Shifting S&T Policy Paradigm: An Experience of an RTO in Thailand

Patarapong Intarakumnerd
Project Manager of Thailand's National Innovation System Study,

National Science and Technology Development Agency (NSTDA), 73/1 Rama VI Road , Bangkok, 10400, Thailand,
patarapong@nstda.or.th Tel. +6626448150-4 ext. 364.

Pun-arj Chairatana
Chair of Technology and Innovation Management Programme,

Graduate School of Management & Innovation, King Mongkut's University of Technology Thonburi
8th Floor, CB5 Building, 91 Pracha U-tis Road, Bangmod, Bangkok, 10140, Thailand
E-mail: pun-arj.cha@kmutt.ac.th, Tel: +6624709400

1st Draft - not to be quoted – comment are welcomed

ABSTRACT

This paper portrays an attempt of a Research and Technology Organisation (RTO) in a latecomer country, Thailand, in changing its own strategic organisation direction from a dominant "knowledge creator" to a "knowledge broker" focusing on strengthening technological capabilities of actors in an industrial cluster and facilitating knowledge flows between them. The authors argue that a positive change in external environment of the RTO, i.e., the transformation of a weak and fragmented national innovation system, in which the RTO is operating, to a stronger and more synergistic one can facilitate and even pressure for the organisational change towards such direction. An RTO itself , however, has to make a considerable effort to break away from their path dependency. It has to change its own organisational routines, create new core competencies of being a knowledge broker in a cluster and blend them with the existing competencies in doing research. In this circumstance, "learning by forgetting" is as important as learning to accumulate new competencies, otherwise the existing "core competencies" can turn to be "core rigidities" for change.

Key Words: Research and Technology Organisations (RTOs), National Innovation System, Cluster, Latecomer Countries, Organisational Change, Thailand

1. INTRODUCTION

Research Technology Organisations (RTOs) are independent, non-corporate, research and technology organisations funded by government, the private sector or both (see Rush *et al*., 1996). Bessant and Dodgson (1996) illustrate that they can perform, not only knowledge creation role, but also act A knowledge broker organisations within clusters. They cited experience of National Research Council of Canada, Fraunhofer Institute of Germany, technology centres in Japan, and so on. These RTOs, for several years, have accumulated technological and organisational capabilities to perform such roles.

In East Asian NIEs, RTOs like Hong Kong Productivity Centre, Korean Institute of Science and Technology, and Industrial Technology Research Institute (Taiwan) successfully engaged in the process of knowledge diffusion and strengthening absorptive capacity of local firms through various mechanisms such as training, TNCs-local firms matching, organised R&D consortium, and spin off (see Hobday, 1996, Wong, 1996). In 'less successful' latecomer countries where actors in the national innovation systems have rather weak capabilities and are not well connected in terms of knowledge exchange, RTOs, despite limitations, are probably best nexus of knowledge and human resources. With right strategies, they can perform roles of coordinators or 'fixers of systemic failures' in innovation systems (see Intarakumnerd and Virasa, 2002).

This paper focuses on how an RTO in a latecomer country, whose national innovation system is undergoing major transformation, determined to change its role from a mere knowledge creator to be a knowledge broker in a cluster. This is elucidated by using the case of Thailand's National Science and Technology Development Agency (NSTDA) in the North Bangkok Innovation cluster (NBIC)

2. RESEARCH TECHNOLOGY ORGANISATION: FROM 'KNOWLEDGE CREATOR' TO 'KNOWLEDGE BROKER' IN INDUSTRIAL CLUSTERS

2.1Research Technology Organisation in transition

There is a general belief that the role of RTOs is limited to generating new knowledge through research and development. In fact, due to the resources it possesses in both human capital and facilities. RTOs can play equally important roles in promoting *diffusion and use* of both existing and new knowledge in the economy. They can perform a "bridging role" that links together research activities on the one hand with those who implement them on the other (Whalley and Hertog, 2000: 30) Dodgson and Bessant (1996) indicate that RTOs can perform activities bridging user needs and supply side as shown in Table 1.

TABLE 1: RTO ACTIVITIES IN THE INNOVATION PROCESS

User needs	Bridging activity	Supply side
Technology	Articulation of specific needs Selection of appropriate options	Sources of technology
Skills and human resources	Identification of needs Selection Training and development	Labor market Training resources
Financial support	Investment appraisal Making a business case	Sources of finance venture capital, banks, government, etc.
Business and innovation strategy	Identification and development Communication and implementation	Environmental signals - threats, opportunities, etc.
Knowledge about new technology	Education, information and communication Locating key sources of new knowledge Bridging linkages with the external knowledge system	Examples of best practice Emerging knowledge base
Implementation	Project management Managing external resources Training and skill development Organizational development	Specialist resources

SOURCE: DODGSON AND BESSANT, 1996

The role of RTOs in this respect is particularly emphasized in Japan and the East Asian Newly Industrializing Economies (NIEs) which have started their industrialization as latecomers. RTOs in these economies played significant roles in facilitating "learning intensive" processes enabling them to successfully catch up with developed countries. Rather than producing their own new knowledge, these economies grew after the post WW II from exploiting existing knowledge developed in advanced economies (see Amsden and Hikino, 1993), RTOs in these countries have played vital roles in facilitating the process of knowledge diffusion from abroad to local firms.

Among the newly industrialized economies, Taiwan has been regarded as a very successful country using RTOs to facilitate technology diffusion in support of indigenous firms, mostly small and medium enterprises (SMEs). The Industrial Technology Research Institute (ITRI), in particular, has been widely credited with helping to create and advanced semiconductor industry in Taiwan through a well-planned strategy of assimilating foreign technology and transferring them to local enterprises through spin-offs. The success of this strategy depended on careful long-term planning, vision at the top, an abundant supply of well trained engineers, and strong link with competitive local electronics industry providing markets and customer feedback (Wong, 1999).

