MICROELECTRONICS IN THAILAND

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INTRODUCTION

The strategy for the economic and social development plan of Thailand called for the promotion of “lead industries”, among which electronics and information-based industries has been identified and targeted for promotion and expansion. Consequently, electronics and information-based industries has become one of the major investments during the past decade with millions of US Dollars in value. In economic terms, electronic products have been the country’s major exports (second in terms of value) for the past three years, with the export value of electronic parts and components amounting to US$2.9 billion dollars in 1991. Besides industrial development, there were a number of successful technical cooperation, regionally and bilaterally, in microelectronics. In academia, microelectronics courses have been offered to university students and a number of research projects have been successfully implemented. One significant milestone in microelectronics development in Thailand was the establishment of the National Electronics and Computer Technology Centre (NECTEC) in 1986.

This paper has been compiled to provide a general overview of significant development of microelectronics in Thailand. It is composed of six main sections. In the second section following this introduction, the evolution of microelectronics firms and products are presented. The third section describes regional and bilateral cooperation, the
programme which has significantly contributed to microelectronics development in the country, followed by the section on microelectronics education. The fifth section presents the policy perspectives, including Thailand’s development targets and research and development. Future vision and proposed development strategies are presented in the last section.

**EVOLUTION OF MICROELECTRONICS FIRMS AND PRODUCTS**

According to a study by Thailand Development Research Institute (TDRI)¹, there are five major development phases in Thai microelectronics firms and products (Table 1), which can be summarized as follows:

**The Consumer Electronics Phase (1960-1970)**

This phase began in the early 1960s with the establishment of TANIN INDUSTRY, a wholly Thai-owned firm, to produce radios and televisions. This was followed by five Japanese consumer electronics producers, who all formed joint-ventures with Thai partners to exploit the well-protected domestic market. Although the market was almost totally dominated by TANIN and joint-venture Thai-Japanese firms, several smaller indigenous firms producing telecommunication and industrial electronics equipment began to emerge.

**The Integrated Circuits Phase (1971-1974)**

The second phase took place when three American producers of integrated circuits set up their assembly plants in Thailand. It was a beginning of export-oriented microelectronics product era. New firms also entered the consumer electronics business, for example Philips of the Netherlands.

**The Consolidation Phase (1975-1982)**

The third phase saw no major developments. About 12 predominantly Thai companies entered the domestic consumer electronics industry in a small way. An equal number of Thai and joint-venture companies began to produce a wider range of electronic components primarily for export markets.
## TABLE 1
THE DEVELOPMENT OF THE ELECTRONICS INDUSTRY IN THAILAND

<table>
<thead>
<tr>
<th>PHASE</th>
<th>NO. OF FIRMS ESTABLISHED</th>
<th>MAIN PRODUCTS OF NEW FIRMS</th>
<th>MARKET ORIENTATION OF NEW FIRMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumer Electronics (1960-1970)</td>
<td>11 (72.7%)*</td>
<td>Radios, Televisions, Electronic Cable</td>
<td>Domestic, Domestic, Domestic</td>
</tr>
<tr>
<td>Phase 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Integrated Circuits (1971-1974)</td>
<td>10 (70.0%)</td>
<td>Integrated Circuits, Telephones, Radio Transceivers, Car Radios</td>
<td>Export, Domestic, Domestic</td>
</tr>
<tr>
<td>Phase 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consolidation (1975-1981)</td>
<td>31 (41.9%)</td>
<td>Consumer Electronics, Ferrite Devices, Electrolytic Capacitors, Television Components</td>
<td>Domestic, Export, Export/Own Use</td>
</tr>
<tr>
<td>Phase 4</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Phase 5</td>
<td></td>
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</tr>
<tr>
<td>Post-Yen Appreciation (1987-present)</td>
<td>13 (100%)</td>
<td>Microwave Oven, Microwave Oven Parts, Telephones, Printed Circuit Boards, Assembled Hard-Disk, Floppy Disk Drives, Wide Product Range</td>
<td>Export, Export, Export, Export/Domestic, Export, Export, Mainly Export</td>
</tr>
</tbody>
</table>

