Transfer of Technology for Successful Integration into the Global Economy

A Case Study of the Electronics Industry in Thailand

United Nations

New York and Geneva, 2005

NOTE

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UNCTAD/ITE/IPC/2005/6

Preface

UNCTAD's series on *Transfer of Technology for the Successful Integration into the Global Economy* consists of case studies on transfer of technology issues in individual industries in selected developing countries. These studies draw lessons from national experiences with the transfer and diffusion of technology through various channels.

The studies highlight the crucial role that successful transfer of technology can play in the integration of countries into the global economy. They focus on the modes of technology transfer, and the adaptation, diffusion and further development of the acquired technology in the wider economy.

The studies also look at the interplay between technology transfer and development. They focus on the contribution of technology transfer to employment creation, export competitiveness and national innovative capacity. Thus, they provide lessons to other developing countries on building technological capacity and promoting development.

The studies deal with sectors where the selected developing countries have demonstrated their ability to create new productive capacities and successfully integrate into the world economy. They provide examples of cases in which a country's factor endowments were modified through investment in physical capital, human resources and the building up of capacities required to develop and use new technologies.

The present study is part of the second round of case studies in this series. The first round included a case study of Embraer in Brazil, a case study of the pharmaceutical industry in India and a case study of the automotive industry in South Africa. The second round will also include case studies on the automobile components industry in Tunisia and the salmon fish industry in Chile.

The identification of firm-level factors as well as government policies and institutions that enable firms to thrive, grow and compete in the world market is vital to understanding the catch-up process and the building of technological capacity. These case studies seek to identify conditions under which industries developed and some of the key institutions that played a role in this process.

Acknowledgements

The UNCTAD's series on *Transfer of Technology for the Successful Integration into the Global Economy* is produced by a team led by James Zhan comprising Maria Susan Arano, Fulvia Farinelli, Victor Konde, Prasada Reddy and Christoph Spennemann.

Khalil Hamdani provides overall direction.

The case study on the electronics industry in Thailand was based on a manuscript prepared by Chanin Mephokee and Kaipichit Ruengsrichaiya, and finalized by Victor Konde and Prasada Reddy. Josephine Ayiku provided administrative support.

Peter Brimble, Jörg Weber and participants in the expert meeting on technology transfer and diffusion provided valuable comments. The study was also submitted to the WTO Working Group on Trade and Transfer of Technology (WGTTT) at its 11th session on 11 April 2005, and benefited from the comments by members of WGTTT.

The views expressed by the authors do not necessarily reflect those of UNCTAD.

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Abbreviations

ASEAN	Association of South-East Asian Nations
BOI	Board of Investment
EU	European Union
FDI	foreign direct investment
GDP	gross domestic product
GNP	gross national product
HDD	hard disk drives
IC	integrated circuits
NESDPs	National Economic and Social Development Plans
NIEs	newly industrialized economies
NITC	National Information Technology Committee
NSTDA	National Science and Technology Development Agency
PCB	printed circuit boards
R&D	research and development
S&T	science and technology
SMEs	small and medium-sized enterprises
TNC	transnational corporation
TOT	transfer of technology
TRIPS	trade-related aspects of intellectual property rights
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
WDI	World Development Indicators
WIR	World Investment Report
WTO	World Trade Organization

Executive summary

Thailand has built up a globally competitive electronics industry. Proactive government policies have played a pivotal role in creating an enabling environment for the development of that industry. The industry has acquired most of its technology through foreign direct investment (FDI) and trade.

Thailand adapted its policies to align with the rapidly changing trends in the global economy. Realizing that its domestic market is small with regard to supporting industrialization, Thailand shifted from an "import-substitution" to an "export-oriented" development strategy. This required liberalization of the economy to promote trade and investments.

The Board of Investment (BOI) of Thailand has provided incentives to, and developed support systems for, foreign investors. Some of the incentives provided include low tariffs for imports needed to produce electronic export units, loosening of controls on foreign ownership of firms and provision of essential infrastructure. Liberal economic policies, coupled with the availability of a skilled but low-cost labour force, made Thailand an important location for export-oriented production activities of transnational corporations (TNCs).

Having been established as an important destination for FDI, Thailand attempted to steer the FDI inflows into areas of national priority. The Government designed incentive schemes to channel investments into rural areas and into sectors of importance, such as agriculture and electronics.

In value terms, about $4.5 billion was invested in the electronics industry between 1986 and 2001. FDI continues to play an important role in technology transfer, financing and marketing of electronic products. Trade has also played an important role in the growth of the electronics industry. The industry currently accounts for more than 30 per cent of Thailand's total exports and employs about 300,000 workers. The main export items include hard disk drives (HDD) and parts, and integrated circuits (IC), which account for about 21 per cent and 20 per cent of total electronic exports, respectively. Thailand is the world's second major HDD producer (after Singapore).

Despite these successes in attracting FDI and the growth of exports of electronic products, the industry's activities are largely limited to assembly operations. There are indications of growing manufacturing capabilities, but the design and product development skills remain low. For this reason, the current policies of the Government focus on upgrading foreign technologies and promoting novel product development. This could increase Thailand's level of productivity to that of other competing nations.

The Government created several initiatives to promote technology transfer, diffusion and innovation. The National Science and Technology Development Agency (NSTDA) established the Industrial Consultancy Services in 1992 to promote the use of local and foreign technical consultants and facilitate the formation of alliances. In 1997, NSTDA set up the Software Park Thailand (SPT) to promote innovation and facilitate development of start-up firms. Furthermore, the Board of Investment also developed the Unit for Industrial

Linkage Development (BUILD) programme to encourage the development of support industries, strengthen linkages and help small and medium-sized contract manufacturers improve their productivity and facilitate cooperation between foreign and domestic firms. It is estimated that about $148 million worth of transactions took place in BUILD in 2001.

These policies have played a vital role in making Thailand a major manufacturer of electronic products and facilitated the acquisition of the skills needed to operate and manage production facilities to assemble intermediate and final electronic products. They have also played an important role in encouraging the development of local contract manufacturers and the transfer and development of technologies. The success stories of domestic companies such as Saim United Hi-Tech Limited, which successfully transformed itself from being a plastic toy manufacturer to being a global supplier of electronic keyboards after licensing technologies from a TNC and innovating further, and the Hana Microelectronics Group, which emerged as a global contract manufacturer of electronics, show the potential of Thai domestic firms in integrating themselves into the global economy.

Thailand is now redirecting its efforts to build the capacity needed to operate increasingly sophisticated assembly plants and generate novel processes and products. The initiatives currently being undertaken, such as the development of the Thailand IC Design Incubator and the hard disk drive cluster development project, signal commitment to promoting innovation and technology development in the industry. These initiatives could further ensure that Thailand does not remain a contract manufacturer but gradually moves up the value chain.

Introduction

Thailand has successfully acquired and adapted foreign technology to build its productive capacity and integrate into the global economy. The Thai economy grew annually at an average rate of between 7.3 per cent and 7.8 per cent during the last four decades. The rapid economic growth played a key role in reducing poverty, and increasing industrial output and exports.

The proportion of the Thai population classified as "poor" declined from about 57 per cent in 1963 to about 16 per cent in 1996 (Khunkitti, 2001). The gross national product (GNP) per capita increased 35-fold between 1961 and 1998. More importantly perhaps, life expectancy has increased from 52 to 69 years, infant mortality has declined almost three-fold and access to safe water has tripled.

These achievements may partly be attributed to the successful transformation of Thailand's economic structure from agriculture to manufacturing. The share of agriculture in gross domestic product (GDP) declined from about 40 per cent in the 1960s to about 10 per cent in the 1990s, even though the contribution of agriculture to the economy grew steadily by more than 2.5 per cent annually between 1965 and 1996. However, the rapid expansion of the manufacturing sector overshadowed the growth in agriculture (Intarakumnerd *et al*., 2002).

Over the last four decades, the manufacturing sector has contributed significantly to the rapid export growth. The share of manufactured exports as a percentage of total exports increased from 5 per cent in 1970 to 74 per cent in 2001 (UNCTAD, 2002). The country's major exports include rubber, textiles, motor vehicles and parts, and electronic products.

The electronics industry has been crucial to the growth of manufactured exports. Electronics account for about 30 per cent of total exports. For instance, in 2002, computers and computer parts and integrated circuits (IC) were the top two major export items and accounted for about 11 per cent and 5 per cent of total export value. Currently, Thailand is among the top five major exporters of computer-related products and a major player in the global market for several products, such as hard disk drives (HDD), keyboards and printed circuit boards (PCB).

The international competitiveness of the Thai electronics industry has largely been based on successful acquisition and adaptation of foreign technology. Thailand has successfully established and maintained effective access to external sources of technology necessary for building the technical, organizational and management skills needed to produce and distribute products and services efficiently. This has mainly been achieved through appropriate incentives to attract FDI and promote trade.