In addition to spin-off strategy, there are many examples of RTOs playing the *coordinating* role by orchestrating R&D consortia to diffuse and upgrade foreign technology among local Taiwanese firms. Over the last 15 years, there have been at least over 60 such R&D consortia established in various industrial sectors. They have supported Taiwanese SMEs to move up technological ladder from OEM to ODM[1] and, eventually, to Original Brand Manufacturing (OBM). This is similar to the roles of

1 OEM and ODM are specific forms of subcontracting. Under Original Equipment Manufacture (OEM), a subcontracting firm produces a finished product to the precise specification of a foreign transnational corporation (TNC), which will market under its brand name via its own distribution channels. Under Own-Design Manufacture (ODM), a subcontractor also carries out some or all of the product design (Hobday, 1995).

Japanese RTOs during 1960s and 1970s when Japan was still behind the West technologically. Japanese RTOs helped private firms to organise research consortia to promote manufacturing technologies. People from government laboratories were placed as head of research consortium since they were perceived as "neutral". In the 1980s, the focus of research consortia gradually shifted to more long-range, risky and basic research (see Goto, 1997). The precondition for the success of R&D consortium apart from neutrality perception of RTOs by private firms is that RTOs at the time had higher technological capabilities than private firms which acknowledged benefits of being a part in consortia (Goto, personal communication, 2003). The usefulness of the consortium approach has been questioned by firms after they have grown both in terms of sizes and innovative capabilities. Some of large firms as well as small but innovative firms now argue that they would prefer pursuing their own R&D rather than share their knowledge with rivals (Wong, 1999: 18).

Knowledge diffusion is a two-way process. The success of knowledge diffusion depends very much on the capacity of the recipients to absorb and assimilate that technology. As pointed out by Cohen and Levinthal (1990) and Leonard-Barton (1995), the firm's *absorptive capacity* enables it to search and access external technological knowledge, and to identify the suitable technological choices for the project. A few case studies shows that when technology was imported with the intent to complement in-house technological effort, rather than only to produce new products, diffusion is more likely to succeed in upgrading technological capability of recipient firms (see Katrak, 1990).

Some RTOs in NIEs helped local firms strengthen their absorptive capacity. Hong Kong Productivity Centre, for instance, has knowledge-intensive training for employees of local firms in technological sophisticated activities like designing and engineering (see Hobday, 1996). It also has a program of employing high-experienced engineers of transnational corporations located in Hong Kong to train personnel of local firms.

With regard to knowledge creation, RTOs such as Korean Institute of Science and Technology (KIST) and ITRI of Taiwan did not only conduct research by themselves and transfer such knowledge, sometimes inapplicable, to private firms, as indicated by conventional wisdom. They also collaborated with private firms in joint-research projects. A large part of their incomes were generated from contracted research. This is an obvious mechanism of RTOs to utilize their research expertise and high-valued researchers to serve the private sector's needs

2.2 Industrial Clusters and RTOs

Industrial clusters are geographical concentrations of interconnected companies, specialised suppliers, service providers, firms in related industries, and associated institutions (for example, universities, standard agencies, and trade associations) that combine to create new products and/or services in specific lines of business (see Porter, 1998; OECD, 2000). At present, the concept of industrial cluster[2] becomes very popular worldwide, policy makers at national, regional and local levels and business people in both forerunner and latecomer countries are keen to implement the cluster concept as an economic development model. Though understanding of clusters and related promoting policies varies from one place to another (see, for example, Steiner, 1997), the underlying benefits of clusters from collective learning and knowledge spillovers between participating actors strongly attract the attention of these people.

The role of RTOs in the clusters can have considerable differences. In some cases, RTOs are central and integral players within the cluster whilst in other cases they are relatively minor and marginal

players. Whether a certain RTO is integral or marginal to developments within a cluster is determined by the interaction between the knowledge that the RTO possesses, the knowledge base of competing firms, the demands placed on the RTO by other actors in the cluster (Whalley and Hertog, 2000: 35). In technologically forerunner countries like Japan, for example, the government is trying to create "intellectual clusters", i.e., regional-based clusters of universities, public R&D institutions, relevant institutes and knowledge-intensive core companies. The central government provides budgetary support yearly while the cluster plans were initiated by local government together with local universities and local firms. The aim is to foster interaction between the original technological seeds of the public research organisations and universities and business needs of regional companies to create the chain of technological innovations and new industries. To achieve this goal, each cluster is managed and co-ordinated by a Central Project Organization. Most of such organisations are local RTOs that have had expertise in dealing with the private sector. They also recruited new and experienced executives used to work for private firms. Some of these people have had international experiences (see MEXT, 2002).

In Swedish biotechnology cluster, an RTO like Swedish Institute for Food and Biotechnology has actively sought to disseminate information through network based knowledge transfer as well as acting as a co-ordinator of external research programmes and the publisher of pertinent journals and newsletters. Another RTO, the Swedish National Board for Industrial and Technical Development (NUTEK), supports the development of biotechnology start-ups by providing both seed and start-up financing and other services like information, advice, and brokerage (see Backlund, et.al., 2000).

In "less successful" latecomer countries, the concept of industrial cluster is very appealing since the aims of cluster-based development policies obviously address the capabilities and linkage problems in these countries. Intarakumnerd and Virasa (2002) elaborate that RTOs in these countries, despite limitations, are probably best nexus of knowledge and human resources. With right strategies, they can perform roles of coordinators or "fixers of systemic failures" in national innovation system and clusters.

2.3 Organisational Learning of RTOs: From Knowledge Creators to Knowledge Brokers

Learning takes place in every level ranging from individual, organisation to society. The ability to learn is crucial for the economic success of individuals, firms, regions and national economies (OECD, 2000). Here, learning refers to the mechanisms and processes that bring about not only technological progress and innovation but also the social sustainability. It can be defined as the acquisition of additional technical skills and knowledge by individuals and by organisations (Bell and Scott-Kemmis, 1985). It also refers to building new competencies and establishing new skills and not just to "getting access to information". 'Learning' plays a significant role, as mediator and structure to generate innovation, while flexibility and unbounded imagination are catalysts of organisational change.

