similar "circle systems" or *kai* were introduced in Thailand to develop local suppliers' management and technologies. Details are in Higashi's report (Higashi, 1995: 39-48)

[41] By law, a "*shitauke*" is defined as a firm which manufactures goods, half-manufactured goods, parts, accessories, raw materials, or manufactures or repairs equipment or apparatus, taking order from larger firms than itself (SME Shitauke Promotion Law, 1970). In Japan, 378,000 firms, 55.9 per cent of all manufacturing firms, are counted as *shitauke* in 1987 (Figure III-2 in Mitsui, 1991: 118). In practice, however, apart from the definition by law, it often refers to *shitauke* in machine industries as previously discussed.

[42] A mail survey to 1500 firms. Answers were collected from 120 firms (8 per cent). Information obtained from questionnaires includes clear pictures of multi-tier structure of *shitauke*.

[43] In 1962, 88% of trade items were liberalised. Furthermore, IMF was advising Japan to shift to the country of IMF Article 8. This was accepted by the Japanese government that SME needed hard efforts to adapt to the new economic environment (Chushokigyo Pii Aaru Senta, 1963: 21).

[44] The author's survey at Bangkok in 1994-5. The *kanban* system is a method to decrease stock and synchronise production by accurate delivery time at the production site. It is also called just in time (JIT). Originally, *kanban* in Japanese language refers to "signboard" or "notice board."

[45] In the 1970s, the number of machines held by machine industries increased. Customers' needs diversified. The shift from mass production to a variety of small-lot product became common. NC machines fit this new environment. The number of machines held in Japan surpassed that of the USA, and Japan has been the world leader since 1982. In the 1980s, introduction of NC machines and FMS was apparent (Kikaishinko Kyokai, 1989: 3). The statistics tells that the number of NC milling machines in 1967, '73, '81, '87 are 79, 1657, 10,997, 29,576; MC for the corresponding years are 0, 679, 4,860, 15,659; EDM in 1963, '67, '73, '81, '87 are 1,078, 1,878, 3,244, 5,144, 7,700 (Kikaishinko Kyokai: 1989).

[46] In the case of a subcontractor of Toshiba Kikai (Toyo Kikai at Numazu) most employees were over 55 years old and failed to learn programming of NC machines. The firm makes six MCs in a month by general purpose machines (interviewed in January 1996 by the author).

[47] Toyota's 1,100 supplier firms were composed of 300 parts suppliers, 500 equipment, machines and tools suppliers and 300 raw materials suppliers (Ohashi, 1987: 9).

[48] Sakdi Na is the social system of the concentration of economic power in the hands of the king and the royal and noble élite (Brown, 1988: 171). The Sakdi Na class absorbed a severely disproportionate share of the Kingdom's surplus product, while, cultivators, the essential creators of wealth, were reduced to bare subsistence (Brown, 1988: 171). Suehiro wrote a good description of Sakdi Na and quoted Wyatt: "Wealth and power was synonymous: ...it was very rare for an individual to have the opportunity, the wisdom, or the incentive to amass private wealth" (Suehiro, 1989: 277)

[49] Based on the author's hearing from Mr. Alongkot Chutinan, who is the managing director of the Siam Nawaloha Foundry, and the chairman of the Thai Auto Parts Manufacturers Association in January 1995.

[50] In contrast to the 3 % import duties of Thailand, "In India, *ad valorem* import duties on cotton fabrics and other manufactured goods were set at a level of 5 % of their import value, while those imported from other countries were levied at 10 %. In the cases of China and Japan, *ad valorem*

import duties were initially set at a level of 5 % in the Nanking Treaty of China (1842) and the British-Japanese commercial treaty (1858) respectively" (Suehiro: 1989: 21).

[51]Prasertkul introduced the case of the Privy Purse and the Royal Treasury (Prasertkul, 1989: 234-242).

[52]Nationality was defined by birth. Children of Chinese immigrants were defined as Thai nationals. Nationality Act in Thailand was promulgated in 1913, stimulated by Chinese Nationality Act which was enacted in 1909, which defined all Chinese descendants as Chinese wherever they were born (Prasertkul, 1989: 289). Therefore, the Chinese who were born in Thailand were regarded as Chinese by the Chinese government.

