# Japan's Role in Technology Transfer in Thailand (30 Years Without Technology Transfer from Japan to Thailand? : The Case of the Electronics Industry)*

*Dr. Anupup Tiralap***

## 1. The Scope and Argument

As widely recognized by academics and industrialists, assessment of technology transfer is a very complicated and perhaps subjective issue. Therefore, objectives of this paper are primarily twofold. One is to lay down a framework for the assessment of technology transfer. It attempts to search for a useful framework for the analysis and avoid the subjectivity. The other is to make an assessment of technology transfer in the electronics industry in Thailand. This is to discuss a case of technology transfer from Japan to Thailand. Of course, it is by no means to be exhaustive in both objectives, but an endeavour to propose something new.

It is true to say that there is a wealth of study on the issue of technology transfer from developed to developing countries. Nevertheless, it is also true to say that we have not yet had a satisfied framework for analysis. Most of the analysis either emphasizes on social aspects or tackles on cultural dimensions. As mentioned earlier, this can be very subjective and sensitive since the technology transfer issues can be judged and measured based upon and against different standing points and interests. For instance, on the case of technology transfer from Japan to Thailand, some studies conclude that by nature, the Japanese is not sincere and never really transfer technical know-how, while others suggest that the Thai staff are not good enough to learn. This tends to bring about emotional debates without discovering informative findings and useful policy implications.

Thus, the following analysis of technology transfer in the electronics industry in Thailand is to present an alternative way for the technology transfer assessment, and an empirical evident of technology transfer from Japan and Thailand. It is argued that by using a new framework, the analysis of technology transfer issues could be less subjective, despite not totally objective. Also, more informative findings and useful policy implications can be derived.

The paper is divided into three main parts, namely, the framework, the industry, and the assessment. The framework is aimed to provide an analytical skeleton. The industry is to lay down some background information of Japanese involvement in the electronics industry in Thailand. And, the assessment attempts to yield a case study for technology transfer assessment.

## 2. The Framework

Traditionally, the Technology Audit Method (TAM) is a technique employed to support the technological forecasting methods such as the technology tree method. It is largely employed to assess the technological process of technologies under a technology tree. Therefore, the auditing method tends to serve the purpose of technological forecasting only. In other words, it merely gives a technical ana-

---

* Commented by Dr. Naris Chayasoot Faculty of Economics, Thammasat University.

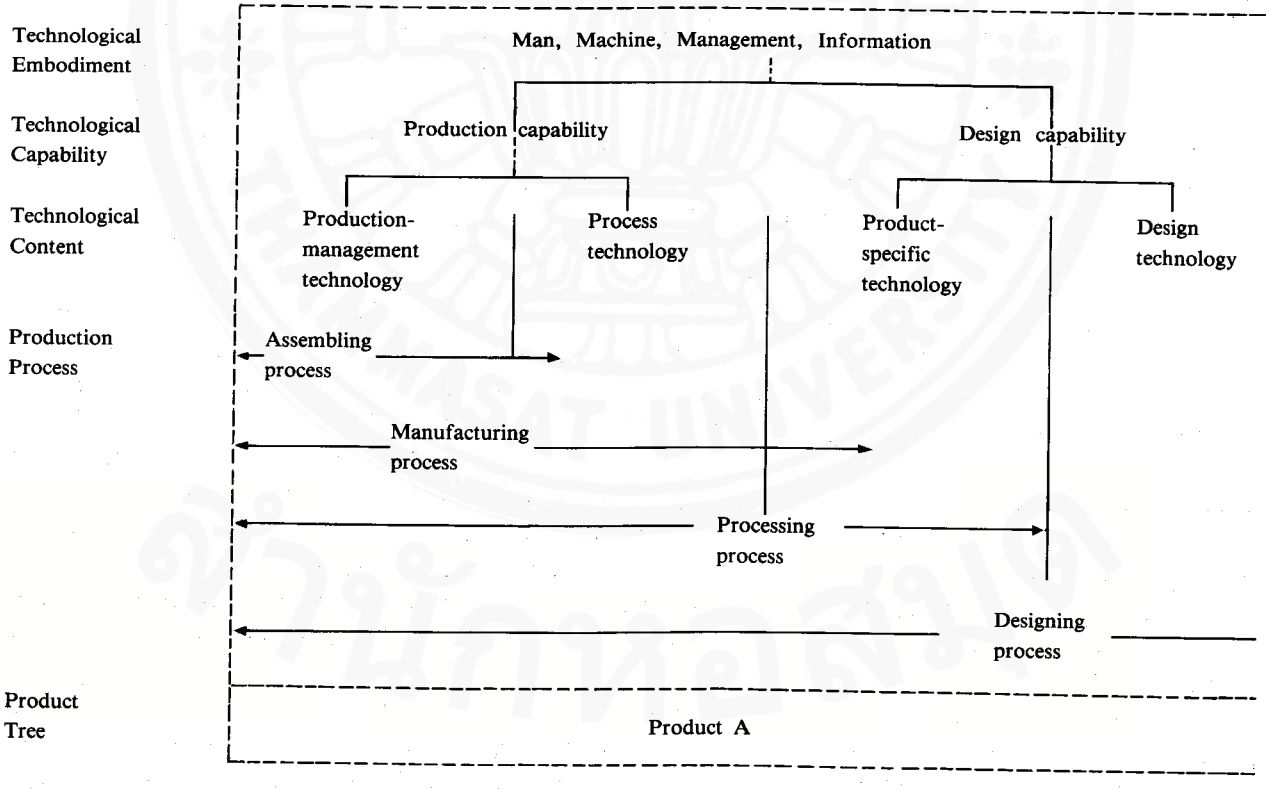
** Science and Technology Development Program TDRI, Thailand.