There are several types of learning. Arrow (1962) inserted the notion of "learning by doing" into economic which was brought from the psychology literature. This is a passive learning from previous experiences i.e., doing similar things repeatedly (Arrow, 1962). In contrast, "learning by searching" is related to the systematic and organised searching for new knowledge. It is a dynamic, difficult and costly process. Learning is also an 'interactive' process which can take place both in vertical interactions (users-supplier) and horizontal interactions (competition and/or co-operation) (see Steen, 1999).

An organisational learning is the process that creates knowledge, which is distributed across the

organisation, allows communication and integrates into the strategy and routines of the institution (Duncan and Weiss, 1978; Kim, 1995). 'Learning to learn' is the most important starting point to organisations, especially in the latecomer countries in the process of building their capabilities. Nonetheless, another important aspect of learning is 'forgetting'. The power of routines constitutes a permanent risk factor for change. "Learning by forgetting" is necessary to avoid the blocking of potential fertile learning processes before new knowledge can be institutionalised (see Steen, 1999).

Moving an RTO from a mere knowledge creator to a bridging institute or a "knowledge broker" is not easily achievable. In Portugal, RTOs had to invest heavily to first gain interest and trust from the private sector before cooperation can be expected. RTOs were blamed for the mismatch between R&D developed and the needs of industry. However, Portuguese RTOs are becoming more proactive in reaching out to potential users of their research (see Fontes, 2000). Apart from developing capabilities necessary for knowledge brokers internally, RTOs can 'buy in' these new capabilities by recruiting people experienced in network creation from the private sector as in aforementioned Japanese case. Forming strategic alliance with or outright acquisition of experienced private firms/associations is another option. An UK's RTO in printing cluster, Pira International, transformed itself into business consultancy organisation through forming a strategic alliance with British Print Industries Federation (see Readman, 1999).

Before examining the changing roles of NSTDA from a knowledge creator to a knowledge broker in a cluster, we will analyse its external context, i.e., the evolution of Thailand's national innovation system.

3. THAILAND: A NATIONAL INNOVATION SYSTEM IN TRANSITION

As mentioned earlier, Thailand's National Innovation System was a weak and fragmented one i.e., actors in the systems have rather weak capabilities and they are not well connected in terms of knowledge linkages. However, it is now undergoing a positive transformation which might lead to stronger and more synergistic. Here we are focusing on the changes in three main actors to its system: government, firms, universities and RTOs.

3. 1 Government

Up to the present Thaksin government (starting January 2001), scope of S&T policy in Thailand is rather narrow. It covered only four conventional functions, namely, research and development, human resource development, technology transfer, and S&T infrastructure development. This narrow scope of S&T was very much based on the perception that private firms are "users" of S&T knowledge mainly produced by government agencies and universities (see Arnold, 2000). There was no articulate national innovation policy. Though the word "innovation" was mentioned in several national plans, it was not whole-heartedly incorporated into the scope of S&T policies (see Lauridsen, 2002). In addition, unlike Japan, Korea, and Taiwan, S&T elements were not part of economic policies (i.e, industrial policy, investment policy and trade policy) and, to the lesser extent, education policies (see Intarakumnerd, et.al., 2002).

Industrial policy of Thailand has not paid enough attention to the development of indigenous technological capability as an integral factor in the process of industrialisation (Sripaipan, Vanichseni,

and Mukdapitak, 1999: 37). Investment policy, especially the promotion of foreign direct investment (FDI), aims primarily at generating inward capital flow and employment. Unlike Singapore where FDI is specifically used to upgrade local technological capability (see Wong, 1999), there is no explicit and pro-active link between promoting FDI and upgrading of local technological capability in Thailand. Trade policy, the most important instrument in Thailand being tariff, has not been used strategically to promote technological learning like in those countries (see Amsden, 1989; Chang, 1994; Lall, 1996). Instead, trade policy was very much influenced by macro economic policy, for instance, to reduce domestic demand for imports at the time of balance of payment deficit. The Ministry of Finance, the dominant agency which controlled the policy, had little knowledge or experience of industry and industrial restructuring (Lauridsen, 2000: 16-20).

Moreover, industrial policy in Thailand has been limited to the so-called 'functional' intervention such as promoting infrastructure building, general education, and export push in general. There have been virtually no selective policy measures, such as special credit allocation, special tariff protection, targeting particular industries or clusters. The exception was the local content requirement in automobile industry, which was rather successful in raising local contents of passenger vehicles to 54% in 1986 (see Doner, 1992). Interestingly, with the exception of automotive industry, there has been no reciprocal performance-based criteria (such as export and local value added and technological upgrading targets) set for providing state incentives like in Korea or Japan (see Johnson, 1982; Amsden, 1989; Evans 1989, 1998; Chang, 1994; Lall, 1996). Investment promotion privileges, for example, are given away once approved. The intention to attract foreign direct investment and promote export overshadowed the need to develop local initiatives and indigenous technological capabilities. As a result, linkages between multinational corporations and local firms were also weak. Unlike Taiwan, the governmental protection and promotion, without strengthening absorptive capabilities of Thai suppliers, left a profound impact on the weak technology and suppliers' network of industries. (Vongpivat, 2003)

The major change in policy came recently under the present Thaksin government. Media and academics in Thailand and the Southeast Asia labeled this government distinctive policy as "Thaksinomics" (Thaksin's Economics). Dual track policy is the main thrust of Thaksinomics. The government is trying to enhance international competitiveness of the nation by strengthening 'external' side of the Thai economy, namely, export, foreign direct investment and tourism. At the same time, it is attempting to increase capabilities of domestic and grass-root economies by implementing projects like Village Fund (one million Baht to increase local capabilities of each village), a three-year debt moratorium on farmers' debt, One Tambon[3] One Product Project (supporting each Tambon to have product champion), People Bank (giving loans to underprivileged people with no requirement of collateral).