[53]The foreign aid to Thailand came mostly from the US and the World Bank. For example, from 1960 to 1964 the US provided 70-80 % and the World Bank 20-30% of the aid, totalling about 40-50 million dollars each year. In the 1970s, Japan's contribution became the second largest to exceed that of the World Bank (Yoshioka, 1976: 270-1).

[54]Ministry of Industry was established on 5 May 1942 (Source: Department of Industrial Promotion, 1993)

[55]Different to the 1932 coup group, the generation of Sarit Thanarat, Thanom Kittikachorn and Praphas Charusathian were entirely educated in Thailand, as the sending of Thai students abroad had been extremely limited during the late 1920s to the early 1950s. This accounts for their strong yet slightly different type of nationalism (Wyatt, 1984: 279).

[56]A Spanish project was submitted which proposed a million *rai* of cotton in the North-east and a huge textile factory to employ one and a half million people. However, at the later stage it became clear that the project requested 25 years of complete import ban on all textiles except silk and woollens. Two other examples around 1959-60 are also introduced (Insor, 1963: 160-2).

[57]In the 1960s state-run factories were established in sacks, sugar, pharmaceutical, chemical fertiliser, paper (Tsuneishi, 1989: appendix table 1). The second Five Year Plan expressed the expansion of state-run factories to follow the demand and necessity of the whole society, stressing paper industry, chemical fertiliser, iron, automobile assembling, cement, gunny bags, textiles, etc. (Warin and Ikemoto, 1988b: 265). Among them, paper, chemical fertiliser and gunny bag industries were under MOI's operation.

[58]Source: JCC, *Kojo-ho, 1992* (Factory Act, 2535) (Bangkok: Japanese Chamber of Commerce and Industry, 1993); "Kojo Kanren no Shin Kogyosho Rei", *Siam Business News,* 11 June 1993; Kuroda, 1994: 40-1.

[59]The years of establishments and the contents of their activities were based on the following source: SIFO (Kuroda and Kasajima, 1987: 231) and SISI (IMC, 1984: III) .

[60]The budget requests for an arsenal by the army and for the Department of Railway were not welcomed in the early 20th century (Brown, 1992).

[61]Both Shamu Kyokai (1929: 527) and Miyahara (1939: 101) mentioned the name of the Bangkok Dock Company by British capital. It is supposed that this firm was handed over to the Navy in 1943.

[62]In 1962, controls were imposed on sugar, paper umbrellas, silk textiles, tin foils, and gold. Later, up to 1971, garlic, glass tumblers, trucks, files, jute bags, insulators, tableware, silk textile fabrics, school exercise books, woods, etc. were added (Bangor, 1988: 218).

[63]CKD refers to complete knock down. The import of CKD components and completely build up cars (CBU) were allowed.

[64]Source: Asahi Shimbun News, 2 September 1966, quoted in Osaka Ajia Chushokigyo Senta, 1967: 34-5

[65]The number of imported CBU and CKD units (passenger cars, pickups, vans, buses and coaches) proceeded from 1970 to 1973 as follows; 39,923, 36,417, 34,205, 55,660. The number decreased from 1970 to 1972 and turned to increase from 1973 (Tara Siam Business Information, 1993: 278-82).

[66]Number of disputes leading to work stoppages increased from 1971 to 1975; 27, 54, 501, 357, 241 (Santikarn, 1981: 50).

[67]The local content was measured by the ratio of the aggregated prices of the local content supplied domestically to the FOB sales price of the cars. For example, if all parts and components are imported, the local content will be zero. If all parts and components are supplied locally, the local content will be 100 per cent.

[68]Prime Minister Prem was requested by Toyota to reconsider the change in the local content policy when he visited Japan (Kesavatana, 1989: 152). Industry Minister Ob withdrew the limitation of car models and the raising of the local content after receiving the complaints from Toyota and Siam Motors (Kesavatana, 1989: 156).

[69]Industry Minister Ob wanted 100 per cent local content and a national car (Kesavatana, 1989: 154).

[70]The World Bank's report in 1980 suggested ten product groups such as hand tools, small agricultural machinery, etc. The report by the Research and Data Resources, Co., Ltd. in 1981 added household electrical goods to the World Bank's report (IMC, 1984: 22).

[71]Ozawa called the law of diminishing return "the Ricardo Hicksian trap". Ozawa quoted Hicks from "Future of Industrialism" *International Affairs* (Vol. 50, 1974):

> Irremovable scarcity (of land or of labour) would cause the rate of return on the spreading of the original improvement to diminish....With labour costs rising, the rate of profit would fall (Ozawa, 1979: 65-6)

[72]Small Business Finance Corporation (SBFC), a government financial corporation for SMEs in Japan.