lysis of the profile and path of various comparable technological processes without policy implication; for instance, why those processes are different, which ones are desirable, why they are desirable, and how to achieve those desirable processes.

Accordingly, in order to make use of the analysis and assessment of the TAM for other purposes, in particular, for assessment of technology transfer, capability, and status, an integrated framework modified and improved upon other technological assessment frameworks is needed. Among the others, the analytical framework of technological embodiment (see Sharif 1991), technological capability, and technological content (see TDRI 1991) seem very useful to extend the traditional auditing method.

As discussed, the main analysis and assessment of the modified technology audit method is to examine the technology audit schema comprising production process, technological content, technological capability, and technological embodiment. The concepts of each technological component are as follows (see Figure 1) :

**Figure 1 Technology audit schema**



## 2.1 Production process

The production process seeks to identify the scope and extent of a firm's production activities, namely, designing, processing, manufacturing, and assembling processes. Each production step of the production processes will be detailed according to the existing production activities of the firm. A firm may have only one production process or more depending upon its internal factors and external environments. In other words, it may have only the assembling, manufacturing, processing or designing process; or constitute all.

The assembling process means the process of final assembly of all required parts and components into the workable and ready-to-use products. This includes all assembling, testing, and packaging activities.

The manufacturing process covers the process of physical transformation of all parts and semi-products into parts and/or components for final product assembly.

The processing process refers to the process of property transformation of raw materials such as mineral and agricultural materials into semi-products or parts for further manufacturing and/or assembly.

The designing process includes all activities relating to conceptual layout, drawing, patterning, prototyping, and R & D activity.

## 2.2 Technological content

The technological content seeks to explain a firm's technological components. Theoretically, if a firm possesses all technological components, namely production-management technology, process technology, product-specific technology, and design technology, its production and technological bases tend to be strong than those which do not. Consequently, it tends to achieve lower production cost, gain higher value-added, and have more spill-over effects between products and processes. The technological performance, which will one way or the other affect its business performance.

Production-management technology is the basic engineering and management techniques. They are necessary and important to a firm's production process, in particular, in the assembly process assembling all required parts and components into the workable and ready-to-use products. However, in order to gain high production efficiency and product quality, additional process technology is needed.

Process technology is the core production know-how and technology embodied in machinery and equipment. It is largely required in the physical and/or property transformation process. In addition to the assembling process, process technology is extremely crucial to the manufacturing process as well as processing process although the latter requires additional product-specific technology than the former.

Product-specific technology is the specific procedure, know-how, and knowledge determining the crucial functions, specifications, and designs of a product. Apart from supporting the processing, manufacturing, and assembling processes, it is the essential technology for the designing process. Without product-specific technology, a firm's activity tends to be limited only to the assembling and/or manufacturing process.