This government, unlike its predecessors which pay most attention to macro-economic stability, focus more on enhancing meso- and micro-level foundations for international competitiveness. The high priority of 'competitiveness' issue on the government's agenda is illustrated by the establishment of National Competitiveness Committee chaired by the Prime Minister. It was the first time that Thai government has serious "selective" policies addressing specific sectors and clusters. The government declares five strategic clusters which Thailand should pursue: automotive, food, tourism, fashion, and software. Clear visions have been given to these five clusters. Kitchen of the World (food cluster),

3 Tambon is a unit of local government administration. One Tambon comprises several villages.

Detroit of Asia (automotive cluster), Asia Tropical Fashion, World Graphic Design and Animation Centre (software cluster), and Asia Tourism Capital. Building innovative capabilities of the nation is highly regard as very important factor increasing and sustaining Thailand's international competitiveness. "Innovative nation with wisdom and learning base" is one of seven Thailand's Dreams projected by this government. To make this dream come true, several strategies have been devised. These include continuous investment in R&D and technology, well environment for attracting and stimulating innovation, high accessibility to knowledge and information across the nation, fluent English as a second language, possessing strong learning basis such as passion for reading, better accessibility to cheap but good books, thinking school with innovation movement (see Phasukavanich, 2003).

To carry out these changes, the government has introduced the private sector's style of management to improve efficiency and effectiveness of bureaucratic system. Chief Executive Officer (CEO) style is now being implemented both at central and local government levels in order to integrate and synergize related government policies under clear leadership. Together, the Performance-Based Management (PBM) which clearly illustrates contractual relationship and delegation of authority in the bureaucratic lines of governance has been put in place.

3. 2 Private Firms

Several studies of Thai firms conducted since the 1980s state that most firms have grown without deepening their technological capabilities in the long run, and their technological learning has been very slow and passive (see Bell and Scott-kemis, 1985; Chantramonklasri, 1985; TDRI, 1989; Dahlman and Brimble, 1990, Tiralap, 1990; Mukdapitak, 1994; Lall, 1998). The recently commissioned by the World Bank's study (see Arnold, 2000) also confirms this long-standing feature of Thai firms. Only a small minority of large subsidiaries of Transnational Corporations (TNCs), large domestic firms and SMEs have capability in R&D, while the majority are still struggling with increasing their design and engineering capability. For a very large number of SMEs, the key issue is much more concerned with building up more basic operational capabilities, together with craft and technician capabilities for efficient acquisition, assimilation and incremental upgrading of fairly standard technology. The slow technological capability development of Thai firms is quite different from those of Japan, Korea and Taiwan. Firms in these countries moved rather rapidly from mere imitators to innovators. As early as 1960s, Japanese firms became more innovative, invested heavily in R&D and relied less on importation of foreign technologies (Goto and Odagiri, 1993). In general, firms in Korea and Taiwan, where industrialisation (beginning with import substitution) started more or less in the same period as in Thailand, are more successful in increasing absorptive capacity (of foreign technology) and deepening indigenous technological capabilities in several industries (see for example, Amsden, 1993, Kim, 1993, Lall, 1996, Hobday, 1995, Kim, 1997). In electronics industry, for instance, Korean and Taiwan firms were able to climb up technological ladders (from simple assembly to own design and R&D) by exploiting institutional mechanism like OEM and ODM to help latecomer firms in those countries to access to advanced technology and demanding foreign markets (see Hobday, 1995).

Comparison between Thailand and Korea Innovation Surveys both conducted in the Year 2002 illustrates the differences in terms of innovative capabilities of these two countries. Table 2 shows clearly that companies in Thailand lag far behind companies in Korea in respect to innovation. More than forty percent of Korean firms carried out innovations against just above ten percent in Thailand.

It strikes that relatively higher share of companies in Korea carry out product innovations. This could be an indication that Thai companies are at the stage where they rather use their resources to improve production process than the product itself, which in turn could hint towards a rather OEM-oriented economy. At the same time very few companies in Thailand do product as well as process innovations, which is very common in Korea. This reflects more mature innovation behaviour of Korean companies which improve in a systemic manner.

TABLE 2: SHARE OF INNOVATING COMPANIES IN THAILAND AND KOREA

	Thailand	Korea
Innovating	11.2 %	42.8%
Product and process innovation	2.9%	21.0%
Only product innovation	4.1%	17.0%
Only process innovation	4.3%	4.0%

SOURCE: THAILAND R&D/INNOVATION SURVEY 2002 AND KOREAN INNOVATION SURVEY 2002

However, higher competition in the global market and the economic crisis started in 1997 has, to some degree, lead to changing behaviour of Thai firms. The Innovation Survey indicates that more than 80% of R&D performing firms, in spite of being a small part of technological activities of firms in developing countries, express strong interest in increasing their spending in the next 3 years. This finding is supported by a recent studies of Thai firms (see, for example, TDRI, 1998; Arnold, *et.al.* 2000). It shows a few interesting phenomenon:

(a) Several large conglomerates recently increased their R&D activities.
(b) A number of smaller companies recently increased their technological efforts by collaborating with university R&D groups in order to stay ahead in the market or to seize the most profitable market section.
(c) Several subcontracting suppliers in the automobile and electronics industries were forced by their TNCs customers/partner to strengthen their efforts lately to modify product design and improve efficiency and were able to absorb the design and know-how from foreign experts.
(d) There were emerging new start-up firms (less than 50 employees) relying on their own design, engineering or development activities. These companies were managed by entrepreneurs having acquired a strong R&D background, while studying or working abroad. Many of them are "fabless" companies.