[73]The survey by SBFC. It collected data from its clients. The number of collected questionnaires was 5,650 firms. Among them 316 reported FDI in operation and 105 reported withdrawals after FDI. The withdrawal rate = 105 ÷ (316 + 105). Source: Japan Center for International Finance (JCIF), *Wagakuni Chokusetsu Toshi-no Arikata* (Tokyo: JCIF, 1990: 60)

[74]Casson uses the expression multinational enterprises (MNEs) instead of multinational corporations (MNCs).

[75]Marshall described:

> The master's eye is everywhere. .....There is no shirking by his foremen or workmen, no divided responsibility, no sending half-understood messages backwards and forwards from one department to anther (Marshall, 1964: 160).

[76]The statistics of FDI in Japan has been based on approvals and reports to MOF. Until 1980, all FDI was requested to obtain prior approvals by MOF. In 1980, prior approvals became unnecessary but prior reports to MOF were required. The minimum size of amount for reports was increased from 3 million yen to 10 million yen in 1984, to 30 million yen in 1989, and to 100 million yen in 1994.

[77]Source: "Amerika no Toshi Kankyo" (Shoko Chukin Bank, July, 1991). A survey by Shoko Chukin Bank in 1991, not published.

[78]Regarding the efficiency in technology transfer, Ramstetter argued that "even if the transfer process is relatively inefficient in Japanese affiliates in the short run, the transfer may be just as effective or more effective than in other multinationals in the long run" (Ramstetter, 1993: 18).

[79]Sedgwick, Mitchell speaks Japanese and surveyed many Japanese firms both in Thailand and Japan. The author met him in London in March 1996.

[80]It is reported that European businessmen enjoyed a comfortable life in Asia: "Their place is now taken by a far greater number of Japanese businessmen, not settling down to a comfortable 'expat' life as did the Europeans, but posted there for short periods of two or three years before returning home" (Wilkinson, 1983: 150).

[81]Mr. Sato Ichiro, a former president of Toyota Motor Thailand, stated that Japanese style management such as the seniority system, the vagueness in the decision making process and the lack of job descriptions has to be adapted to the American style management analysing the social customs of individual countries (Sato in Yamashita, 1991: 196).

[82]Source: "Nikkei Kigyo-no Jittai (Kokendo) Chosa"(A survey on the contribution of Japanese firms to Thailand), Japanese Chamber of Commerce and Industry, Data No. 197 (JCC, December 1990).

[83]Source: TDRI, *Thailand's Economic Structure: Towards Balanced Development? Background Report* (Bangkok: TDRI, December 1992: 7)

[84]Concepts of *improvement* and *development* are equal to the concept of technical change by Freeman and Perez or innovations by Schumpeter (see Chapter 2).

[85]Rosenberg pointed out that the distinction between innovation and adaptation should not be overstated (Rosenberg, 1972: 23-4). He also stated that technology developed continuously from "imitation" to "innovative adaptation", and then to "pioneering, creative innovations" (Rosenberg, 1994b: 122). Ruttan also discarded a clear distinction between "invention" and "innovation" (Ruttan, 1971: 83). In this thesis, adaptation is called "improvement", and innovation is called "development (creation)".

[86]A classification by the Ministry of Industry, the Royal Thai government.

[87] In Thailand, industrial statistics are collected and printed by MOI, but not aggregated and published. Therefore, there are a few unauthorised calculations of industrial statistics. Different sources give slightly different estimates of the total number of industrial firms. The difference, however, arose from the difference in classification and the surveyed time, e.g., the total number of firms in the machine industry has been put as 15,658 in 1984 (Kuroda and Kasajima, 1987: 365), 15,215 in 1984 and 12,180 in 1986 (*Bangkok Bank Monthly Review*, April 1988: 180); 16,787 in 1989 (Kaigai Konsarutingukigyo Kyokai, 1992: 65-7) and 22,355 in 1990 (Ajiakeizai Kenkyusho, 1992: 215).

[88] "about five per cent" was based on the calculation by Ajiakeizai Kenkyusho shown in the note above.

[89] In the following, symbols (J-1 to J-23, W-1 to W-13, T-1 to T-20) present serial numbers for firms in the survey. For example, J-1 refers to the Japanese subsidiary firm No. 1, W-2 to the Western subsidiary firm No. 2 and T-3 to the Thai firm No. 3 in the survey (see Table A-1, A-2, A-3).