*Numbers in percentages represent BOI promoted firms total established firms
The Component Expansion Phase (1982-1986)

This phase was dominated by American and Japanese firms. It began with the establishment of Minebea factories in Thailand in 1982. Minebea factories produced a wide range of parts and components including small-size and miniature ball bearings, stepping motors, and keyboards. The second major company in this phase was Seagate Technology, which entered Thailand to carry out a number of sub-assembly processes to support its hard-disk assembly operations. This phase also saw an expansion of integrated circuit assembly industry. Four new companies have entered an IC-assembly industry, one of which being the first majority Thai-owned firm. A number of printed circuit board producers and assemblers were set up, mainly for overseas sub-contracting work.


In this phase, several existing companies expanded so rapidly, both in the existing product lines and new ones, e.g. the sub-assembly of magnetic recording devices, a wider range of electronic motors, electronic ball bearings, etc. The most notable new entrant into the industry was Sharp, which became the first major producer of consumer electronics products to locate a factory in Thailand to primarily serve export markets. The company was followed by several sub-contracting firms from Japan which were located close to the assembly plant to supply a number of component parts. Several other export-oriented firms were also established to export printed circuit boards, floppy disk drives, and powerline conditioners. In the integrated circuit industry, some new firms began to use advance packaging technology in their products, e.g. Sony Semiconductor, Alphatech (a local IC sub-contracting firm), etc. Some of the IC packaging firms have now expressed interest in upgrading their services to cover wafer fabrication for some selected products in the near future. One driving factor for this development was the mega-projects in telecommunication services in Thailand.

REGIONAL AND BILATERAL COOPERATION IN MICROELECTRONICS

Microelectronics is entirely a phenomenon of the late 20th century and has become the enabling technology for communications, computers, information systems, automation, medical, and many other industries. It appeared, however, that ASEAN’s earlier uncoordinated efforts in acquiring this technology were fraught with difficulties
e.g. prohibitive costs, export restrictions, and impossible licencing agreements. It was to the extent that no viable microelectronics programme has emerged before 1983. The ASEAN-EC seminar and the ASEAN Committee on Science and Technology (COST) visit to Australia were the two significant milestones in microelectronics cooperation with Australia and the EC, as both regional and bilateral activities.

It can be said that VLSI design activity in Thailand was virtually initiated by the ASEAN-Australia Economic Cooperation Programme (AAECP) Microelectronics Design and Application Project in 1987. The VLSI design activity was started by the installation of the first two IC design workstations, donated by the Australian Government under the AAECP Project, at the leading technological universities i.e. King Mongkut's Institute of Technology Ladkrabang (KMITL) and King Mongkut's Institute of Technology Thonburi (KMITT). The Project was honoured by Royal Visits to both design centres in 1987 and 1991. The Phase I Project (1986-1989) led to the design of the first Thai-designed microchips. The chips were presented to the Prime Minister of Thailand upon the visit of the Australian Prime Minister in 1989.

The first three years of the Phase II Project (1989-1994) induced the advancement of microelectronics technology in Thai indigenous industries. The first ASIC-based Thai display adapter card for PC was the indirect result of the Project. Under the present Phase II, the project has created business opportunity for both Thai and Australian companies, for example, CIMA Electronics of Victoria is working with Thonburi Infotech of KMITT to provide human resource development for electronics industry in Thailand, AWA Microelectronics of New South Wales can now offer their PROTOCHIPS services through Thonburi Infotech. Besides CIRCAD II, there is still a business opportunity for other Australian microelectronics design tools e.g. Protel, Tycoon, etc. Such opportunities have been created from activities of the Phase II Project.

In summary, the four projects during the first three years of Phase II can be described as follows:

**THAI Language Display Card and Preset-Counter Chip Prototype**

This activity was undertaken by KMITL, with the initial objective to develop the first Microchip based Thai character display cards for Monochrome PC. However, with rapid change in PC technology and other immediate requirements from the co-private-partner, the goal of the project has been modified to the design of industrial
control chips. The design of the required chip, called "Preset-Counter Chip", was completed, however, the co-private-partner decided to replace the proposed chip with a 4-bit controller. This was mainly due to the chip fabrication cost and not the design technology. Some parts of the Preset-Counter Chip were redesigned by using Prootech method implemented at the Bandung Workshop in 1991. The Prootech based design was successfully fabricated and functioned properly in the Prototype.