There are several channels through which technologies may be transferred. However, the commercial transfer of technology at the international level largely takes place through trade, FDI and licensing agreements. These channels are not mutually exclusive. International trade promotes learning through the import of capital goods (e.g. machinery) and intermediate products, and export of technology-intensive products to advanced markets. FDI is an efficient channel for acquiring advanced technologies, as the investor may meet the cost of technology transfer, its adaptation and use. Investors may also introduce new managerial and marketing know-how.

Although the mode of entry plays an important role regarding the extent of positive technological spillovers or diffusion to domestic firms, TNCs are likely to transfer sufficient technologies to enable their affiliates to compete successfully in the host economy (UNCTAD, 2000). The technological sophistication of host country firms and consumers, and the level of competition in the host economy may also influence the nature and quantity of technologies transferred through FDI.

Thailand is a good example of a country that has exploited FDI and trade to acquire technology in its quest to industrialize. The country initially provided incentives that encouraged the formation of partnerships during the period of import-substitution policies (1960s). These policies generated only limited FDI flows owing to the limited size of the domestic market. The change of government policies in support of export growth accounted for most of the increase in FDI to Thailand. The country currently imports a significant amount of intermediate products and machinery.

Technological capabilities may be subdivided into four possible layers of skills sophistication. These include skills to use and operate technology, skills to assimilate the acquired technology, skills to upgrade and reverse-engineer foreign technologies, and skills to design and develop novel technologies. The first two are basic and almost all firms possess them. However, only a few firms are able to upgrade and develop novel products. The latter two layers of skills can be built up through learning and accumulation of knowledge over a long period.

Thai firms seem to focus on skills needed to operate and adapt foreign technologies. The majority of firms in the electronics industry, including some affiliates of TNCs, use modern equipment and operate state-of-the-art plants. Operational capabilities are important in enabling firms to manufacture or assemble products or offer services efficiently in the short term. They also offer a quicker return on investment than development of novel products and technologies.

Thai domestic firms are largely subcontractors of TNC affiliates. Emerging Thai firms have largely acquired foreign technologies to enable them to produce intermediate products needed by TNC affiliates. As domestic firms in the electronics industry mature from being suppliers to TNCs to original equipment manufacturers, they will require capacity to innovate in order to remain competitive. Thailand is undertaking several initiatives that may facilitate technology development and linkages between public and private sectors, and the Government.

The two firms in this study may be considered frontrunners of such a learning process. They are not representative of most firms in the electronics industry. One firm acquired its technology through licensing, while the other acquired most of its technology by being part of a TNC production network and later through acquisition of firms that owned technologies of interest.

Chapter I

Policies and strategies supporting a competitive electronics industry

Over the last four decades, the Government of Thailand has adapted its policies to meet the changes in the global economy and overcome developmental challenges. Many of theses policies are reflected in the National Economic and Social Development Plans (NESDPs). NESDPs contain detailed indicators and targets that serve as guidelines for government agencies.

The investment agencies and the science and technology institutions have played a critical role in the industrialization of Thailand. The investment policy measures developed by the Thailand Board of Investment (BOI) promoted Thailand as a favourable destination for export-oriented FDI. These measures were particularly important for investment in the electronics industry.

On the other hand, the science and technology policies facilitated transfer of technology and promoted the development of the technological base. Several institutions and ministries addressed areas such as manpower training and education, establishment of incubators and science parks, and provision of grants.

An overview of the evolution of these policies provides a look at some of these government efforts that influenced the development of the manufacturing sector in general and the electronics industry in particular.

1 Overall national development policies

Since 1961, the development policies of Thailand have been reflected in the five-year National Economic and Social Development Plans (NESDPs). NESDPs serve as the main guideline for medium-term economic development and play an important role in directing national development. Each plan contains detailed targets such as economic growth rate, inflation rate, export growth rate and the number of jobs to be created, and how the targets would be achieved. Although the plans are only indicative, the Government strives to achieve the performance indicators contained in the NESDPs.

The first and the second plans (1961-1971) focused on import-substitution policies to promote the local industrial development, attract investment and reduce the current account deficit. The objective of the third plan (1972-1976) was to increase exports as a way of boosting growth in per capita income and employment opportunities. The annual growth rate target was set at 7 per cent. The fourth plan (1976-1982) had the same focus but paid more attention to investment as a tool for employment creation. It set the growth rate at 7.2 per cent annually and aimed at the creation of 2.2 million jobs.

The aim of the fifth plan (1982-1986) was to expand investment flows to the rural areas, while achieving an economic growth rate of 6.6 per cent and export growth rate of 22 per cent. It induced industries to move production bases to the rural area through tax incentives and provision of support infrastructure. This led to the creation of the Eastern Seaboard as an export-processing zone. The sixth plan (1987-1991) saw the rise in exports of

electronic products and the location of industries in eastern, northern and southern regions of Thailand. The eighth plan (1997-2001) and ninth plan (2002-2006) have placed emphasis on, among other things, human resource development and the role of SMEs in the competitiveness of the nation.

The national development plans have played a key role in creating a sound macroeconomic environment and progressively opening up the country. First, having a sound macroeconomic profile enhanced the confidence and trust of foreign investors in the Thai economy. Second, opening up the country created opportunities for export-oriented FDI. The national development plans have been instrumental in integrating Thailand into the global economy and the production networks of TNCs, particularly in the electronics industry.

Investment promotion, development of science and technology capabilities and implementation of measures supporting the development of the electronics industry have been important components of the national development strategy as reflected in the NESDPs. For example, the sixth plan (1987-1991) identified software engineering, circuit designs, production management, and computer-aided and mechanical technology as key technologies for the electronics industry. In addition, it recommended strategies to promote investment in manufacturing products with high technology content and to promote support-industries and product design. Specific products of interest included personal computers, mobile phones and facsimiles, among others.

2 Investment promotion policies

The Government recognized the importance of FDI in building the national productive and technological base as reflected in the NESDPs. One institution that has played an important role in the development of the electronics industry is the Board of Investment (BOI). BOI is the Thai government agency responsible for investment policy advocacy and its implementation, and investment promotion and facilitation.

BOI is composed of two bodies: the Board and the Office of the Board of Investment. The Board is currently chaired by the Deputy Prime Minister and is responsible for formulating policy guidelines and implementing the Investment Promotion Act. The Office of the BOI is the administrative arm that implements the decisions of the Board. BOI works with the Ministry of Foreign Affairs, the Ministry of Commerce and the Ministry of Industry, and has overseas offices in Frankfurt, New York and Paris.

BOI provides investors with a wide range of incentives such as exemptions from and/or reduction of import duties, corporate income and other income-related taxes, credit assistance, guarantees, infrastructure support and services. The non-tax incentives (e.g. guarantees) are available to all BOI-promoted projects, regardless of location or industry. Tax-based incentives are location- and/or industry-specific. Over the last four decades, the incentives have evolved from those supporting import-substitution policies to those promoting export growth and encouraging location of industries in rural areas.

Since 1993, investment projects in the Government-defined zones have been exempted from corporate income tax for two to eight years and import duty on raw materials for production of export products for a period of one to five years. Similarly, investment projects in Government-defined priority areas (agriculture and agricultural products,

involvement in technological and human development, public utilities and infrastructure, among others) receive corporate income tax exemption for eight years and exemption from import duty on machines.

Thailand has skilfully employed incentives to attract investment in priority sectors. The incentives were designed to respond to changes in the country's development goals at various stages of economic development. For example, in the 1960s and 1970s, incentives were designed to attract firms that produced products for the domestic market. Since 1973, export-oriented projects have been favoured following the change in the country's economic policy. Indeed, more than 90 per cent of the firms benefiting from investment incentives provided by BOI exported 80 per cent or more of their total production (see table 1.1).

Table 1.1 BOI-promoted investment in the electronics industry

Total annual investment ($ million) categorized by export proportion of total products (1964-1995)

	Domestic market 100%		**Export market 100%**		**Export market 80-90%**	
	Number of firms	Investment	Number of firms	Investment	Number of firms	Investment
Total	27	568.16	333	7159.96	165	1527.47
%	5.14	6.14	63.43	77.36	31.43	16.50

Source: Board of Investment Office, Thailand.

Note: "Domestic market 100%" means that the products were exclusively for sale on the domestic market, while "Export 100%" means that the products were exclusively for export. "Export market 80-90%" means that 80-90% of the products were export.

The Thai electronics industry has benefited tremendously from FDI. The share of FDI stock in the electronics industry is about 90 per cent. This underlines the important role that TNCs have played in the development of the Thai electronics industry.

3 Science and technology policies

Thailand's science and technology policies can be traced back to the 1950s. In 1956 the Government passed the National Research Council Act, which formed the basis for the establishment of the National Research Council of Thailand. The Council was developed to promote sustainable development through the use of scientific research and guide the development of the country's scientific and technological capabilities.

In 1963, Thailand established the National Applied Science Research Institute to promote the use of natural resources as a basis for industrial development. The objective of the Institute was to promote the development of industries that add value to natural resources. The Ministry of Science, Technology and Energy was established in 1979 as the lead government agency for the planning and implementation of science and technology (S&T) policy.