[90] The following story mainly depends on the interviews with Dr. Furubayashi (J-17), Mr. Chaya (J-19) and Mr. Komechi. Mr. Komechi Yasuhito is the general manager of Nissan Trading Co., Ltd., former president of SNN Tools and Dies.

[91] There are many reasons of Japanese car's excellence. Japanese cars have less troubles, better after service, cheaper prices, better accessories, better functions, etc. A beautiful look of outer panels is only a part of Japanese car's excellence (Kawahara, 1995: 228-38).

[92] Fingleton reported that Chrysler's new model car "Neon" is made using Japanese presses and other sophisticated production equipment. In general, Japan supplies the Detroit Big Three with advanced moulds (Fingleton, 1995: 72).

[93] The importance of the handling of "springback nature" in making the automotive body is described (Hammett *et al*, "Producing a World-Class Automotive Body", 1995: 243)

[94] Korea achieved 85-8 per cent of local content in 1992. However, Korean cars still have to depend on imported parts for their critical parts (Mizuno, 1994: 50).

[95] "Often they are easier to fabricate than metals, and the final cost is frequently cheaper than metal parts" (Amstead *et al*, 1987: 215)

[96] TDRI wrote:

> Spurred on by the enthusiastic technical input of the company's founder, the technology transfer was successful enough to enable the company to rapidly develop the capability to make significant design changes in some basic consumer products in the late 1960s and early 1970s (TDRI, 1989: 4-4).

[97] In Japan, there is a law for the small-medium enterprises co-operatives under MITI. In addition, there are government agencies to support the small-medium enterprises co-operatives. For example, the Small Business Corporation (SBC) and the Shoko Chukin Bank (SCB) have advanced long term loans and short term loans for the development of co-operatives and facilitated their investments and activities when they had needed expansion funds. SCB was established in 1936 in order to support co-operatives.

[98] Legally, NEWI (Nippon EWI) is not a co-operative. It is a limited company. However, NEWI is managed by Mizushima Kikai Kinzoku Kogyodanchi Kyodokumiai (a co-operative). NEWI was established separately from the co-operative because the co-operative law doesn't describe the foreign investment in its activities. The law did not expect that a co-operative might go abroad.

[99] ISO stands for "International Organization for Standardization" which aims to promote the development of standardization in the world in the sphere of intellectual, scientific, technological standards. Some 9,200 international standards have been published by ISO (*Yearbook of International Organizations, Vol. 1, 1995/96*)

[100] The Thai partner was established in 1959 and the number of workers was over 2,000 in 1992 (SEAMICO, 1993).

[101] It is a common understanding among industrialists, as a text book says, that "....they (plastics) are easier to fabricate than metals, and the final cost is frequently cheaper than metal parts" (Amstead *et al*, 1987: 215).

[102] LTEC Ltd. (J-9) is an exceptional case which invested a large amount in land, house and equipment. This firm plans to carry out R&D activity in Thailand.

[103] Sanshu, a Honda's subcontractor in Tokyo, boasts of its press technology for auto parts such as poli-V shaped pulley. A poli-V shaped pulley has multiple grooves, yet the process doesn't produce steel waste, which will be produced if done by machining process. Equipment and dies were designed and developed in-house. Interviewed by the author on 12 January 1996 in Tokyo.

[104]Mr. Oshima Ken, Toshiba Corporation Europe Office, UK. Interviewed by the author in October 1995.

[105]This idea is called "humanization of work" or "quality of working life (QWL)". A successful case of parts assembly at *Mitsubishi Denki* is introduced (Hasegawa, 1991: 134-6).

[106]A unit of pressure that is taken to be the standard pressure of the earth's atmosphere at sea level; equal to the pressure of a column of mercury 760 mm high, or about 14.7 pounds per square inch (Morris, 1992: 175).

[107]Mr. Paibool Choopuengart, Chief of Testing Section, Metalworking and Machinery Industries Development Institute (MIDI), Department of Industrial Promotion (DIP)

[108]The author met Mr. Sunsurn several times during his stay in Bangkok between 1984 and 1988.