**PC-based Low Cost ASIC Design Tool**

This activity was proposed by KMITT as a low cost tool for a Prootech project. The first version was distributed to the public during the Third ASEAN Science and Technology Week in Singapore in 1992. Upon completion of the third year, there was a low cost ASIC design tool that functioned successfully with AWA Prootech. The Design Tool is assigned as public domain software for ASEAN and Australia community presently.

**PABX ASIC Chip**

This activity was proposed by Kasetsart University (KU) to supplement a PABX project supported by the National Electronics and Computer Technology Centre (NECTEC). The first ASIC chip for a PABX was fabricated in October 1990, using gate array technology and funded by NECTEC. The MPC version of the PABX chip was completed in June 1992. In addition to chip design activity, there was also the regional workshop on PABX, an activity of the project, in Bangkok during April 1992.

**Voice Mail System**

A voice mail system has been developed by Chulalongkorn University (CU) since the first year of Phase II. A prototype using random-logic chip is now available. However, further developmental activity is required and the project is continuing to year 4 and 5 of Phase II.

Some product prototypes implemented in the first three years of the Project had demonstrated to local investors the ability of each design centre to design commercial products. With a commercial design capability developed in the first three years, the fourth and fifth year of the project aimed to develop technologies that can subsequently be transferred to our local industries for commercialisation.
were proposed for the fourth and fifth years of the Project. Some were new and some were enhancement of the activities of the first three years.

**Microelectronics Solution Centre**

This represents an effort to employ microelectronics infrastructure established in Phase I and II for commercial exploitation. The centre offers design consolidation and various services for local industries by using Australian technology. The centre also serves as the linkage between Thai and Australian industry once the Project activities are completed.

**Hard-Lock For PC**

This is an application of microchip design for software protection in a personal computer (PC).

**Low Cost Instrumentation Chip-Set**

This is an application of microchip design for agricultural industry. One proposed application is a grain moisture meter. This can be used in almost all agricultural processing factories.

**Voice-Mail Network**

This is an application of microchip design for a ‘mailing’ voice in Local Area Network (LAN). It is a continuation of a Phase II design.

Based on the achievement of projects in Phase II, the cooperation programme is very likely to extend to Phase III which could last for 3-5 years.

Besides the AAECP Project, there has been many technical visits from EC. The notable ones were the visits of experts from the National Microelectronics Research Centre of Ireland. In return, Thai experts also made a number of technical visits to many research institutions in the EC. It is foreseen that with the proposed IC wafer fabrication facility project to be implemented in the near future, the bilateral linkage between Thai and EC institutions will significantly be enhanced.
Modern Era of Microelectronics Education in Thailand

A modern era of microelectronics education in Thailand began in 1987, when the first two sets of IC design workstations were installed at KMITT and KMITL. Prior to this, there were some initiatives in microelectronics at CU and KMITL, with an emphasis on fabrication technology. The first 10-micron fabrication laboratory was set up at KMITL in 1981, followed by device fabrication laboratory at CU. The impact on Thai industry then was not as obvious as initially expected. Within a couple of years after the installation, there were four universities participating in VLSI design activities. It was only at the end of Phase I of the AAEC Project that a number of courses teaching full custom IC design emerged in many Thai universities. It is not far fetched to say that the AAEC Project has provided significant learning steps for Thai IC designers. As a result, Thai students in more than ten institutions are currently working on the state-of-the-art design tools, e.g. Mentor Graphics, Valid-Logics, Synopsys, etc.

NATIONAL POLICY

Thailand’s Development Targets

For the past three decades, Thailand’s developmental direction has been guided by a 5-year National Economic and Social Development Plan developed by the central planning body, the National Economic and Social Development Board (NESDB). The country is in its seventh plan at present (1992-1996). Awareness of the role of science and technology in national development is a fairly recent development, first expressed in the fifth plan. The science and technology development section of the present plan calls for strengthening of technological capability in three main areas, namely, biotechnology, material sciences, and electronics and computers. In addition, electronics is listed among the lead industries to be promoted for development.