These developments played a major role in integrating the S&T policies into the national development plans. For instance, the fifth NESDP (1982-1986) included bold S&T policies that focused on increasing production efficiency, and the need to develop capabilities to modify and upgrade technologies, and to develop novel technological products. It specifically sought to promote transfer of foreign technology, develop S&T manpower and increase research and development (R&D) performance. As a result, several technical cooperation agreements were signed with other countries. For instance, the Science and Technology Development Project, with technical assistance from the United States, had a total budget of $49 million to support S&T activities over a period of seven years.

The sixth-Plan (1987-1991) sought to promote cooperation among the various government agencies involved in R&D and improve the linkages between the R&D institutions and industry. The main measures included the setting up of an effective S&T management system and development of S&T infrastructure, increasing the efficiency of production and S&T activities, and developing S&T manpower.

The Plan identified some key technologies that cut across several industries. For instance, computer-aided, software engineering and production management technologies were identified as key technologies for the electronics, iron and steel, gem and jewellery, and metalworking and machinery industries. The electronics industry was seen as vital to the development of other industries as well.

The establishment of the National Information Technology Committee (NITC) in 1992 was another step that Thailand took to exploit information technology (IT) for social and economic development. The NITC is chaired by the Prime Minister and is composed of ministers, permanent secretaries and senior public and private sector leaders. It develops IT-related policies and proposes them to Cabinet; it conducts policy research, establishes information centres, coordinates relevant IT-related development activities and disseminates information.

In 2002, the Ministry of Information and Communication Technology (ICT) was established to promote the role of IT in national development. Its role includes development and implementation policies and plans related to information and communication technologies (ICTs). The NITC and the Ministry of ICT work together in driving the use of IT in different sectors to achieve long-run prosperity.

4 Intellectual property rights

Thailand enacted its Patent Act in 1979. Its main goal was to exploit intellectual property rights in order to promote economic prosperity. Non-resident individuals/organizations wishing to have protection are required to file in Thailand within 12 months of filing a patent application in the home country (Kaosa-ard, 1991). The patent law was reformed in 1992 to provide wider protection to inventions. The Act increased the period of patent protection from 15 to 20 years and extended patent protection to other products such as pharmaceuticals. The patent law was amended again in 1999.

For the electronics industry, the need to protect designs of electronic systems is very important.[1] The development of a new layout design of an integrated circuit requires substantial investment. However, the design can easily be copied and built using components that are readily available in the market place. Therefore, without protection for those designs, few firms and institutions are likely to invest their time and resources in developing such systems.

It is for this reason that Thailand introduced legislation in 2000 for the protection of integrated circuit designs. The legislation protects novel circuit designs or new designs resulting from rearrangement of standard components. The legislation offers protection for 10 years from the date of filing or the first date of commercial exploitation, whichever is earlier (Kelly and Chuenjaipanich, 2002).

Similarly, software plays an important role in the development of the electronics industry. Software development requires substantial investment, but software is easy to copy and reproduce. Thailand revised its Copyright Act in 1995 and ratified the Berne Convention, and its obligation in respect of copyright protection under the TRIPS Agreement took effect in 2001. Copyright protection also affects other works of art such as visual and audio.

Furthermore, the draft legislation on protection of trade secrets and the production of compact disks was passed by Parliament in 2003 (IIPA, 2004). This legislation is important in controlling the production of compact disks to minimize or control the illegal production of optical disks (e.g. CDs, CVDs and DVDs). It could help facilitate increased investment in facilities for production of optical disks.

Thailand has made great strides during the past few years towards implementing an effective intellectual property protection system that seeks to meet the needs of the electronics industry. It has also taken several enforcement steps to stem the violation of intellectual property rules. For example, the Government seized over 600,000 DVDs on the grounds of copyright violations in 2003 alone. Patent violations, on the other hand, are not common. In 2001, only 4 civil and 10 criminal patent infringement cases were filed compared with 1,293 criminal cases of copyright infringements.

Thailand has an active intellectual property protection advocacy business community that works with the Department of Intellectual Property (DIP). They are engaged in drafting of intellectual property regulations and in public campaigns. For example, the Business Software Alliance, the International Federation of the Phonographic Industry and the Motion Picture Association of America are involved in anti-piracy campaigns.

Intellectual property regulation is improving, but the positive impact of enforcing intellectual property rights (IPR) remains limited. Technology transfer has been confined mainly to "turnkey" projects despite the enforcement of IPR (Kwon, 1995). Increasing intellectual property protection does not seem to be accompanied by greater technology development, transfer and diffusion. However, in the case of Thailand, the protection of IPR has probably encouraged enhanced FDI and trade flows.

[1]The Treaty on Intellectual Property in respect of Integrated Circuits (1989) recognized the investment needed to create a lay-out design of integrated circuits and the need to protect such creations. The treaty has not entered into force, but some aspects are included in the TRIPS Agreement.

5 The electronics industry and the NESDPs: Policy shift from import-substitution to export promotion

The electronics industry has benefited from favourable government policies and measures. The government policies influenced the location, ownership and export growth of electronic firms. There are four distinct periods that capture the broad policies and overall development of the sector. These periods match with the national development plans (see table 1.2).

Table 1.2 Electronics industry development and the NESDPs.

Electronics industry development	NESDPs
Import substitution, 19601971	1st-2nd Plans 1961-1971
Export orientation, 1972-1985	3rd-5th Plans 1972-1986
Rapid export expansion, 1986-1992	6th Plan 1987-1991
Supporting industry, 1993-present	7th-9th Plans 1992-2006

- **The import-substitution period (1960-1971).** During this period the government policies aimed at promoting production of consumer products for the domestic market. Tax incentives and tariffs were structured to attract FDI in the manufacturing sector to supply the home market. Most of the projects were joint ventures with Japanese investors such as Sanyo Electrics Co. Ltd., Thai-Toshiba Industry Co. Ltd. and Hitachi Consumer Product Co. Ltd., mainly involved in the assembly of radios and televisions for the local market. Thanin Industry Co. Ltd was the only domestic electronic producer. Overall, the import substitution strategies achieved modest growth owing to the limited size of the domestic market.

- **The export orientation period (1972-1985).** During this period the policies focused on export promotion. The Investment Promotion Act was amended in 1972 to include additional incentives to promote exports, and helped expand the electronics industry. In addition, Thailand benefited from improved access to the US market under the Generalized System of Preferences (GSP). These factors helped the electronics industry increase production volume and diversify the export product range. The diverisifed export products included printed circuit boards (PCB), piezoelectric crystals and microwave isolators. Major world producers of electronic products such as the Japanese Minebea Group, Seagate Technology and Hana Semiconductor established production facilities in Thailand. These developments led to an increased diversification and sophistication of electronic exports.

- **The rapid export expansion period (1986-1992).** During this period**,** the appreciation of the Japanese yen and the stable macroeconomic and political environment in Thailand attracted Japanese firms and firms from the newly industrialized economies (NIEs) to relocate their production facilities to Thailand. These firms played a central role in the rapid growth of electronic exports and gave rise to the development of some supporting industries such as subcontractors of and/or suppliers of parts to foreign affiliates. New export products during this period included floppy disk drives (FDD), computer components, and flexible and multi-layered PCB.

- **The supporting industry promotion period (1993-present).** The policies sought to exploit the continuous expansion of the electronics industry in order to develop domestic suppliers of components and parts. For example, the rapid increase in the production of hard disk drives (HDD) resulted in the emergence of support industries, such as manufacturers of plastic-metal parts, PCB and printed circuit board Assembly (PCBA). This period also witnessed the global growth of ICT, which provided additional stimulus to the Thai electronics industry.

Chapter II
Performance of the electronics industry

The electronics industry has performed well in many respects over the last four decades. The value and diversity of electronic export products have continued to increase, thus greatly contributing to enhanced trade and GDP growth. The sector has continued to attract significant investment. Furthermore, the industry is one of the main employers in the manufacturing sector. The industry's R&D expenditure, however, remains low and does not have recognized domestic brand names.

It is important to define the different segments of the electronics industry. Thai electronics industry is largely composed of computers and peripherals (34 per cent), electronic parts (40 per cent) and consumer electronics (15 per cent). There are also sizable electrical household appliances (6 per cent) and telecommunication and office equipment (4 per cent) producers. The semiconductor and HDD segments account for about 20 per cent of export value each (or combined export value of about 41 per cent). Semiconductors account for about half of the export value of electronic parts and HDD account for about 63 per cent of computers and peripherals.

1 Foreign direct investment

Thailand has been one of the major FDI recipients in South-East Asia over the past two decades (Brimble and Sherman, 1999; Mephokee, 2002). In general, FDI flows into Thailand were small prior to the 1980s. An estimated $31.6 billion was invested in Thailand between 1991 and 2002. Of this, 27 per cent and 16 per cent of the investment came from Japan and the United States, respectively, while the NIEs and member countries of the European Union accounted, respectively, for 35 per cent and 13 per cent of total FDI. The flows of FDI have changed over time in terms of origin. For instance, the share of US net FDI inflows increased from about 19 per cent in 1996 to 25 per cent by 1998 but declined to 23 per cent in 2002. Table 2.1 summarizes the trends in FDI flows to Thailand from 1996 to 2003.