Design technology is the general method and knowledge to translate conceptual ideas and layouts of a product into formulas, specifications, drawings, and/or prototypes, and to use the equipment and tools for designing such a product. A firm needs both design and product-specific technologies to design a product. This is because while design technology provides general frameworks and basic equipment and tools, product-specific technology yields specific conditions, specifications and/or formulas for a product design.

## 2.3 Technological capability

The concepts of technological capability seeks to explain a firm's technological levels. Clearly, a firm's production and technological bases differ from the other not only in terms of the components of technology but also the technological levels. Two firms may have identical technological components but different levels of manufacturing and design capabilities. This could widen the technological gap between firms, and hence their production and technological bases, and technical and business performances.

Production capability, to the large extent, means the ability to efficiently use (operate, control, and maintain) the firm's machinery and equipment.

This requires the ability to run the production line in order to transform the production inputs into desirable output (both quantity and quality). Manufacturing capability largely requires the basic engineering and management techniques (production-management technology) and the core production know-how and technology embodied in machinery and equipment (process technology) in order to achieve the highest production efficiency and product quality.

Also, it, to some extent, requires the ability to search, assess, negotiate, and install the most relevant and suitable raw materials, machinery and equipment, and know-how for production.

Design capability covers the ability to reproduce (absorb, digest, and command) the existing products and/or production processes, the ability to modify (rectify, improve, and enhance) the core technology or main function of the existing products and/or production processes, and the ability to create (develop, research, and invent) a new product and/or production process.

This, certainly, requires the specific procedure, know-how, and knowledge determining the crucial functions, specifications, and designs of a product (product-specific technology), and the general method and knowledge to translate conceptual ideas and layouts of a product into formulas, specifications, drawings, and/or prototypes and to use the equipment and tools for designing such a product.

Similarly, design capability also requires the ability to search, assess, negotiate and install the most relevant and suitable ideas, information, methods, procedures, know-how, and knowledge for product design.

## 2.4 Technological embodiment

The technological embodiment seeks to explain a firm's technological factors. This is to look at the factors affecting those technological levels and components discussed above. That is to say, technological embodiments (namely, man, machine, management, and information) are the factors causing differences in technological capabilities (namely, manufacturing and design capabilities) and hence differences in technological contents (namely, production-management, process, product-specific, and design technologies) of a firm. The technological embodiment will determine the technological path (the rate and direction of technological progress) of a firm through changes in its human-embodied ability, equipment-embodied facility, institution-embodied management, and document-embodied information.

Man means the human-embodied abilities such as experience, skills, and knowledge. These abilities are to acquire, use, reproduce, modify, create and manage all equipment facility, institutional management, and documented information for production.

Machine means the equipment-embodied facilities such as production machines, machine tools, measuring instruments and other production-related equipment and tools. These facilities are to enhance human capabilities to transform inputs into outputs.

Management means the institution-embodied management frameworks such as management techniques and practices. These frameworks are used to organize all equipment facility, human ability, and documented information into an integrated force for production.

Information means the document-embodied information such as minutes, manuals, texts, specifications, and designs. These documents are to support the efficient and effective use of human ability, equipment facility, and institutional management for production.

**3. The Industry**

Although the electronics industry has rooted in Thailand over 30 years, technology as well as production remain in foreign hands. Some of the underpinning reasons are that firstly, the growth of the electronics industry itself has been generated by foreign investment rather than local initiative. Secondly, this has occurred during the period of export promotion rather than import substitution. Thirdly, Government has not yet played an active role in developing local technological capability by assisting technology transfer and/or research and development. Although the electronics industry is clearly moving towards an export base for the Far East, the questions as to whether its growth will be last long and generate benefits to local industries remain unclear.

The development of the electronics industry in Thailand can be divided into four phases as follows:

## 3.1 The phrase of import substitution, 1960-1970

From the beginning, the bulk of investment in the industry came from Japan. This was in part a result of tax incentives and tariff barriers provided and imposed by the government to create import substitution industries and reduce trade deficits. Government policy towards import substitution began in 1960 with the establishment of the Board of Investment (BOI) and the enactment of the first investment promotion act (followed by others in 1962, 1966, and 1968). Due to tax incentives and the sheer size of the protected market, there were altogether 10 firms inaugurated in this period. Nevertheless, the industry was mainly dominated by five Japanese joint ventures since local firms were very small (20-50 workers). The five were Sanyo Universal Electric (Sanyo), National Thai (Matsushita), Kan Yong Electric Manufacturing (Mitsubishi), Thai Toshiba Electric Industry (Toshiba), and Hitachi Consumer Products (Hitachi). Japanese investment clearly played a large part.