[109]TDRI wrote: "They largely produce fake and imitative spare parts for the spare parts market. They just can copy the outlook of the products without knowledge on product specification and underlying technology (e.g. the use of casting instead of forging for connecting rods)". (TDRI, 1994: 60)

[110] Information source: Mr. Inoue Takeshi. He is the technical team leader, JICA mission, for the study of the supporting industry in Thailand (JICA/UNICO, 1994a, 1994b). He was formerly involved in the setting up of the Siam Kubota Industry Limited. Mr. Inoue was interviewed by the author in November 1994.

[111]Mr. Inoue Takeshi, a former employee of Kubota Corp. See the note above.

[112]An anonymous plant manger of a Western firm said: "Technological capabilities of Thai people; I think they are reasonable. Our production processes don't require high technological skills, so that was no problem to us. To find Thai people with good organising capacities is more difficult. On top of that the level of English speaking is rather low. Training the organisational skill according to European standards becomes therefore very difficult". (December 1994 in Bangkok)

[113]Examples are Gerlach (1992) and Fruin (1992). A Korean business manager, Kang, compared Japanese and American management styles through his working experience in foreign companies in Japan and the US (Kang, 1990).

[114]SEAMICO directory provided exhaustive data covering the addresses and the telephone numbers, the names of managing directors, the year of establishment, the number of employment, capital shares by country, products and processes, major equipment, etc. This directory is helpful to grasp a grand view over the machine industries. The author classified and analysed the distribution of firms in the directory. A summary of the analysis was shown in the Appendix B. In addition, JICA/UNICO (1994a, 1994b) also provided useful information on the machine industry.

[115]The terms QIB, TA, etc. are defined in pages 227 to 231.

[116]See the glossary in page 10.

[117]Akamatsu quoted the "flying geese pattern" development theory by List (F. List, 1841) in his paper in 1942 when he himself analysed the trade development focusing Japan and China. He wrote in the paper that his theory of the "flying geese" pattern development is to be referred to "Wagakuni Sangyo Hatten no Sogo Benshoho (Dialectic analysis of Japan's Industrial development)", *Shogyo Keizai Ronso Vol. 15*. (Akamatsu, Kaname, 1942: 75).

[118]Source: Sedgwick (1995).

[119]The concept of *routine* was developed by Nelson and Winter. See Chapter: 1-2.

[120]Examples are Toshiba with GE (JV, 1905), Mitsubishi with Westing House (JV, 1923), Fuji Denki with Siemens (JV, 1923) and so on (Takeuchi, 1966). Takeuchi's book summarised the development of the electrical industry in Japan and the West since the nineteenth century. He contrasted the monopoly in the Western electrical industries and the government-private co-operation in the Japanese industries from a historical perspective.

[121]The phrase "that assumption being included in the premises" is a quote from Veblen (1939: 39). Yet, Veblen used the phrase in a different context.

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Appendix A: Profiles of the surveyed firms (October 1994-March 1995)

Table A-1 Profile of the surveyed firms (23 Japanese subsidiaries)

Holding company			Thai investment						
firm no.	**capital** mil. yen	**employee**	**start -up**	**capital** mil. baht	ratio **Thai**	**Japan**	**emp**	**exp**	products and processes
1	14	980	66	4	0	100	280	4	Bolts and nuts(auto)
2	898	65	89	100	19	62 (USA 19)	209	5	Press, assembly(auto)
3	2,000	1,100	89	26	5	90 (Singa-pore 5)	270	2	UPS, bar code readers
4	4,170	778	90	60	51	49	210	5	Clutches
5	80	160	90	48	0	100	110	2	Silicone rubber
6	2,506	1,200	74	17	73	27	450	6	Steel wheel
7	365	215	91	24	19	81	62	5	Metal press
8	21,207	1,500	88	200	20	80	263	4	Valves (brass and zinc)
9	40,000	5,000	91	500	0	100	1,350	9	Electric wires
10	30	180	89	20	0	100	1,500	4	Precision mould
11	80	600	87	220	33	67	3,800	40	Components assembly
12	780	1,000	89	100	51	49	303	5	Engine parts
13	160	350	88	12	20	80	130	4	Timers
14	2,600	280	88	40	0	100	700	6	VTR parts
15	2,500	700	79	20	51	49	140	1	Super hard dies
16	339	240	89	5	10	90	159	3	Anchor bolts
17	200	350	89	80	51	49	270	7	Dies and tools
18	2,008	700	80	10	27	73	1,165	8	Condenser
19	400	120	92	90	0	100	215	4	Precision mould and die
20	104	340	89	40	10	90	64	3	Brake hose sockets
21	38	230	87	19	0	100	230	3	Microwave oven parts
22	14,220	3,200	89	60	30	70	85	4	Dump trucks units
23	108	620	89	50	69	31	37	5	Heat treatment
average	4,122.0	865.6	86.6	75.9	23.4	75.5	521.8	6.0	
							86.3		←worker-expatriate ratio