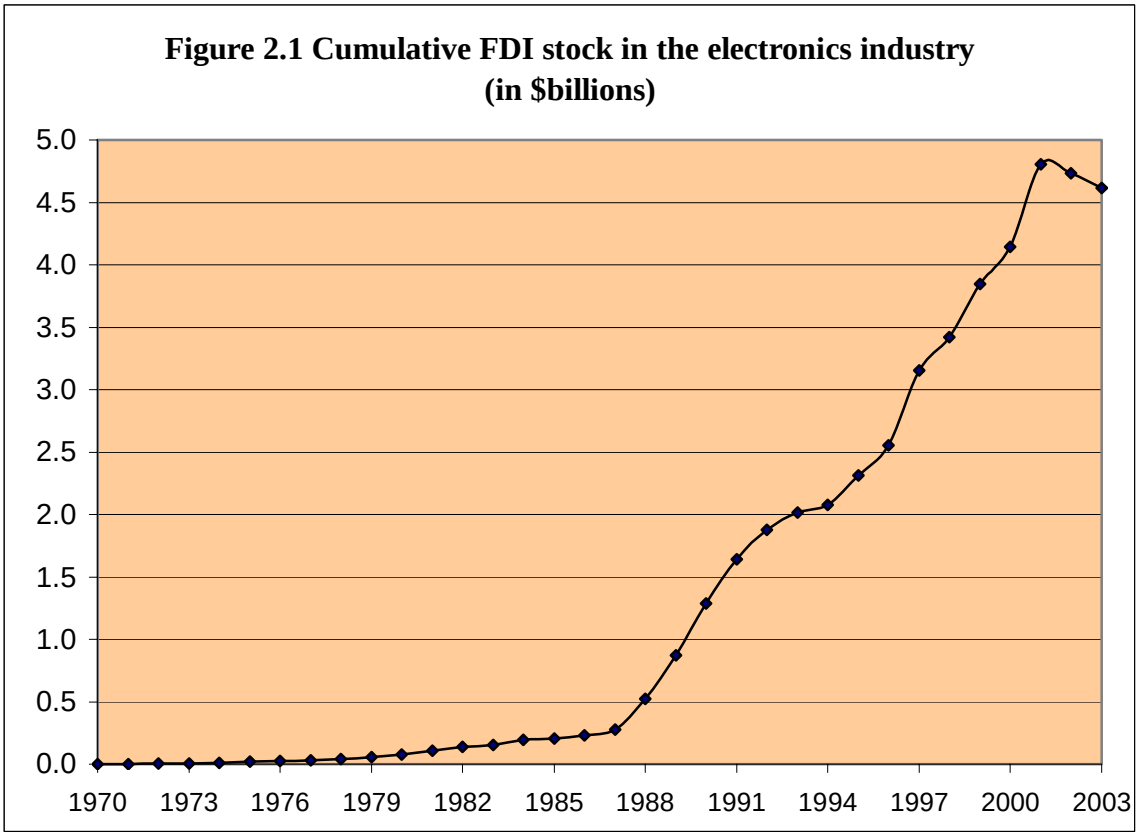
Table 2.1 Net FDI flow in Thailand by country or region of origin (percentages)

	1996	1997	1998	1999	2000	2001	2002	2003
Japan	23	37	29	14	31	36	62	45
United States	19	22	25	18	22	1	-23	-12
European Union	7	10	18	38	18	5	-43	3
Newly industrialized economies	29	24	22	25	30	50	135	53
ASEAN (without Malaysia)	1	1	1	1	1	1	-1	3
Other countries	20	6	6	4	-2	8	-29	8
Total (in $millions)	**2 271**	**3 627**	**5 143**	**3 562**	**2 813**	**3 873**	**1 023**	**1 526**

Source: Bank of Thailand.

The Plaza Accord,[2] which resulted in the appreciation of the Japanese yen and the currencies of NIEs, played an important role in facilitating FDI flows as firms relocated to cheaper manufacturing destinations such as Thailand. For example, in 1988 net FDI flows exceeded $1 billion for the first time and increased to reach about $5 billion in 1998 (see figure 2.1).

Figure 2.1 Cumulative FDI stock in the electronics industry (in $billions)



Source: UNCTAD, based on Ministry of Commerce, Thailand.

The electronics industry is one of the major recipients of FDI in the manufacturing sector. As in the case of other industries in that sector, FDI flows increased rapidly after 1988. Before 1988, the net FDI in the electronics industry was below $50 million. In 1988, the value of net FDI jumped to $250 million and remained above $200 million until 2001. Despite some fluctuations, FDI inflows into the industry increased significantly. For instance, the FDI stock in the industry increased from about $250 million in 1987 to above $4 billion by 2001.

The electronics industry has seen its share of net FDI flows increase from about 11 per cent in the early 1990s to about 17 per cent in 2001, with a significant fall of its share in 1998 (5.1 per cent). That fall was mainly due to increased FDI in other industries following the Asian financial crisis. The depreciation of the Thai bhat resulted in increased liquid challenges. The Government decided to relax foreign ownership rules after the crisis.[3] These two factors catalyzed an increase in mergers and acquisitions (UNCTAD, 2000), most of which involved foreign investors taking up more shares in their domestic affiliates. For

[2] Parties to the Plaza Accord of 22 September 1985 agreed to devalue the US dollar in relationship to the Japanese yen and German Deutsche Mark. This led to a decline of 51% in the exchange rate of the dollar by 1987. The goal was to help the US current account deficit and the US economy to emerge from a recession.

[3] There were foreign ownersship limits for BOI promoted resource-based projects, and services and manufacturing for the domestic market until recently. Foreign investors can now own up to 100 per cent

example, the financial sector's FDI went up nearly eight-fold and total net FDI reached $5.1 billion, the highest ever. However, the electronics industry registered a net outflow of FDI ($187 million) in 2002 and 2003 even though the sector's performance has remained strong.

The support offered to firms, such as low import tariffs on electronic equipment and parts need to manufacture exports, is important in enabling the Thai electronics industry to compete internationally. The industry has benefited from incentives offered by BOI. A large part of approved investment projects benefiting from BOI packages were in the electronics industry. For instance, the electronics industry accounted for between 18 per cent and 40 per cent of projects granted incentives by BOI from 1998 to 2002 (see table 2.2).

Table 2.2 Percentage of investment projects granted incentives, by sectors

Sector	1998	1999	2000	2001	2002
Agricultural products	4.6	8.0	10.9	11.1	24.8
Minerals and ceramics	0.4	0.3	4.7	2.3	1.3
Light industries/textiles	5.2	6.3	11.3	5.6	11.4
Metal and machinery	3.7	8.9	12.3	10.2	17.5
Electric and electronic	***23.3***	***40.5***	***33.7***	***20.3***	***18.0***
Chemicals and paper	17.0	29.4	25.6	27.3	10.5
Services	45.7	6.7	1.6	23.3	16.4
Total	100.0	100.0	100.0	100.0	100.0

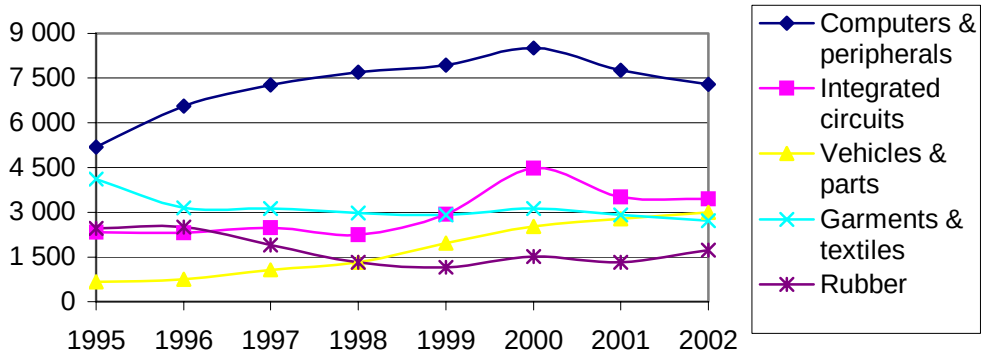
Source: Board of Investment Office, 2003.

Recently, BOI has introduced new incentives to promote the entire electronics industry supply chain. This is a major departure from earlier packages that targeted mainly the manufacturing sub-sector. The new incentives will provide firms that engage in R&D, training and marketing with similar privileges to those extended to contract manufacturers. In addition, there are provisions to facilitate recruitment of foreign IT personnel to work in Thailand.

2 Export performance

Thailand has significantly increased the export of manufactured products over the last four decades (Sribunruang, 1986). The share of manufactured exports as a percentage of total exports increased from 4.7 per cent in 1970 to 65.5% in 1991. The electronics industry has contributed greatly to the successful transformation of the composition of Thai exports. For instance, computers and peripherals and IC have been the main exports of the manufacturing sector since 1995 and their combined annual export value has stayed above $10 billion since 1999 (see figure 2.2).