The industry grew during this period for largely three reasons. The first was the sheer size of the protected market. The second was government promotion of radio and TV broadcasting stations. The last was the fact that monochrome televisions and transistor radios were relatively new products in Thailand at that time.

## 3.2 The changing phase of import substitution, 1971-1980

With the amendment of the investment promotion act in 1972 onwards, government policy switched towards export promotion. This aim was to turn the economy away from import substitution towards export orientation. Apart from the pressures of international competition, zero tariffs on materials inputs and machinery and equipment and cheap labour and overhead costs, attractd three American firms to invest in IC packaging for exports. Subsidiaries of American MNCs such as National Semiconductor, Signetics, and Data General set up their plants in Thailand in 1974. Japanese investment was not insignificant during this period.

The growth of the industry during this period was due to the huge volume of production and export of ICs, changing the industry from the assembly of consumer products for domestic consumption to electronic components for export. This was the second leap of the industry with wholly foreign-owned firms, mainly American.

### 3.3 The phase of export promotion, 1981-1985

Government policy during this period shifted fully to export promotion. The modified investment promotion act sought to encourage more foreign investment in order to earn foreign exchange to tackle trade deficit problems and create jobs to alleviate unemployment problems. There were a number of world electronic producers established during this period. For instance, three affiliates of the Minebea group of Japan were set up. NMB Thai started producing miniature ball-bearings, stepping motors, and fan motors in 1982. Another two firms in the NMB group (Pelmec Thai manufacturing small size ball-bearings, and Minebea Thai manufacturing computer keyboards, printers, and other related parts) were founded two and three years later. In addition, Fujikura (a Japanese manufacturer of computer cords and cables for IBM) started operations in 1985. With regard to American investment, Seagate Technology (a world producer of hard disks) started subassembly and then assembly of hard disks in Thailand. In addition, AMD and AT & T Microelectronics also established IC packaging plants for export.

During this period, Japanese direct investment was predominant. More interestingly, investment in this period alone was apparently higher than the total investment of the past two decades. Equally importantly, it was the first time that a number of electronic products had been locally produced rather than merely assembled.

### 3.4 The phase of booming economy, 1986-1990

After the appreciation of the yen, investment from Japan and other Asian NICs soared steadily. New investments were mainly for export. Up to 1990, there were around 250 firms already operating with more than 100 firms (encompassing promoted and non-promoted firms) preparing to start their operations. Apart from expansion of the existing firms, new foreign investment have continually moved to Thailand and dominated total investment. With regard to the expansion of existing Japanese firms, the NMB group set up another new plant for manufacturing electronic components such as hybrid ICs, floppy disk drives, computer peripherals, and PCB assembly. Fujikura set up another four subsidiaries for the production of new products such as flexible PCBs and multi-layer PCBs and for increasing local component and parts for existing products such as connectors and other plastic and metal parts for computer cords.

As far as new investment is concerned, new firms such as Sharp, Sony, Mitsubishi and a large number of Japanese medium-sized firms came in. They mainly concentrated on export business for various electronic products such as microwave ovens, video tape recorders, floppy disk drives, electronic watches, printers, computer parts and components, and so on. New investments from the Asian NICs and the United States ranked second and third. Higher value-added and more complicated products such as facsimiles, modular telephones, cordless telephones, public exchanges, satellite receivers, hard disks, modems, printers and a number of electronic components for TVs, computers, and other electronic devices were produced or partially produced and assembled locally.

The growth of the industry during this period was apparently a result of the currency appreciation

of Japan and the protectionism of developed countries. The relocation of foreign investment to Thailand took place rapidly. For instance, the sum of the number of promoted firms during the first half of this decade (1982-1986) outnumbered the total of the past two decades (1960-1981). Moreover, the sum of the number of promoted firms during the last two years (from 1987 to 1990) outnumbered the total over the past two and a half decades (1960-1986). This also held true for Japanese investment.