More-recent study by NSTDA's researchers also indicates the positive change of Thai firms. Several locally-owned OEM manufacturers experiencing external pressure especially from foreign customers that adopted global sourcing strategies started to develop products under their own designs and brand names (see Intarakumnerd and Virasa, 2002).

3.3 Universities and RTOs

From the Thailand R&D/Innovation Survey 2002 and Korean Innovation Survey 2002, universities and research institutes were regarded as much more important sources of information of Korean firms compared with Thai firms (see Table 3)

TABLE 3 IMPORTANCE OF EXTERNAL INFORMATION SOURCES

Thailand		Korea	
Clients	77.4	Customers	77.7
Internet	63.0	Competitors	69.3
Parent/ associate company	61.2	Exhibition	65.5
Locally-owned suppliers	59.9	Internet	64.9
Specialist literature	56.6	Component suppliers	61.7
Professional conference & meetings	55.2	Patents	59.8
Foreign-owned suppliers	54.8	Equip. suppliers	57.7
Fairs and exhibitions	53.1	**Universities**	53.6
Competitors	42.1	Enterprise within the group	52.9
Technical service providers	40.2	**Public Research Inst.**	52.6
Universities or other higher education institutes	35.8	New personnel	51.9
Business service providers	33.1	Trade Associations	44.2
Patent disclosures	32.0		
Gov. or private non-profit research institutes	29.5		

SOURCE: THAILAND R&D/INNOVATION SURVEY 2002 AND KOREAN INNOVATION SURVEY 2002

Technological activities of public Research Technology Organisations (RTOs)[4] mainly focused on R&D and providing technical services such as testing and calibrating, not particularly on assisting firms to build up their 'internal' technological capabilities especially lower levels capability such as technology assimilation and adaptation, designing and engineering, which are the technological thresholds faced by most Thai firms. In this aspect, Thai RTOs behave differently from those of Japan and East Asian NIEs, as mentioned above, when their levels of development were more or less at the same level of Thailand. Recent study done by the College of Management of Mahidol University summarizes the gaps in industry-academia collaboration. It demonstrates the weaknesses of both sides, which obstruct meaningful collaboration (see Table 4).

4 These include National Science and Technology Development Agency, Thailand Institute of Scientific and Technological Research, Synchrotron National Research Laboratory, National Institute of Metrology, and Geo-Informatics and Space Technology Development Agency.

TABLE 4: GAPS IN INDUSTRY-ACADEMIA COLLABORATION

Industries	Gaps	Academia
• Passive actors in initiating collaboration • No tangible/substantial activities that might lead to collaboration with education institutes	• Lacking continuous cooperative projects cooperative projects cooperation. Education institutes • Missing the clear goals and objectives of the collaboration • Lacking assistants who can understand both sides, coach , and foster the relationship • Lacking analysis of problems from the industry's perspective	• Major activities are not two-way or activities and motivation for usually initiate and dominate the relationship. • Linkages are more or less in term of asking for help than achieving the project together for maximum benefit of both parties • No substantial linkages in term of R&D projects

SOURCE: COLLEGE OF MANAGEMENT, MAHIDOL UNIVERSITY (2003)

Nonetheless, public RTOs and universities are under the pressure from the Budget Bureau to increase their revenue, hence reducing their reliance on the national budget. They will be forced to be more relevant to industrial needs to earn extra income. In the next few years, Thai public universities will attain autonomous status as well as several public RTOs. They will be out of red-tape bureaucratic system and will enjoy more freedom financially. Most of their budget will be subsidised by government but they are expected to generate relatively more income from other sources, especially from the private sector. Therefore, they have to conduct research and other activities, which are more relevant to industry. Recently, universities have increasingly tried to increase industry sponsorships and to forge links with industry through collaborative R&D and training activities (College of Management, 2003).

4. NSTDA: A CHANGING RTO IN THE TRANSFORMING NIS?

Given the transformation of Thailand's NIS, government RTOs are needed to adjust their organisational direction to accommodate such transformation. However, this transformation is far from being smooth.

4.1 NSTDA's path and previous performance

NSTDA, as a leading autonomous funding and research organisation, is trying to change its direction to fit the aforementioned government initiatives and new S&T policy paradigm. It undertakes a broad-based, systematic approach towards enchanting the entire science and technology system of Thailand in support of national economic and social development. Three specialised centers-Genetic Engineering and Biotechnology (BIOTEC), Metal and Materials Technology (MTEC), and Electronics and Computer Technology (NECTEC), - come under the NSTDA umbrella. These three centres have been established in the 1980s in line with the global trend at the time and perceived local needs for strong research capability in these areas. Though it is not an official policy, NSTDA, therefore, has strong path dependency of focusing on R&D with a smaller interest in supporting advancement of technological capability development of private firms through several financial and technical supporting

schemes such as technical consultancy services, IP services, training services, quality control services.

Even NSTDA's main thrust is on R&D, NSTDA has performed rather successfully several knowledge-brokering or bridging activities linking user needs with industry demand. According to aforementioned Framework of Dodgson and Bessant (Table 1), these activities are as follows:

A) Articulation of specific technological needs and selection of appropriate options and locating key sources of new technology

The major programme is the Support for Technological Assessment and Mastery Programme (STAMP). It provides technical information from abroad and makes contacts with potential foreign partners in business ventures or technology transfer. These links are brokered through relationships with technology transfer agencies abroad. STAMP also runs and subsidises visits by groups of Thai manufacturers to potential sources of foreign technology. NSTDA is now also in the process of setting up its own technology licensing office to license its own technologies.

B) Human resources training and development.

NSTDA's Central Office and three national centres have this type of activities. To name a few, BIOTEC's Technology Transfer and Publication Unit have training programmes, seminars and conferences in various issues of biotechnology. NECTEC's Information Technology Education Division is a training centre in electronics, computers and IT for public and private organisations. MTEC's Technical Section organise training in specific metrology and materials technology areas. Scholarships and grants are given to S&T education and research from the level of secondary school (Junior Science Talent Project) to levels of Ph.D. and young researchers.