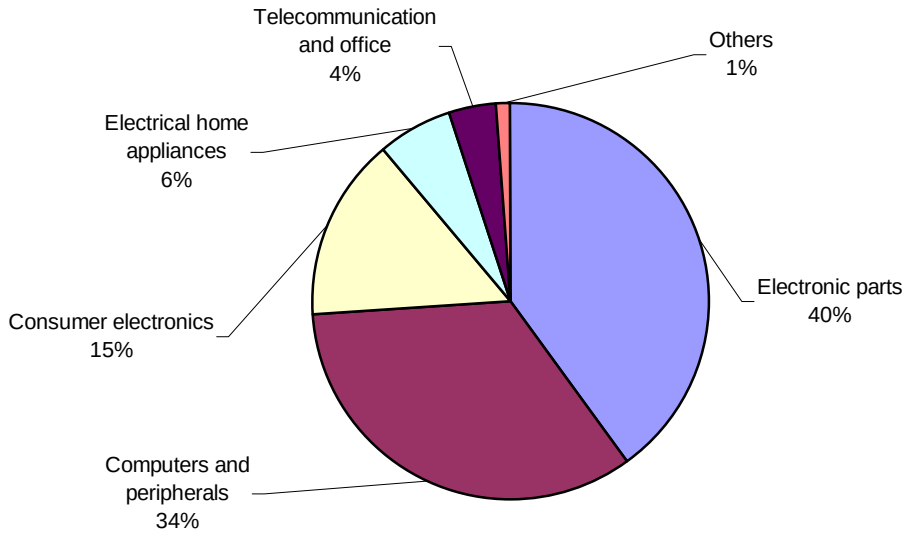
Figure 2.2 Top five exports of Thailand ($ million)



Source: Office of Business Economics 2004, Ministry of Commerce, Thailand.

In 2000, the electronics industry accounted for about 40 per cent of exports and contributed $6.2 billion to Thailand's foreign exchange revenue. About 91 per cent of all the products of the electronics industry are exported. Of the electronic exports, totalling about $23.6 billion in 2000, 40 per cent were electronic parts and 34 per cent were computers and peripherals. The remaining 26 per cent were composed of consumer electronics, electrical household appliances, telecommunication and office equipment, and others (see figure 2.3).

Figure 2.3 Electronics industry exports structure in 2000
(Total export value: $23.6 billion)



Source: McKinsey (2002).

In terms of products, HDD and parts accounted for about 21 per cent of total exports in 2000, while semiconductors accounted for about 20%. They are the two major export products and contributed about $9.4 billion. Thailand is the world's second largest HDD producer (after Singapore) and accounts for almost 20% of the global production. Similarly, the semiconductor sub-sector of the electronics industry in Thailand has expanded rapidly since 1995, with an average annual growth rate of about 18 per cent.

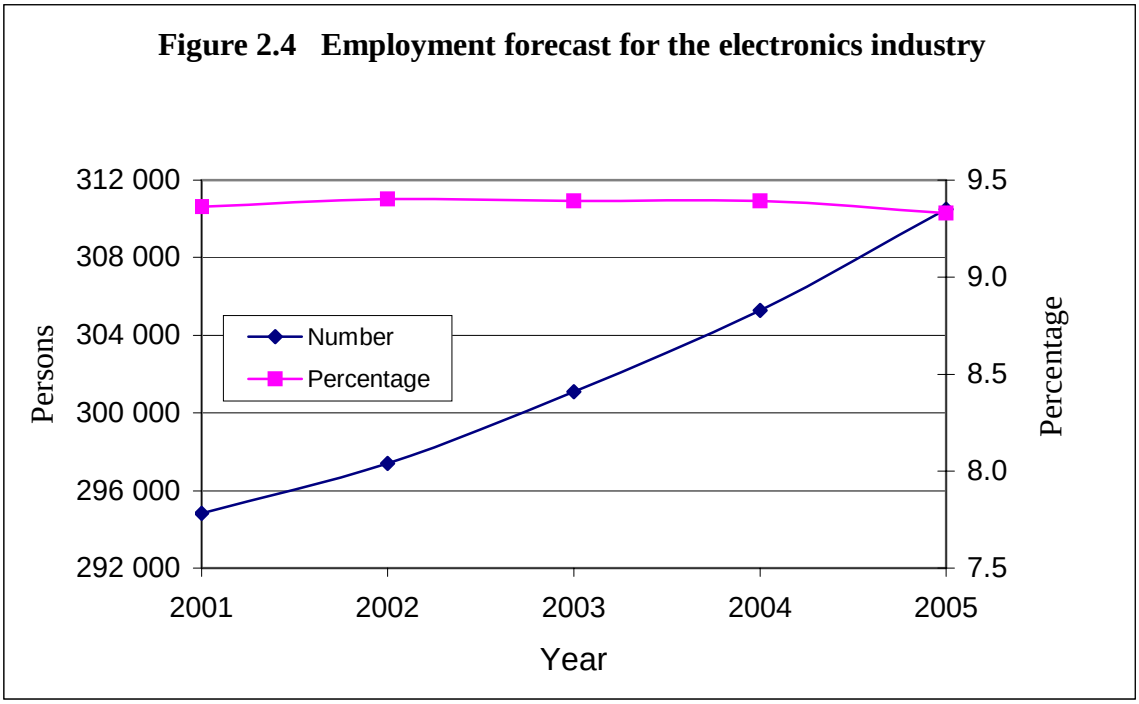
The major producers of HDD in Thailand include Seagate, Quantum, IBM, Maxtor and Fujitsu. Seagate, IBM and Fujitsu are among the top five world producers of HDD. However, Seagate has the largest HDD assembly plant and ships its products to Singapore for final assembly.

The majority of high-value-added products are either exported to the home countries of foreign investors, as in the cases of the United States and the EU, or to other stages of production, as in the cases of Japan and ASEAN markets.

3 Employment and firm ownership

The industry employs a large number of Thai workers and is expected to grow at the same rate (see figure 2.4). The number of persons employed in the electronics industry is predicted to rise from about 295,000 in 2001 to about 310,000 in 2005. Within the manufacturing sector, it is ranked as the third largest employer and accounts for about 9% of the total Thai labour force in the manufacturing sector. Foreign-owned firms employ most of the workers in the electronics industry (Tambunlertchai, 2004)

Figure 2.4 Employment forecast for the electronics industry

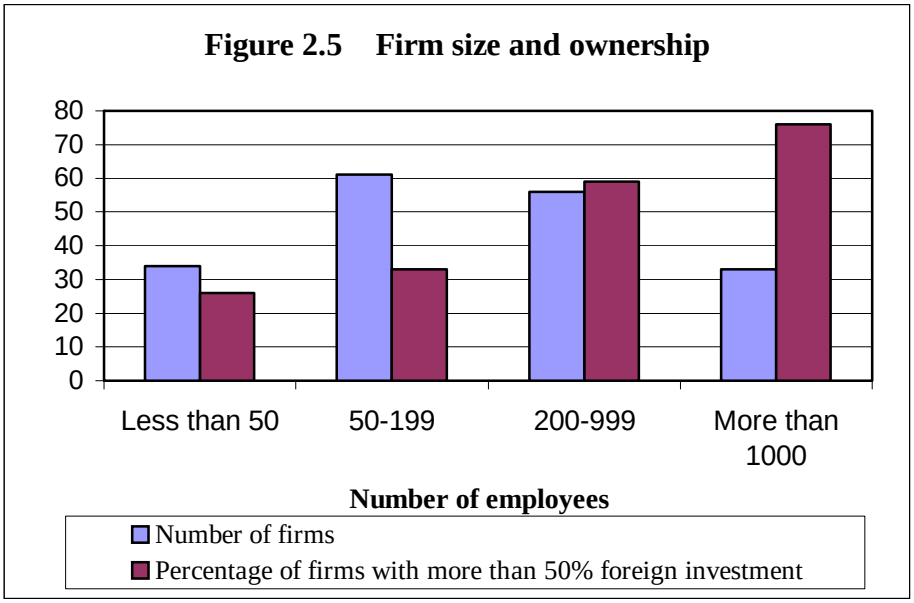


Source: Office of Industrial Economics, Ministry of Industry, Thailand.

The industry has a normal distribution of firms by size of employees. About 18 per cent of the firms in the industry have fewer than 51 employees and another 18 per cent have

more than 1,000 employees. Most of the firms (about 64 per cent) have between 50 and 1000 employees (see figure 2.5).

Figure 2.5 Firm size and ownership



Source: Office of Industrial Economics, 2001.

The ownership composition of firms in the electronics industry reflects the impact of FDI. Most of the firms employing under 200 workers are owned by Thais or have Thai majority control. About 76 per cent of the 33 firms employing more than 1,000 workers have a foreign participation (ownership) of above 50 per cent, while only 26% of the 34 firms with fewer than 50 employees have a foreign participation of above 50 per cent. Therefore, most of the larger firms are either wholly owned or controlled by foreign investors.