This period, perhaps, marks the starting point of the subcontracting and supporting industries in Thailand. Japanese firms (except the recent move of the NMB group) tend to bring their own subcontractors from Japan or created their own satellite subcontractors. Nevertheless, since there exists shortage supply from Japanese satellite subcontractors and excess demand for some simple plastic and metal parts, a few local firms (which traditionally provided support for local markets) have expanded their capacity and upgraded their capability to meet export quality. Also, new foreign firms from Taiwan and Hong Kong have been set up and some existing Thai firms have expanded their activity to provide support for PCBs and PCBAs. Other firms (which traditionally manufacturing standard components for export) have gradually started in-direct export activity by supplying parts and components for export products.

Although this has significantly created backward linkages, critical and high value-added parts and components largely internally produced by foreign firms or supplied by their satellite firms. Up to 1990, there are about 200 subcontracting and supporting firms ranging from small Thai firms to large foreign firms. Products are, for example, metal working parts (such as die casting, metal pressing, and mould making), plastic parts (such as plastic injection, blowing, and coating), wiring (cables, harnesses, cords, and connectors), PCBs, PCBAs, ICs, stepping motors, and other electronic and electrical components and parts.

**4. The Assessment**

This assessment of technology transfer of the electronics industry in Thailand is based upon various sources of information, namely, expert interview, literature review, and firm survey. Firms covered in this analysis are both Japanese joint ventures and wholly Japanese owned firms. They comprise various sizes and manufacture various electronic products. The analysis of technology transfer is divided into four main technological dimensions according to the framework in section two. Based upon such a framework, the assessment points out that there is almost no technology transfer from Japan to Thailand for the joint-venture firms mainly gathering in the consumer electronic sector. Meanwhile, although in purely Japanese owned firms, some technical skills and perhaps know-how are transferred from Japan to Thailand. They are strictly limited to the assembly process. Therefore, the transferred components confined to technological contents, technological capabilities, and technological embodiments are minimal, as discussed herebelow.

## 4.1 Product ranges

Product ranges offered by Japanese joint ventures in Thailand are rather narrow and conventional. The very obvious case is in the consumer electronic sector which is mainly dominated by Japanese joint ventures. Over 30 years of Japanese involvement in this sector, product ranges have technically changed very little. Also, there are only few versions offered in each product range and its changes are very minor and time-consuming. Differences in size and casing design are normally the main feature of changes in new versions.

E1 is a classic case which manufactures consumer products for over 30 years (established in

1962). Within this period, one model of televisions is approximately offered every two years. All of which are manually controlled and mainly different in casing design, except the recent models.

E2's main products, established in 1961, are also colour televisions. Differences in models are sizes and casing designs since changes in electronic circuits controlling input/output features are carried out by its Japanese parent company. Attempt to design its own electronic circuits has just started in recent years. No consideration for other electronic products, in particular, high value-added such as VCRs.

In contrast, wholly Japanese owned firms offer a wider range of products. These include higher value-added products such as video cassette recorders, microwave ovens, fascimiles, public and private exchanges, computer disk drives, etc. Also, models with some changes in functions and features are regularly introduced. Nevertheless, products manufactured in Thailand are largely old versions of products of their parent companies.

E3 is a subsidiary of a large electronic manufacturer in Japan established after 1988 (after the yen appreciation). Main products are microwave ovens and fascimiles. They are largely produced for the export market, which requires frequent changes in versions. However, most of the changes are carried out its parent companies.

E4 is a also subsidiary of a well established Japanese electronic firm. Its operation started two years ago (1990). At present, it manufactures one main product, computer floppy disk drives, with a few versions offered. However, more products are being planned for next year production.

## 4.2 Production processes

Production processes of the electronic firms in Thailand are largely confined to the assembling process. Designing process virtually rests on parent company both joint ventures and pure foreign subsidiaries. Nevertheless, some active joint ventures do have some sorts of casing and peripheral-circuit designs.

E1's production processes for colour televisions are typical to electronic firms. The production process mainly covers the assembling and testing processes. This has hardly changed for 30 years. With regard to designing processes, it virtually leaves for the parent company, ranging from schematic drawing, printed circuit board (PCB) designing and component specification. PCB etching is undertaken outside by local vendors according to the design from Japan. Although, the testing process in the final assembling process is carried out by its own staff, technical standards and specifications are set from Japan.

The production process at E3 is also a good example of purely Japanese owned firms. That is to say, its main production process is to assemble final products for export. As the production process is limited to activities necessary to final assembly, the assembling and testing processes are excellent. It has utmost been upgrading its assembly processes up to the world standard. However, designing processes are not existed since the firm relies upon parent's company designs (product's specification defining, drawing, and patterning).