Source: The author's survey (*Survey A*).

capital = capital amount, employee/emp = number of employee including foreign expatriates, start-up = the year of start-up, ratio = capital ratio between countries, expatriate/exp = number of foreign expatriates,

worker-expatriate ratio = the number of workers divided by the number of expatriates

Table A-2 Profile of the surveyed firms (13 Western subsidiaries)

Holding company	Thai investment							
	start	**capital**	ratio			**employee**	**expatriate**	products and processes
firm no.	**-up**	mil. baht	**Thai**	**West**	**Japan**			
1	89	n.a.	0	100	0	300	0	Rubber parts(auto)
2	88	500	98	2	0	1,059	5	Telephone
3*	86	2	0	100	0	70	2	UPS
4	87	20	2.5	97.5	0	350	3	Aircraft goods
5	88	145	51	5 (Taiwan 44)	0	250	0	Electric wire
6	90	100	95	5	0	450	0	PCB
7	89	80	66.5	33.5	0	300	0	Hermetic compressors
8	89	60	90	10	0	200	1	Electric motor
9	89	5	2	98	0	200	2	HDD
10	90	15	70	30	0	220	0	Electrical appliances
11	89	152	0	100	0	156	1	Electric control board
12	89	113	51	49	0	450	2	IC
13*	79	150	24.5	51	24.5	228	2	Engine valves (auto)
average	87.8	103.2	42.3	52.4	1.9	325.6	1.4	
						235.2		←worker-expatriate ratio

Source: The author's survey (2 *Survey A* and 11 *Survey B*). * denotes *the survey A*.
capital = capital amount, employee = number of employee including foreign expatriates, expatriates = number of foreign expatriates, start-up = the year of start-up, ratio = capital ratio between countries

Table A-3 Profile of the surveyed firms (20 Thai firms)

firm no.	**start-up in**	**capital** mil. baht	**ratio** Thai	Japan	**employee**	**expatriate**	product
1	81	30	100	0	280	3	Core stamping
2	74	120	100	0	360	1*	Radiators
3	86	50	100	0	240	0	Radiators, press
4	53	0.3	100	0	450	0	Agricultural machinery
5	91	20	100	0	42	1	Die making
6	90	5	100	0	50	0	Mould and die
7	89	150	100	0	503	1	Bolts and nuts (auto)
8	75	0.1	100	0	25	0	Repairing
9	94	1	100	0	17	0	Mould base
10	92	170	100	0	170	0	Casting
11	91	0.5	100	0	12	0	Mould making
12	88	5	100	0	25	0	Mould and die
13	86	50	100	0	1,329	5	Auto body press
14	90	10	100	0	65	0	Die and press
15	72	100	100	0	1,739	3*	Auto seats
16	77	37	100	0	117	1	Forging parts(auto)
17	77	108	90	10	590	3	Casting
18	86	85	100	0	520	1	Diecast, machining
19	67	85	100	0	1,300	0	Car body assembly
20	72	10	100	0	350	0	Agriculture machinery
average	81.55	51.8	99.5	0.5	409	0.95	

Source: The author's survey (*Survey A*).
capital = capital amount, employee = number of employee including foreign expatriates, start-up = the year of start-up, ratio = capital ratio between countries, expatriate = number of foreign expatriates.
* denotes employees with Japanese background, not expatriates from specific Japanese firms.