Chapter III

Technology capacity-building

The transfer of technology to Thailand has largely taken place through FDI and trade. FDI has transferred the production, management and marketing technologies. Thailand, as a contract manufacturer and component producer, has access to some of the technologies required for assembling and manufacturing the products needed by the principal firms or contractors (see cases below).

To benefit from it, the acquired technology has to diffuse into the wider economy. This has required closer linkages between the technology owners, other potential beneficiaries and relevant public institutions. The Government has used incentives, training programmes and other support measures (e.g. incubators and science parks) to facilitate the formation of alliances or networks.

1 Technology transfer and innovative capacity

The production of electronic goods may be divided into three major stages that can be performed separately: design, manufacture and assembly. The design stage requires extensive and intensive technical knowledge, and investment in R&D to develop novel products and processes, while the manufacturing of components requires capital-intensive investment for mass production. Finally, the assembly of the final products is capital - and labour-intensive and requires lower skills than the other stages of production. Each of these stages involves significant learning and innovation processes.

The Thai electronics industry started with the assembly of low-technology consumer products and has steadily developed into assembly and manufacture of high-technology products. In the early stages, the industry mainly acquired technology to assemble household consumer products such as radios and television. Since the 1980s, it has acquired more complex technologies to assemble advanced electronic products such as PCB, microwave isolators, floppy disk drives (FDD) and HDD. This achievement reflects the fact that the industry has acquired the capacity to source, adapt and operate foreign technologies as well as the capacity to upgrade and improve assembly processes.

However, manufacture and design capabilities remain limited to a few sub-sectors. For instance, the HDD sub-sector has acquired strong manufacturing capabilities. Some of the major HDD producers have manufacturing facilities in Thailand. However, the Thai HDD firms have not yet acquired research and product development capabilities. The TNCs perform most of the design and product development activities outside Thailand.

Similarly, the Thai semiconductor industry has some capacity in process design (largely in the assembly process) but lacks manufacturing capacity and the ability to design new products. On the other hand, the PCB sub-sector has a strong manufacturing capacity, with Thailand emerging as one of the major manufacturers of PCB. In 2003, Thailand's output

of PCB components exceeded $700 million in sales.[4] At the current level of growth, Thailand's PCB sales are expected to exceed the $1 billion mark in 2006.

Overall, Thailand's electronics industry has caught up with other leading nations as a productive and efficient assembler of electronic products. This has enabled firms to supply electronic products that can successfully compete in the international market. In other words, firms have assimilated production, management and process technologies. The industry is also beginning to acquire manufacturing capabilities.

FDI facilitated the transfer of production, management and process technologies to Thailand (Enos, 1989). The participation of TNCs has facilitated the development of local contractor manufacturers and provided knowledge of external market needs (e.g. standards). In addition, some TNC affiliates have helped some local firms to upgrade technologies and skills to meet their own requirements.

Thai firms perceive FDI as a major source of new and advanced technology (IMD, 2004). On a scale of 1 to 7,[5] Thailand scored 5.2, which is comparable to Malaysia's 5.8 and Singapore's 6.3. This is because FDI has facilitated the transfer of new technologies needed to assemble and manufacture electronic products.

However, few firms have assimilated and mastered foreign technologies to enable them to undertake technology upgrading or reverse-engineering activities. Even fewer firms have the capacity to design and develop novel products. This may be explained by the fact that technology diffusion in the electronics industry has largely occurred within the production networks of TNCs. As contract manufacturers, the domestic firms are more inclined to assemble or manufacture products required by the contractors than develop novel products that compete with the established firms. In this case, firms need only the capacity to develop efficient and flexible assembly or manufacturing platforms to meet the needs of their customers. This has limited the innovative activities to process upgrade and design.

In general, the performance of the electronics industry in terms of physical productivity[6] closely matches that of other Asian competitor countries. However, the value-added productivity[7] in the electronics industry is lower than that of Singapore and Taiwan Province of China. If value-added per employee in the electronic sector is set at 100 per cent for the United States, Singapore scores 72 per cent while Thailand scores only 8 per cent (McKinsey, 2002). This reflects the fact that the industry is largely at the assembly stage.

Consequently, the Government has developed several initiatives to encourage the electronics industry to develop and move from assembly to the manufacture and design stages. To that end, the National Science and Technology Development Agency (NSTDA) established the Industrial Consultancy Services in 1992. The goals of the project were to encourage Thai enterprises to use local and foreign technical consultants, and channel industrial problems to research institutions and universities.

The programme provides 3,000 bhat per day for preliminary problem diagnosis, not exceeding two days, and up to 50 per cent of the cost of consultancy for problem solving and

4 Runckel (2004).

5 Where 1 = FDI brings little new technology, and 7 = FDI is an important source.

6 Physical productivity may be defined as the quantity of output produced by one unit of production input in a given unit of time.

7 Value-added per unit of labour input.

technology development activities. To qualify for support, the firm must register and have manufacturing facilities in Thailand and be at least 51 per cent Thai-owned. In addition, the firm must be interested in improving productivity. The use of experts has helped many participating firms to produce new products and/or processes or improve their existing ones.

In 1997, NSTDA set up the Software Park Thailand (SPT), a government agency to stimulate the development of the Thai software industry, promote innovation and facilitate the development of start-up firms. The cluster occupies 13,000 square metres and offers a technology transfer service. Among its strategic partners are Oracle, IBM, Intel, Microsoft, the Centre of Excellence for Computer Security and Internet Thailand. The establishment of SPT has facilitated technology transfer within and outside the Park and encouraged knowledge flows between tenants, NSTDA, participating universities and TNCs.

The Thailand Board of Investment also developed a programme called the Unit for Industrial Linkage Development (BUILD). The objectives were to encourage the development of support industries, strengthen the relationship between suppliers and contractors, help small and medium-sized contract manufacturers to improve their productivity, and facilitate cooperation between foreign and domestic firms. In 2004, the programme received the World Association of Investment Promotion Agencies (WAIPA) Award for best practice in promoting linkages that facilitate technology transfer and innovation. A number of firms in the electronics industry, such as Hitachi, Toshiba, IBM, Fujitsu, Canon and Sony, are involved in BUILD. Issues such as business policies on purchasing and subcontracting and technology confidentiality are addressed. The linkages include TNCs in Thailand and abroad. It is estimated that about $148 million worth of transactions took place in BUILD in 2001.

In terms of technology transfer and upgrading, BUILD provides training courses to SMEs to help them upgrade their production and product standards, quality and reliability. The programme also provides matchmaking services and arranges visits by SMEs to the facilities of contractors. BUILD has enabled participating SMEs to acquire technology and innovative capacity to improve the quality of their products. The programme played an important role in encouraging the development of contract manufacturers and the transfer and development of technologies, as well as encouraging technology diffusion and spillovers. However, most of the electronic exports have a high import content.

More recently, the Government has developed additional support programmes. One such step is the development of the Thailand IC Design Incubator (TIDI) to promote semiconductor design capabilities, and the training and certification of IC layout designers. It is hoped that it will attract IC designers from abroad and help bring together different players in the semiconductor sub-sector (industry, universities and public institutions) to collaborate or enter into strategic alliances to promote knowledge exchange. This may encourage innovation, skills development and the creation of stronger linkages and greater trust.

The NSTDA has also commissioned the HDD cluster development project to develop and implement several projects to address the needs of the HDD sub-sector. The project seeks to make the sub-sector competitive, increase the local content of assembled products, and promote design and product development capabilities. Currently, the industry relies on imports for high-technology components. The cluster is intended to promote strong partnerships between public and private sector players, and skills development, improve support infrastructure and facilitate development of innovative industrial policies (AIT/APRC, 2004).

These efforts, among other initiatives, are expected to help overcome the current challenges and accelerate the development of high-value electronic products. There are increasing efforts to provide incentives to stimulate industry to perform R&D activities in Thailand as a way to promote innovation and technology upgrade and development.

However, It is also important to note that some of the incentive schemes that governments traditionally used to attract export-oriented FDI may no longer be compatible with the disciplines set out in the WTO Subsidies and Countervailing Measures Agreement. For further details, see the World Investment Report 2002 (UNCTAD, 2002) and the WTO Subsidies and Countervailing Measures Agreement.

The industry still faces many challenges as it seeks to establish itself as a global leader. In comparison with competing countries, Thailand has a lower concentration of researchers and private sector expenditure on R&D per capita. Perhaps more importantly, the R&D performance reveals that government and higher education institutions account for more than 60 per cent of Thailand's national R&D expenditure (see table 3.1). Of the total R&D personnel (i.e. full-time equivalent), 92 per cent work in the public sector (government and higher education institutions) and only 8 per cent work in the private sector (public and private enterprises, and not-for-profit organizations).[8] About 2 per cent and 22 per cent are engaged in computer and communication-related technologies and engineering related-technologies, respectively.

Table 3.1 R&D expenditure as percentage of GDP by sector of performance

	1996	**1997**	**1999**	**2001**
Government institutions	0.058	0.055	0.04	0.098
Higher education	0.026	0.033	0.056	0.038
Private and public enterprises	0.027	0.02	0.013	0.078
Private non-for-profit	0.007	0.001	0.001	0.002
Total	**0.12**	**0.11**	**0.11**	**0.22**

Source: Office of the National Research Council of Thailand, 2004.