## 4.3 Technological capabilities

With regard to technological capability of electronic producers in Thailand, foreign subsidiaries and joint-venture firms are not much different. First of all, both of them have no innovative capability as does adaptive one. Next, acquisitive capabilities (searching, assessing, negotiating, and installing capabilities) are different in terms of technological sources, not abilities. Both acquire information and imitate

products of foreign firms. However, one is of its parent company, the other is of various general makers. What is the major differences is the operative capability. While foreign subsidiaries possess ability to operate, control, and maintain high production efficiency and product quality, Thai firms are less capable.

As mentioned, E2 is a Japanese joint-venture firm manufacturing colour televisions for over three decades. Although it has in-house designing activity at present such as PCB drawing and casing with some peripheral electronic ciruit designs, it possesses neither adaptive capability (ability to ratify, improve, and enhance) nor innovative capability (ability to develop, research, and invent). That is to say, its designing activity is a modest modification of foreign products. However, with some in-house trouble-shooting and product improvement activities, it gradually builds in-house design capability. However, it is possible after E2 proved to its parent company that the local design activity and capability do benefit and make profits to the company. This clearly does not encourage the adaptive capability and innovative capability of E2.

E2's operative capability (ability to operate, control, and maintain) is largely based upon years of experience in the production line. Training is largely on-the-job training. Therefore, the defective rate is rather high, compared to purely Japanese owned firms. Despite having some good production machines (automatic insertion machines and automatic testing equipment), E2's staff do not well trained to understand the basic principle, hence the machine and equipment are frequently not used and maintained in a proper way. This partly leads to low production efficiency and unrepeatable product quality.

E3, a Japanese microwave oven makers, concentrates soley on the assembling (assembling and testing) process as some metal and plastic parts rely on subcontractors. Therefore, it leaves design technology (knowledge and procedures to translate ideas into prototypes) and product-specific technology (specific knowledge and know-how determining the critical functions and features) parent company, and hence adaptive and innovative capabilities. This also holds true for acquisitive capability.

However, with strong process technology (equipment and know-how for production) and good training, its operative capability seems very efficient. All machinery and equipment (both new and second-hand equipment) are equipped with user manuals and operation instructions. Operators must obtain at least two-month on-the-job training. The training content not only covers operation but also control and maintenance. Obviously, total defectives (including machining, assembling and testing) declined from about 10 to 6 and 5 percent within the first year of operation. Product quality is assured through precision production equipment and tools including precision jigs and measuring instruments. In addition, maintenance is based on the firm's schedule maintenance program.

## 4.4 Technological contents

Foreign and joint-venture firms not only differ in terms of product ranges, production processes, technological capabilities but also technological contents. While technological contents of the former are strong in process technology (efficient machinery and equipment and strong production know-now) and production management technology (engineering and management techniques to support production processes), technological contents of the latter are scattered with no strong technical ground on any. However, both of them are weak in product-specific and design technologies although foreign firms are somewhat better.

E5, manufacturing consumer electronics could be another representative of Japanese joint-venture firms operating in Thailand for more than 2 decades. Firstly, its process technology is not advanced. Machinery and equipment tend to be second-hand from Japan. Some are as old as 20 years. Tools (such

as jigs and measuring equipment) are not much used or correctly used. Production know-how largely stems from years of experience in the production line. Secondly, it has no product-specific technology in the production process, as do other Japanese joint ventures. This becauses they manufacture a product according to the blue-print from its parent company. Also, E5's production-management technology such as engineering and management techniques to improve production efficiency and product quality are neglected. Design technology is virtually not rooted.

E6, assembling computer cable cords and harnesses, is another typical purely Japanese owned firm located in Thailand. Production machinery and equipment are imported from parent company. Production know-how (e.g. working sequences, critical manufacturing points, and problem solving procedures) is also transferred from Japan. E6 is generally strong in process and production-management technologies in order to support their production processes (manufacturing and assembling processes). Design technology has clearly not been practiced. The designing process is entirely left for parent company, and thereby design technology. This is similar to other Japanese foreign subsidiaries. It can keep upgrading its products and production processes because of know-how and product-specific technology transferred from parent company. However, it is only for production, not for product design.