C) Investment appraisal and making investment and innovation strategies

All three centres have business development divisions/departments. NSTDA's Investment Centre analyses and forecasts business opportunities and recommends investment strategies. It co-invested with private firms to set up eight joint venture companies. The Innovation Development Fund actively helps Thai SMEs and start-up companies write business plans, developing innovation strategies and secure financial support for their innovation projects. NSTDA's central office and the three national centres also provide financial support in terms of grant and loans to finance private firms in doing R&D, product and process development and design and engineering activities.

D) Bridging and managing specialist external resources

Since 1992, NSTDA has implemented a pilot project called Industrial Consultancy

Services (ICS). ICS is based on the "demand driven" and "sharing responsibility" concept that each company must pay at least 25% of the expenses of the technical experts, who could be from within or outside the country, to help participating SMEs while the government pays the remaining 75% (which, however, must not exceed 500,000 Baht) . The reason behind this concept is to induce the SMEs to upgrade their technological capability in manufacturing and stimulate their product and process innovation, and, at the same time, to make sure that a participating company has a real need and commitment. During nine years of operation, ICS provided technical advice to 176 out of around 3,460 applying companies. This project mainly aims to encourage the private sector to upgrade their internal capabilities and foster technological innovation at an enterprise level. Through the advice of experienced technical experts, post evaluation of the project shows that

many companies were able to *improve* their products and/or processes or *produce* new products and/or processes. Based on this success of technology transfer to the industrial economic sector, a larger and more intensive program called the Industrial Technical Assistance Program (ITAP) has been initiated and operated to support and provide technical services to 120 projects per year.

4.2 New Challenge: NSTDA as a Knowledge Broker in an Industrial Cluster

In the middle of 2002, NSTDA's headquarters has moved to the first-ever Science Park in Thailand located in the north of Bangkok. NSTDA would like to follow government's policies focusing on strengthening relationship between RTOs and the private sector and building micro/meso foundation of competitiveness through cluster development. NSTDA is, therefore, positioning itself to be a knowledge broker in the north Bangkok area approximately 40 kilometers around the Science Park. It was named "North Bangkok Innovation Cluster" (NBIC). It would like to strengthen the role of a knowledge broker or a bridging institute, i.e., being a vehicle to transfer knowledge to other actors (especially private firms) and facilitate knowledge flows in the NBIC. It has commissioned a study of the NBIC to Chulalongkorn University (2003). The study focuses on three clusters: electronics, automobiles and food. These three clusters are very much in line with NSTDA's expertises (i.e. the three national centres) and the government's strategic industries. The maps of the three clusters have been drawn. Key actors (connecting firms in the value chains, supporting and relevant government agencies, training and education institutes, financial institutes, trade and professional associations, infrastructure and service providers and so on) in the area of NBIC have been identified. The extent of knowledge linkages among these actors has been evaluated. The study also suggests the new roles NSTDA should play to facilitate the development of NBIC. For example, NSTDA should set up a high-level working committee to oversee the NBIC. Cluster managers/coordinators should be developed. NSTDA's researchers should be trained to understand firms' innovation process and to be more entrepreneurial. Regular forums between NSTDA and firms in selected industries should be organized.

As mentioned above, a knowledge broker role is not new for NSTDA, and NSTDA can definitely rely on its past successes in this aspect. However, NSTDA's new roles as a knowledge broker in a cluster require different competencies. Abilities to persuade and cooperate with other actors in the clusters, especially private firms need to be strengthened. The greater challenge is on how to "connect" the research side of the organisation, which has 'logged in' the organisational routine of building R&D capability since the very beginning, with the private sector support side (and existing knowledge brokering activities). Most researchers in laboratories, who comprise the major workforce of NSTDA have little experience in dealing with the private sector. As many researchers in other countries, they regard working with the industry are "inferior" to research for creating new scientific knowledge. New incentives scheme to induce researchers to work with private firms in the cluster is strongly needed. Also better internal channels of communication between researchers in laboratories and NSTDA's people who are now working with the industry have to be established. Series of training courses on innovation management, cluster concept, entrepreneurship are required both for researchers and people who will act as cluster managers/cooperators. As in the case of Japanese cluster development, recruitment of new personnel who have high experiences in the private sector might be necessary.

It is obvious that NSTDA needs to make an organisational change and build in new capabilities. There is also the need to integrate its capabilities in doing research with knowledge brokering

capabilities. It needs to *somewhat* break away from its strong path dependency in doing research. Therefore, 'learning by forgetting', to a certain extent, might be as necessary here as learning to accumulate new capabilities. If not, NSTDA's "core competencies" in doing research might become "core rigidities" for changes to its new roles.

A small but serious step has been taken. The high-level committee was appointed to design and drive cluster strategies. The committee is now trying to collect data on NSTDA's collaboration with the industry and university. It is also identifying small projects which NSTDA's researchers are interested and already have capabilities as the pilot projects to start the clustering process.

5. CONCLUSION

NSTDA's case has theoretical and policy implications. It illustrates the difficulties of organisations in latecomer countries wishing to change its organisational direction to focus more on "knowledge broker" role in strengthening technological capabilities of actors in a cluster and facilitating knowledge flows between them. Eventhough the positive transformation of national innovation system (from a weak and fragmented one to a stronger and more synergistic one) can facilitate and even pressure for NSTDA's organisational change. To a certain extent, NSTDA itself has to make a considerable effort to break away from its path dependency and its domineering role of a research performer.

NSTDA has to change its own organisational routines, create new core competencies of being a knowledge broker in a cluster and blend them with the existing competencies in doing research. For such an organisation, "learning by forgetting" is as important as learning to accumulate new competencies, otherwise the existing "core competencies" can turn to be "core rigidities" for change.

REFERENCES

Amsden, A. and Hikino, T. 1993. Borrowing Technology or Innovating: An Exploration of the Two Paths to Industrial Development, in R. Thomson (ed.), *Learning and Technological Change*, New York: St. Martin's Press.