Furthermore, the NSTDA R&D/Innovation Survey 2000 revealed that 15 per cent of firms have R&D facilities, while 48 per cent have no facilities at all. The majority of the firms surveyed possess mainly quality control assurance and testing facilities. The survey also revealed that the linkage between private firms and public research institutions is weak. Only 20 per cent of the firms surveyed have used the services of public research institutions and perceive the services offered as important to them.

The limited R&D investment and human resource development and the weak linkages between public research institutions and industry may be affecting the performance of the Thai electronics industry. In general, the performance of the industry in terms of physical productivities closely matches that of other Asian competitors. However, the value-added productivity in the electronics industry is lower than that of Singapore and Taiwan Province of China (McKinsey, 2002).

[8] Office of the National Research Council of Thailand, 2001 data (http://www.nrct.net/).

2 Successful technology transfer cases

A Technology transfer through licensing: The case of Siam United Hi-Tech Limited

SUH was formed in 1990 following the acquisition of the WN keyboard technology (101 keys) from Honeywell, the US electronics company. Previously, SUH had manufactured plastic toys, but was not able to compete in the market owing to cheaper Chinese-made plastic toys. With the licensed technology, the company switched to the production of keyboards. Although the production of keyboards requires more sophisticated technology than toys, they too are made of plastic. Therefore, only a modest technological upgrade of SUH's production facility was needed to switch from the manufacture of plastic toys to that of keyboards.

During the first period (1990-1994), the company manufactured the WN keyboards under the "SUH-Honeywell" brand name. In 1994, the licensing arrangement with Honeywell expired, and SUH had to develop its own brand name and technology. To meet these challenges, the company employed several foreign technicians and marketing experts who had previously worked with Honeywell. In 1994, SUH released its first originally designed keyboard and sold its entire production to one major customer. In 1996, it developed two new keyboards in addition to updating the product line to include the new Windows 95 keys on all keyboards.

In July 1996, SUH moved into a new state-of-the-art manufacturing facility to meet the increasing demand. Currently, SUH has four keyboard assembly lines with a production capacity of 300,000 keyboards per month with additional space for expansion. SUH uses either laser engraving or sublimation process technologies to print graphics on the key tops. Both methods produce durable characters on the key tops. All keyboards undergo functional testing of every key to ensure that they produce the right electrical signals. Testing is performed using an automatic functional tester that depresses each key. All plastic modelled parts are made in-house using injection moulding facilities adjacent to the final assembly lines.

Keyboards can be divided into low-end and high-end categories according to customers' needs. The low-end keyboards have a limited number of functions and use less sophisticated technology. They are made to complement personal computers. SUH aims to produce high-end products that require a higher level of technology, sophisticated designs and advanced functions. SUH products include the AT/PS2 keyboard, the USB keyboard and the Darkie Multimedia Keyboard (the company's latest product).

SUH provides customized keyboards designed in-house using the CAD workstations. The onsite model and tool shop is used to build prototypes. SUH also has its own product development laboratory facilities that generate new products and provide engineering support for existing products.

The licensing of technology from a reputed international electronics company was just the first step for SUH. Much of its success is largely due to its ability to innovate and upgrade the acquired technology, and keep up with technological developments and the needs of its customers. It harnessed the extensive experience of Honeywell to build its brand name and customer base. For instance, the hiring of former Honeywell employees helped in the acquisition of technical, managerial and marketing capabilities. In addition, SUH sent some of its local technicians for training to Honeywell's headquarters in the United States. By 1994,

SUH had mastered all stages of keyboard production, such as product design, production and testing.

Human resources development has played a key role in the success of SUH. SUH has a skilled human resource base that is capable of designing a range of keyboard layouts to meet the requirements of a wide range of customers. All operators are trained and certified before being assigned to their production stations. Recertification of all operators is performed on a periodic basis. In-house training is the main mode of human resource development.

B Technology transfer through subcontracting: The case of Hana Microelectronics Group

The Hana Microelectronics Group is one of the South-East Asia's leading independent "electronic manufacturing service (EMS)" company. Hana was established in 1978 in Bangkok with 30 employees assembling LED watch modules. In 1979, the company moved into the assembly of liquid crystal display (LCD) watch modules. In 1982, a Swiss watch company, SMH Group[9], gave a subcontract order to Hana to assemble E-module for quartz analogue watch movements. In 1983, the company assembled and distributed watch movements for the SMH Group in the Hong Kong market.

In 1986, the Hana Group formed Hana Coil Co. Ltd. to produce wind coils for watch movements and wind coils for other electronic industries using the technology it had acquired from SMH Group. In 1992, Hana Semiconductor was established to give the firm a stronger presence in the electronics industry. In 1993, the company moved its PCBA, chip on board (COB) and coil winding division to a new facility in Lamphun, and Hana was listed on the Securities Exchange of Thailand (SET).

The company established Hana Microelectronics Co. Ltd. in Shanghai (China). It employs over 1,200 people and is equipped with fully automated machinery for COB, chip on flex, surface-mount, micro-coil winding, PCBA and several other electronic products. In 1998, the Hana Group acquired the total assets of Olin Technologies, a division of Olin Corporation from the United States, which produced metal parts for the semiconductor industry, and was renamed Advanced Interconnect Technologies (AIT) Company. AIT provides a comprehensive range of IC assembly and testing services. It employs over 6,000 people and produces over 100 million IC packages a month.

In 1999, Hana completed the purchase of the Ohio factory of S-Vision (Ohio, United States). The acquisition of the S-Vision manufacturing plant provided Hana with the technology and facilities needed to assemble the new "video monitor on a chip" technology for reflective "liquid crystal on silicon" micro displays. Micro displays have a high potential as a key component in large-screen television and computer monitors, multimedia projectors, viewfinders for digital and video cameras, and video headsets and handheld devices.

[9] SMH group was renamed the Swatch Group in 1998.

Table 3.2 The Hana Group

Manufacturing services	Location	Holding (%)
Custom products	Hana Semiconductor (Bangkok)	100
IC assembly and testing	Hana Semiconductor (Ayuttaya)	100
Printed circuit board assembly	Hana Microelectronics PCL (Lamphun)	100
Chip on board assembly	Hana Microelectronics (Shanghai, China)	100
IC assembly and testing, leaded and leadless package	Advanced Interconnect Technologies (Indonesia)	43
Micro displays	Hana Microdisplay Technologies (Ohio, United States)	100

*Source***:** Interviews.

Hana Semiconductor (Bangkok) Co. Ltd. provides several manufacturing services for customized products, such as assembly of light-emitting diodes, opto electronic packages and hybrid devices on a captive line basis. Hana Semiconductor (Ayutthaya) offers complete turnkey subcontractor services such as wafer testing and wafer back grinding, assembly, testing, dicing and drop shipment services. The company also provides several new packages, including an image sensor package used for mobile phones, digital and web cameras, and custom design IC package assembly.

Hana Microelectronic Assembly and Test (Lamphun, Thailand) has 1,600 employees and assembles products such as camera control circuits, smart cards, HDD parts, telecommunication parts, automotive parts and timer controls. Hana Microelectronics (Shanghai, China) employs over 1,200 people and produces COB, SMD, micro-coil winding, PCBA, hybrid modules and RFID card lamination assembly services.

Hana Microdisplay Technologies, Inc., located in Ohio, United States, focuses on supplying independent assembly services to OEMs in the micro display industry. The main service is to assemble the reflective LCOS micro displays, which are the key components for large-screen televisions, computer monitors, multimedia projectors, viewfinders for digital video cameras, video headsets and handheld devices.

C Success factors

There are a number of factors that determined the successful integration of the two firms into the global economy. Both firms benefited from transfer of technologies from TNCs, and their adaptation and further development to keep up with the changing competition. The two firms used the transferred technologies to become contract manufacturers in the global electronic production network.

The two firms have used different modes of technology transfers. While SUH acquired technology through licensing, Hana adapted the technology acquired as a contract manufacturer. Hana received production and managerial know-how as well as materials and some machinery from the contracting TNCs. Furthermore, Hana purchased technologies (through the acquisitions) to expand its technological base.

The two firms have developed their own in-house R&D facilities and human resource development programmes. These efforts have enabled the firms to upgrade the acquired technologies to produce original products as well as to remain reliable subcontractors.

SUH has successfully switched from producing plastic toys to producing keyboards and further diversified production into several computer-related products (e.g. multimedia speakers and computer mouses). Similarly, Hana went from assembling watch modules to producing a variety of electronic products. Their vision to focus beyond the domestic market and a few customers has enabled them to become global players within their industrial segments.

Both firms already had some expertise in the areas of interest. For example, SUH did not undertake a major upgrade of its facilities since toys (its original products) and keyboards are made of plastic. SUH successfully transferred the skills it had accumulated in plastic moulding to keyboard production. A similar transformation is seen in the success of Hana, namely that it has used its experience in the production of displays of watches to develop capacity to produce video, phone and computer displays.