Research and Development

In 1986, the government realized and became concerned over the problem of manpower shortage in the field of microelectronics and inadequate R&D activities. In an attempt towards solving these problems, the government established the National Electronics and Computer Technology Centre (NECTEC) as a national centre under the Ministry of Science, Technology and Environment. The major objective of NECTEC is to promote cooperation between government, academia, and private
sector in the area of electronics and computers, through its function as a funding agency for research and development.

In 1991, the Thai Parliament approved the new Science and Technology Development Act, which called for the establishment of the National Science and Technology Development Agency (NSTDA). With this, NECTEC and the two other national centres (i.e. National Centre for Genetic Engineering and Biotechnology and National Metal and Materials Technology Centre) are to be brought together under the umbrella of NSTDA, allowing NECTEC to expand the scope of objectives and to operate less restrictedly from bureaucratic government regulations. NECTEC now not only provides R&D funding to various agencies but also carries out its own in-house R&D activities and technical services.

A master survey and study on the Thai electronics and computer industry was conducted in 1987 to assess current status of the industry and to provide recommendations on future direction and strategy for development. A follow-up study was conducted in 1992. Based on the study findings, NECTEC has selected to focus its activities on twelve programmes as follows:

1. Artificial Intelligence
2. Computer Network
3. VLSI Design and Fabrication
4. Biomedical Electronics and Instrumentation
5. Industrial Electronics and Instrumentation
6. Materials and Devices Technology
7. Computer Software Development
8. Computer System Technology
9. Telecommunications Equipment Development
10. Development of Motors for Electrical Appliances
11. Computer Software Development for Industry
12. Technology Transfer and Human Resources Development

To date, NECTEC has played an important role in strengthening research and development capability in microelectronics in Thailand. Throughout seven years of its operation, NECTEC has provided funding of about 180 million baht (approximately US$7 million) to support over 170 R&D projects, many of which have been successfully commercialised, e.g., a PABX system, an electronic hand-held dictionary, a laser pointer, etc. In line with the government policy to promote electronics industry, NECTEC is currently undertaking steps to establish an IC fabrication facility at pilot plant level and a testing facility on Electro-Magnetic Interference and Compatibility (EMI/EMC).
FUTURE POTENTIAL OF MICROELECTRONICS IN THAILAND

According to the study conducted by Thailand Development Research Institute in 1992, three main industrial goals were identified for the electronic industry in the next five years. They are as follows:

1. to increase a share of industrial output to 10% of GDP;
2. to develop capability in the design and manufacture of local telecommunication equipment, to capture a share of about 5% of the market, and
3. to increase the level of value-added in the production process from 18% at present to about 25%.

Additionally, the study has identified technological goals, including both generic and specific technologies. For generic technologies, the study recommended that the emphasis be placed on Computer-Aided Design (CAD), Printed Circuit Board (PCB), and software standards. Furthermore, to produce actual products, specific technologies would be needed. Some target products identified as product goals were cellular telephone, remote concentrator unit, workstation, etc.

To achieve the identified goals, the study proposed the following strategies:

1. Productivity improvement and quality assurance
2. Elimination of tariffs on components
3. Manpower development
4. Industrial linkage development
5. Trading firm promotion
6. Revision of intellectual property rights protection
7. Encouraging technology licencing
8. Establishment of national laboratories
9. Expansion of technical services
10. Concentration on R&D management

Many of the above recommendations have been adopted and implemented to some extent by government agencies responsible for science and technology development, such as Ministry of Science, Technology and Environment, NSTDA, and NECTEC. It is envisaged that these efforts, coupled with the government’s policy to develop electronics and computers as one of the three priority technology areas, will have a significant impact on the future development of microelectronics in the country.
Lastly, it is obvious that R&D has been one of the major driving forces for microelectronics development in Thailand. The R&D projects funded by NECTEC have created tens of researchers and hundreds of students in this field. There are still many projects that have high commercial potential. Further development will be reinforced by the national sub-micron fabrication laboratory and full custom IC design and fabrication services to be established in the near future.

REFERENCES