Arnold E. et al, 2000. 'Enhancing Policy and Institutional Support for Industrial Technology Development in Thailand,' Volume 1: The Overall Policy Framwork and the Development of the Industrial Innovation System, December 2000, World Bank.

Arrow, K., 1962. "The Economic Implications of Learning by Doing", *AER*

Bell, M., 2002. *Knowledge-Capabilities, Innovation and Competitiveness in Thailand: Transforming the Policy Process,* A report for National Science and Technology Development Agency (Thailand) sponsored by the World Bank.

Bell, M., 1984. 'Learning and Accumulation of Technological Capacity of Developing Countries,' in M. Fransman and K. King (eds), *Technological Capability in the Third World*, London: Macmillan.

Bell, M. and Scott-Kemmis, D., 1985. 'Technological Capacity and Technical Change,' *Draft Working Paper No. 1,2,4 and 6*, Report on Technology Transfer in Manufacturing Industry in Thailand, Science Policy Research Unit, University of Sussex.

Bessant, J., 2003, 'High-Involvement Innovation: Building and Sustaining Competitive Advantage Through Continuous Change', John Wiley and Sons, West Sussex, England

Brimble, P. *et al*, 1999. 'The Broader Impacts of Foreign Direct Investment on Economic Development in Thailand: Corporate Responses,' An unpublished paper prepared for the high-level roundtable on *Foreign Direct Investment and its Impact on Poverty Alleviation*, Singapore, 14-15 December 1998; Revised April 1999.

Brooker Group Public Company Limited, 2003. 'Final Report - Thailand's 2nd R&D/Innovation Survey in Manufacturing and Service Sectors and Database Development,' May 2003.

Chang, H., 1997. 'Institutional Structure and Economic Performance: Some Theoretical and Policy Lessons from the Experience of the Republic of Korea,' *Asia Pacific Development Journal*, 4(1), 39-56.

Chang, H., 1994. *The Political Economic of Industrial Policy*, London: Macmillan.

Chang, P. L. and Hsu, C.W 1998. The development strategies for Taiwan's semiconductor industry. *IEEE Transactions on Engineering Management* 45(4), , 349-356.

Chantramonklasri, N., 1985. 'Technological Responses to Rising Energy Prices: A Study of Technological Capability and Technological Change Efforts in Energy-Intensive Manufacturing Industries in Thailand,' Unpublished D.Phil. Thesis. Science Policy Research Unit, University of Sussex, Brighton.

Churstensen, S. et al, 1992. *Institutional and Political Bases of Growth-inducing Policies in Thailand*, (mimeo) Bangkok, TDRI.

Cohen, W. and Levinthal, D 1990. Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, 35, 128-152.

College of Management, 2003. Draft Final Report of S&T Needs and Production of Manpower in the Manufacturing Sector, Mahidol University, June 2003 *(in Thai).*

Dahlman, C. and Brimble, P., 1990. 'Technology Strategy and Policy for Industrial Competitiveness: A Case Study of Thailand,' Paper Prepared for the

World Bank, April, 1990.

Dahlman, C. et al, 1991. 'Technology Strategy and Policy for Industrial Competitiveness: A Case Study of Thailand,' In World Bank, *Decision and Change in Thailand: Three Studies in Support of the Seventh Plan*, Washington, D.C.

Davenport, T. H. and L. Prusak, 2003, What's the Big IDEA?: Creating and Capitalizing on the Best Management Thinking, HBS Press

Dodgson, M. and Bessant, J. 1996. *Effective Innovation Policy: A New Approach*, London: International Thomson Business Press.

Doner, R., 1992. 'Politics and the Growth of Local Capital in Southeast Asia: Auto Industries in the Philippines and Thailand,' In McVey, R. (ed.), *Southeast Asian Capitalists, Southeast Asia Program (SEAP)*, New York: Cornell University Press.

Evans, P., 1989. 'The Future of the Developmental State,' *The Korean Journal of Policy Studies*, 4, 129-146.

Evans, P., 1998. 'Transferable Lessons? : Re-examining the Institutional Prerequisites of East Asian Economic Policies,' *Development Studies*, 34(6), 66-86.

Goto, A. 1997. "Cooperative Research in Japanese Manufacturing Industries," in A. Goto and H. Odagiri, *Innovation In Japan*, Oxford: Oxford University Press

Hobday, M 1995. *Innovation in East Asia: the Challenge to Japan*, Aldershot: Edward Elgar.

Hobday, M. 1996. Taiwan-Incubating High-Technology Industries, In Rush, H. *et al* (eds), *Technology Institutes: Strategies for Best Practice*, Suffolk: St Edmundsbury Press,

Hou, C. and Gee, S., 1993. 'National Systems Supporting Technical Advance in Industry: The Case of Taiwan' In Nelson R. (ed), *National Innovation System*, Oxford: Oxford University Press.

Intarakumnerd, P., Chairatana, P., Tangchitpiboon, T., 2002 "National Innovation System in Less Successful Developing Countries: the Case Study of Thailand," *Research Policy*, Vol.8-9, 1445-1457

Intarakumnerd, P., Virasa, T. "Broader Roles of RTOs in Developing Countries: From KnowledgeCreators to Strengtheners of National Innovation System" Paper presented at Science, Technology and Innovation Conference, JFK School of government, Harvard University, 23-24 September 2002

Johnson, B. And B-Å, Lundvall, 2000. 'Promoting innovation systems as a response to the globalizing learning economy', second draft of contribution to the project Local Productive Clusters and Innovations Systems in Brazil: New industrial and technological policies

Johnson, C., 1982. *MITI and the Japanese Miracle: The Growth of Industrial Policy, 1925-1975*, CA: Stanford University Press.

Katrak, H 1990. Imports of Technology, Enterprise Size, and R&D Based Production in a Newly Industrializing Country: The Evidence from Indian Enterprises. *World Development*, 23(3), 459-68.