While these firms are not representative of technological upgrading and innovation in the Thai electronics industry as a whole, they at least show that some firms in the industry have developed as partners of TNCs as suppliers and/or distributors. They did not develop as competitors of TNCs. In general, Thai electronic firms do not compete with TNCs; rather, they become suppliers of components or provide manufacturing services to TNCs. Some TNCs provide training support to Thai electronic firms. This kind of assistance would not be possible if Thai firms were competing with the TNCs.

Conclusions

Thailand has been successful in building up an internationally competitive electronics industry and in integrating itself into the global economy. It is now a major global manufacturer and exporter of several electronics products/components.

FDI and trade have played a key role in building up this industry by facilitating inflows of capital and technology and providing access to international markets. Between 1986 and 2001, FDI inflows into the electronics sector amounted to $4.5 billion. In terms of trade, electronics currently account for more than 30 per cent of Thailand's total exports. The main export items include hard disk drives (HDD) and parts, and integrated circuits (IC), which account for about 21 per cent and 20 per cent of the total electronic exports, respectively. Thailand is the world's second major HDD producer (after Singapore). At the present time, the electronics industry employs about 300,000 workers.

Government policies have always played a vital role in building up a successful electronics industry. Thailand adapted its policies to align with the rapidly changing trends in the global economy. First, realizing that its domestic market was rather small to support industrialization, Thailand shifted from an "import-substitution" to an "export-oriented" development strategy. This required liberalization of the economy for trade and investments. The liberal economic policies, coupled with the availability of a skilled but low-cost labour force, made Thailand an important location for export-oriented production activities of TNCs. Having been established as an important destination for FDI, Thailand attempted to steer the FDI inflows into areas of national priority. The Government has designed incentive schemes to channel investments into sectors of importance, such as electronics.

TNCs have played a major role in the transfer of technologies by setting up facilities to assemble and manufacture electronics products. TNCs' operations have enabled local employees in Thailand to learn process technologies, mainly how to operate and maintain production equipment. The transferred technologies mainly relate to assembly processes and in some cases to manufacturing. Nevertheless, there are few cases of transfer of design and product development skills to Thailand. The technologies and skills transferred largely remained within the production networks of TNCs, with limited diffusion to some domestic suppliers and subcontractors. This limited diffusion facilitated the emergence of a number of Thai firms as suppliers to TNCs. Thailand's electronics industry remained dependent on imports for the vast majority of high-tech components.

To address this weakness of the electronics industry, the Thai Government now began to emphasize developing local support industry and building up domestic innovative capacities.

Among the government measures to strengthen domestic capacities in the electronics industry are the following:

- Industrial Consultancy Services. The National Science and Technology Development Agency (NSTDA) established this programme in 1992 to

promote the utilization of local and foreign consultants by Thai firms and to facilitate the formation of alliances.

- Unit for Industrial Linkage Development (BUILD). In 1992, the Board of Investment of Thailand created the BUILD programmes to encourage the development of support industries, strengthen linkages and help small and medium-sized contract manufacturers improve their productivity, as well as to facilitate cooperation between foreign and domestic firms.

These programmes also played an important role in the emergence of local contract manufacturers and in technology development and transfer.

The establishment of the Ministry of Information and Communication Technology in late 2002 was another step in determining the role of IT in national development and its use in different sectors for long-term growth. The IT-2000 was initiated in 1996 to provide the fundamental elements for IT, such as IT-related infrastructure, IT-literate human resources and good governance in both urban and rural areas. Since then, the relevant infrastructure has improved significantly, but the human resources and regulatory elements remain modest. The IT-2010 has two action plans that were approved in 2002. These plans seek to improve the utilization of resources and invest in the development of knowledge-based human resources, IT infrastructure and promotion of innovation.

The Government has also initiated measures to develop clusters to foster the emergence of innovation-based support enterprises. They focus on key clusters or specific sectors of the economy. For instance, the NSTDA has commissioned the HDD cluster development to develop and implement several projects that address the needs of the HDD sub-sector. It seeks to improve the sub-sector's competitiveness, increase the local content of the assembled products and promote design and product development capabilities.

The successes of the two firms - SUH as a global electronics parts supplier and Hana as a globally competitive contract manufacturer of electronics - show that given the right environment, a number of Thai firms have the potential to integrate themselves into the global economy.

It is expected that the new policy initiatives described above will help develop stronger local support industries and build up domestic innovative capacities in the years to come.

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UNCTAD's work in the area of technology transfer and intellectual property rights

Responding to the mandate received from member States at UNCTAD XI in São Paolo as well as from the Bangkok Plan of Action, the UNCTAD secretariat is implementing a transfer of technology and intellectual property rights (TOT-IP) work plan under its international arrangements programme (covering issues related to investment, as well as technology and intellectual property). The TOT-IP initiative seeks to help developing countries participate effectively in international discussions on technology transfer and intellectual property, and to identify policy options for successfully integrating developing countries into the world economy. The programme conducts research and policy analysis, technical assistance and policy dialogues with negotiators, diplomats and policy makers.

A. Work in the area of technology transfer

The TOT study series addresses government officials, international organizations and agencies, and researchers. It draws lessons from successful experiences with technology transfer and diffusion in developing countries and the effectiveness of the different modes of technology transfer.

- ***Case studies on TOT in developing countries.*** UNCTAD's series *Transfer of Technology for the Successful Integration in the Global Economy* consists of a number of case studies on TOT issues in individual industries in selected developing countries. These studies draw lessons from successful experiences with the transfer and diffusion of technology through various channels.

- ***Home-country measures in promoting TOT.*** The paper presents an overview of initiatives and measures as well as incentives provided to industry and public institutions in developed countries to facilitate the transfer of technology to developing countries. It covers measures that promote technology transfer through investment, training, matchmaking services, financing and development of the technological absorptive capacity of developing countries.

- ***Compendium of international TOT arrangements.*** To provide an overview of existing technology-related provisions in international instruments, UNCTAD has compiled a *Compendium of International Arrangements on Transfer of Technology: Selected Instruments*. [a] This compendium contains a selection of TOT-related provisions drawn from international instruments. It includes relevant excerpts from international instruments at the multilateral, regional, interregional and bilateral levels. The technology-related provisions contained in such instruments follow different approaches, depending on the purpose of the respective instruments. They all aim at promoting access to technologies

[a] UNCTAD/ITE/IPC Misc.5.

and, in some cases, the development of local capabilities in developing countries, particularly least developed countries.

B. Work in the area of intellectual property rights

The UNCTAD-ICTSD[10] Project on Intellectual Property Rights and Sustainable Development is intended to address the concerns voiced by developing countries with respect to implementation of the TRIPS Agreement and new developments brought about in the area of IPRs by multilateral treaties and regional and bilateral free trade agreements.

The project aims at improving the understanding of the development implications of IPRs and facilitating informed participation in ongoing multilateral, regional and bilateral negotiation, as well as assisting national authorities in the implementation and adoption of forward-looking IPRs policies.

The project consists of three interrelated components:

1. Policy-oriented interdisciplinary research. Highlights of the project's research outputs include:

- A *Resource Book on TRIPS and Development* providing a development-oriented analysis of each provision of the TRIPS Agreement, taking into account economic and social implications and IPR trends in non-WTO forums. The entire book is available on the project website (*www.iprsonline.org*) and was published as a revised version by Cambridge University Press in late 2004.

- Studies on various topical IPR issues, including transfer of technology, public health, geographical indications, nutrition, traditional knowledge, TRIPS-plus in bilateral and regional agreements, technical assistance, innovation, competition and computer software.

- *A Policy Discussion Paper*: *Intellectual Property Rights: Implications for Development*, intended to be a synthesis of the main issues to help policy makers, stakeholders and the public in developing and developed countries to understand the development impact of IPRs and different policy positions regarding TRIPS.

2. Enhancing policy formulation. The project places considerable emphasis on assisting developing countries in enhancing IP policy formulation through establishing and supporting networks. The overall objective is to facilitate the emergence of a critical mass of well-informed stakeholders that could play an active role in future policy-making.

- *At the international levels*, the project has convened a series of dialogues involving key policy makers and stakeholders at the Rockefeller Foundation

[10] International Centre for Trade and Sustainable Development.

facilities in Bellagio, Italy, in order to build and promote a development-oriented agenda on IPRs.

- *At the regional and national levels*, the project works closely with selected centres of excellence based in established universities and research institutions in developing countries, as well as with NGOs, the media and parliamentarians. The main means of collaboration are joint research and regional dialogues, which draw *inter alia* on the existing and ongoing research described above.

3. Outreach and dissemination. Outreach and dissemination are carried out both through traditional channels and, in particular, through the continuous updating and maintenance of the project website (*www.iprsonline.org*). Regular informal encounters with stakeholders in Geneva are organized to continue raising awareness and to keep Geneva-based delegations properly informed of the project's activities, including the regional dialogues.

Since 2001, the project has benefited from the financial support of the Department for International Development (United Kingdom), the Swedish International Development Cooperation Agency and the Rockefeller Foundation.