## 4.5 Technological embodiments

Not only are joint-venture firms inferior to foreign subsidiaries in terms of technological activities and levels but also factors. Japanese joint-venture firms tend to be weak in all technological factors: machinery, manpower, information, and organization. Firstly, equipment-embodied facilities such as production machinery, equipment, and tools are rather simple and largely second-hand. Also, experience, skill, and knowledge are not widely distributed within firms. They tend to be personally embodied. Merely a few persons within the firms get transferred these abilities. Thirdly, document-embodied information is scared. This is partly because of no effort paid for searching, processing, and documenting, and partly because of management and production based upon past experiences. Lastly, organizational-embodied framework are also weak since decision-making, trouble-shooting, reporting, and rewarding processes tend to be undertaken by persons having unclear mandates.

With regard to foreign subsidiaries, they are, in fact, a divided part of a well-established firm. Thus, a large part of the parent firm's technological factors are inherited, in particular organization and information. Machinery and manpower are to some extent transferred to affiliates in Thailand as well. Of course, as the affiliates in Thailand are new established entities, foreign subsidiaries have to accumulate their own technological factors too.

Equipment-embodied facilities at E1 (e.g. insertion conveyor, wave-soldering, in-circuit testing, electrical and electronic testing, and fine-tunning equipment) are all manually operated. Although some machines are equipped with numeric control functions, these are very trivial. Human-embodied abilities in the firm are not technically high. This is rather based upon experience and skills, not knowledge. In other words, they are able to imitate and made some modifications, but surely not realy adaptive. Any improvement in products or production processes largely stems from years of practices. Document-embodied information is not well recognized. There is no action to accumulate and distribute nor to use. Organizational-embodied framework is also not well structured since the firm's operation is based upon one-man decision. Rules and procedures are created to cope with immediate problems only.

E4's equipment-embodied facilities are mainly new equipment transferred from its parent company in Japan. As the products required precision assembly as well as stringent testing processes, there are,

at present, several expensive equipment to serve testing and measuring functions only. Human-embodied abilities are initially all Japanese engineers and technicians from the parent company. Nevertheless, this is gradually reduced as the firm starts building its own personnel. E4 adopts the same manufacturing practices (working attitudes, norms, procedures, and rules) as its parent company. In fact, it is exactly the organizational-embodied frameworks of the parent company in Japan. This also holds true for document-embodied information.

**5. Problems and Policy Issues**

As discussed, Japanese technology transfer in the electronic industry in Thailand marks at least three paradoxes as follows:

First, although the industry has established more than 30 years, its technological embodiments have upgraded very little, particularly, among joint ventures operating in Thailand for more than three decades in the consumer electronic sector.

Second, although demands for electronic products have prolongly high, the industry's technological capabilities have been minimal. Although technological capability in the purely Japanese owned firms (which they solely benefit) is certainly higher than in the joint-venture firms (which the benefits needed to be shared), it is only operative capability which the local subsidiary get transferred.

Third, although the consumer electronics sector of the industry has been highly protected, its technological contents has made little improvement. This clearly shows that technology transfer is not really linked to market demand and size of production. It is rather linked to the competitive pressure which is absent in the sector.

The answer to the question whether there is technology transfer from Japan to Thailand in the electronics industry during the past 30 years is yes. However, it is very minimal as the production process, technological content, technological capability, and technological embodiment improve very little compared to the 30 years of the industry's life in the case of consumer electronics. Also, firms established recently (after the yen appreciation), those technology components do not show any significant transfer to Thailand.

Therefore, the policy issues are basically the role of government. The policy of "tariff protection without technology transfer" in the past seems to end up with tragedy of technology mastery, leaving aside the recent trend of "no protection and no technology given".

**6. Strategies and Policy Recommendations**

Needless to say, technology transfer from Japan is desired and needed to Thailand. This because it not only generates spill-over effects in terms of technology and skills, but also directly boosts Thailand's competitive ability. No country can make an industrial progress without learning technology from outside. However, this needs clear policy and good stratgy to obtain the required technology, not emotional debates without substantive information and findings and encouraging policies.

Thus, the question is what strategy we should pursue since policy in the past seems to yield no result. General strategy needed to be concerned is "technical support not economic pretection". Firms should be encouraged to be competitive, hence economic protection should not be given. However, technical support is strongly required. Otherwise, the adverse effect of lifting economic protection is so acute. Technology transfer from outside is undoubtedly required, however, indigenous technological efforts are strongly required to make the full use of transferred technology.