Table A-4 The production processes and products of surveyed firms (56 firms)

			Japanese firms			Western firms			Thai firms			
			auto	electrical	general	auto	electric	general	auto	electric	general	
Plastic, Rubber	1	Assembly		3, 9			3, 5, 11, 12					6
	2	Injection /Assembly		10, 13, 14, 19#			2					5
	3	Injection		5#		1						2
Metal	4	Press /Assembly		7, 11, 21#								3
(change in the shape)	5	Sheet works-welding Press Machining	2, 6, 20				7, 9, 10	4	2, 3, 13, 14, 15, 19	1#	4, 8, 20	17
	6	Mould and die	17						5, 6	9, 11, 12#		6
Metal (change in the nature)	7	Forging, Casting Press, Machining	1, 4, 12, 22		8, 16	13	8		7, 10, 16, 17, 18			13
8		Special product /process		15, 18, 23			6					4
number of firms (sub-total)			8	13	2	2	10	1	13	4	3	
number of firms (total)			23			13			20			56

Source: The author's survey (*Survey A* and *Survey B*).
auto = auto parts industry, electric(al) = electrical parts industry, general = general parts industry.
Each figure from 1 to 23 in the columns of Japanese firms denotes the code number of 23 Japanese firms. The same is applicable to Western and Thai firms.
The classification depended on the *main* processes. For example, J-2 has not only "Press/ Assembly" but also "heat treatment", but was classified in "Press/Assembly (No. 4)". J-11 and W-7 have "Injection" additionally, but was classified in "No. 4" and No. 5" each.
The symbol mark # in the electrical parts industry denotes that the firm makes moulds and dies in-house. In the case of the auto parts industries, most of the surveyed firms make moulds, dies and jigs in-house.

Appendix B: The supporting industry in Thailand (SEAMICO directory)

Table B-1 Three main groups of the supporting industries (years of establishment)

industry	-59	60-69	70-79	80-84	85-89	90-92	(-84)	(85-92)	(-92)	n.a.	total
1. auto parts industry	4	33	74	35	50	27	146	77	223	74	297
auto/electrical ind.	1	3	4	9	12	3	17	15	32	3	35
2. electrical parts industry	5	22	35	31	125	92	93	217	310	49	359
sub-total	10	58	113	75	187	122	256	309	565	126	691
(ratio)	1.8	10.3	20.0	13.3	33.1	21.6	45.3	54.7	100.0		
3. general parts industry	5	58	99	63	123	113	225	236	461	47	508
Total	15	116	212	138	310	235	481	545	1,026	173	**1,199**

Source: SEAMICO, 1993. By the author's data processing. The same applicable to below tables Table B-1, 2, 3 and 4 are re-classified and calculated by the author.

Table B-2 The supporting industries by majority-ownership country

	Thailand	Japan	Asia	West	Foreign country	na.	**sub-total**	-(50%+50%)	total
-1984	406	13	5	24	42	37	485	8	481
		(31.0)	(11.9)	(57.1)	(100.0)				
1985-1992	329	106	65	35	206	16	551	12	545
		(51.5)	(31.6)	(17.0)	(100.0)				
year na.	87	4	15	4	23	63	173		173
sub-total	822	123	85	63	271	116	**1,209**		
-(50% +50%)	9	4	4	3	11			20	
total									**1,199**

Source: SEAMICO, 1993. The country classification by majority ownership. The 10 firms of 50%+50% ownership are double counted as majority. Therefore, sub-total (1,209) includes the 10 double counting and hence needs the deduction of 10.

Table B-3 The investment in the auto parts industry (include 35 auto/electrical parts industry)

capital share	classified by country					unclassified	total
	Thailand	Japan	Asia	West	sub total		
100%	157	2	2	4	165		
80-99%	8	7	0	0	15		
51-79%	80	12	0	4	96		
Majority	*245*	*21*	*2*	*8*	*276*	**56*	*332*
20-50%	16	55	18	10	99		
1-19%	6	3	8	5	22		
Minority	*22*	*58*	*26*	*15*	*(121)*		
Total	267	79	28	23	(397)		

Source: SEAMICO, 1993. *Minority* share holder firms are subject to double and triple counting. **56* firms are unclassified because (i) share holders are not disclosed or (ii) there are no majority holders.

Table B-4 The investment in the electrical parts industry (include 35 auto/electrical parts industry)

capital share	classified by country					unclassified	total
	Thailand	Japan	Asia	West	sub total		
100%	109	41	25	11	186		
80-99%	17	25	9	9	60		
51-79%	87	13	16	6	122		
Majority	*213*	*79*	*50*	*26*	*368*	**26*	*394*
20-50%	39	41	34	19	133		
1-19%	30	4	15	11	60		
Minority	*69*	*45*	*49*	*30*	*(193)*		
Total	282	124	99	56	(561)		

Source: SEAMICO, 1993. *Minority* share holder firms are subject to double and triple counting. *2*6* firms are unclassified because (i) share holders are not disclosed or (ii) there are no majority holders.