Kim, L., 1993. 'National System of Industrial Innovation: Dynamics of Capability Building in Korea,' in Nelson R. (ed), *National Innovation System*, Oxford: Oxford University Press.

Kim, L.1997 *Imitation to Innovation: the Dynamics of Korea's Technological Learning*. Harvard Business School Press, Boston,

Kim. L. and Nelson, R. (eds.) (2000) Technology, Learning, and Innovation: Experiences of Newly Industrializing Economies. Cambridge University Press.

Lall, S., 1996. *Learning from the Asian Tigers: Studies in Technology and Industrial Policy,* Macmillan Press.

Lall, S. 1992 Technological capability and industrialization. *World Development* 20(2), 165-186.

Lauridsen, L., 1999. *Policies and institutions of industrial deepening and upgrading in Taiwan III-technological upgrading*, Working Paper no.13, International Development Studies: Roskilde University, Roskilde.

Lauridsen, L., 2001. *Coping with Globalization: The Recent Thai Experience with Openness and Increased World Market Integration.* International Development Studies, Roskilde University: Denmark.

Lauridsen, L., 2002. 'Coping with the Triple Challenge of Globalization, Liberalization and Crisis: The Role of Industrial Technology Policies and Technology Institutions in Thailand,' *The European Journal of Development Research,* 14, 1 (June 2002): 101-125.

Leonard-Barton, D. 1995 *Wellsprings of Knowledge: Building and Sustaining the Sources of Innovation*, Boston: Harvard Business School Press.

Lind, M. and Persborn, M., 2000 'Possibilities and risks with a knowledge broker in the knowledge transfer process', paper presented at the 42nd Annual Conference of the Operational Research Society, 12-14 September 2000, University of Wales, Swansea, UK

Lundvall, B-Å, B., Johnson, E. Slot Andersen, and B. Dalum 2001. 'National Systems of Production, innovation and competence building, paper presented at the Nelson and Winter DRUID Summer Conference, Aalborg Congress Centre, Alborg, Denmark, June 12-15, 2000.

MEXT, 2003. "Cluster: Cooperative Link of Unique Science and Technology for Economy Revitalization" Paper prepared by Ministry of Education, Culture, Sports, Science and Technology, Japan.

Mukdapitak, Y., 1994. 'The Technology Strategies of Thai Firms', Unpublished D.Phil. Thesis. Science Policy Research Unit, University of Sussex, Brighton.

Niosi, J. *et al*, 1993. 'National systems of innovation: in search of a workable concept', *Technology in Society* 15, 207-27.

Odagiri, H. and Goto, A. (1993) "The Japanese System of Innovation: Past, Present and Future." In Nelson R. (ed), *National Innovation System*, Oxford: Oxford University Press.

OECD, 1999. Boosting Innovation: the Cluster Approach, Paris.

OECD, 2000. Knowledge management in the learning society, Paris.

Porter, M. E. 1998, Cluster and the New Economics of Competition, Harvard Business Review, 76-90

Prusak, L. and Cohen, D., 1998. 'Knowledge Buyers, Sellers, and Brokers: The Political Economy of Knowledge' in The Economy Impact of Knowledge, Neef, D., A. Siesfeld and J. Cefola (eds.), Butterworth Heinemann

Rush *et al* 1996. Overview In Rush, H. *et al* (eds), *Technology Institutes: Strategies for Best Practice*, Suffolk: St Edmundsbury Press.

Sripaipan, C., Vanichseni, S., and Mukdapitak, Y., 1999. *'Technological Innovation policy of Thailand'*, (Thai version), Bangkok: National Science and Technology Development Agency.

Steiner, M. 1998. Cluster and Regional Specialization, Pion limited, London

Teece, D. J., G. Pisano and A. Shuen, 1997, 'Dynamic capabilities and strategic management', Strategic Management Journal, Vol. 18:7, 509-533

Teece D. J., 1981., 'The Market for Know-How and the Efficient International Transfer of Technology'. *The Annuals of the Academy of Political and Social Science*, 458: 81-96

Teece, D. J., 2000. 'Managing Intellectual Capital', Oxford University Press

TDRI, 1989. *The Development of Thailand's Technology Capability in Industry*, 2-5, TDRI: Bangkok.

TDRI , 1994. *Final Report of S&T Manpower Production*, Thailand Development Research Institute Foundation *(in Thai).*

TDRI, 1998. 'Effective Mechanisms for Supporting Private Sector Technology Development and Needs for Establishing Technology Development Financing Corporation,' A report submitted to National Science and Technology Development Agency.

TDRI, 2002. Final Report S&T Manpower Production Framework. *(in Thai).*

Teubal, M 1996. R&D and technology policy in NICs as learning processes. *World Development* 24(3), , 449-460.

Tiralap, A., 1990. 'The Economics of the Process of Technological Change of the Firm: The Case of the Electronics Industry in Thailand,' Unpublished D.Phil. Thesis. Science Policy Research Unit, University of Sussex, Brighton.

Tunzelman, N.-Von, 1995. Technology and Industrial Progress: The Foundations of Economic Growth, Edward Elgar, Aldershot

Vongpivat, P., 2003. 'A National Innovation System Model: An Industrial Development in Thailand,' Unpublished D.Phil. Thesis, The Fletcher School of Law and Diplomacy, Tufts University.

Winter, S., 2002, 'Understanding Dynamic Capabilities', A Working Paper of the Reginald H. Jones Center, The Wharton School, University of Pennsylvania

Wong, P., 1996. *National Systems of Innovation: The Case of Singapore*, Korea: Science and Technology Policy Institute.

Wong, P 1999. National innovation systems for rapid technological catch-up: an analytical framework and a comparative analysts of Korea, Taiwan, and Singapore, *paper presented at the DRUID's summer conference,* Rebild, Denmark, 1999.