Chapter 1

Enhancing Innovation Capability Using Local Universities and Public Research Institutes as External Resources: Thailand's Experiences

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CHAPTER 1

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The automotive industry in Thailand started in the early 1960s when transnational corporations (TNCs) started their assembly plants here. High demand from assemblers, coupled with a local component requirement imposed by the Thai government since the late 1960s, led to the emergence and growth of local manufacturers of automotive parts and components from the 1970s onwards. In the 1980s Thailand became the ASEAN automotive production centre. From the 1990s, the industry has gone through major liberalization. The local content requirement was phased out and import tariffs were reduced substantially in compliance with World Trade Organization (WTO) rules.

In 2010, Thailand produced around 1,645,000 cars of which around 900,000 were exported, equivalent to 18 billion US$. Thailand ranked as number one in ASEAN and number 12 in the world in terms of production volume. Firms in the industry can be classified into three groups: 16 assemblers, approximately 648 first-tier suppliers, and around 1641 second and third-tier suppliers (Thailand Automotive Association, 2011). All assemblers are either subsidiaries of TNCs or are joint ventures. Thailand has already become one of the key production bases of most global players from Japan, the US, and Europe.

Until recently, TNCs only carried out production in Thailand, while more sophisticated activities like design and R&D were done in their home countries. During the 2000s, TNC investment strategies in the automotive industry have started to change, as they have begun to invest in more technologically sophisticated activities in Thailand, such as advanced engineering, process and product design, and advanced testing and validation. Several major automotive TNCs (mostly Japanese) have set up technical centres in Thailand, separated from their normal production plants.

This change highlights the increasing importance of other local actors in Thailand's automotive innovation systems, especially universities and public research institutes, in supporting TNCs and local suppliers to upgrade their activities from production to the more technologically sophisticated activities already mentioned. The Thai country study, therefore, will examine the roles of nine non-firm players in the Thai automotive innovation system. These are; a sector-specific development agency (the Thailand Automotive Institute); four public universities (Chulalongkorn University, King Mongkut's Institute of Technology Ladkrabang, King Mongkut's University of Technology Thonburi, King Mongkut's University of Technology North Bangkok); one private-sector technology development promotion agency and its private university (the Technology Promotion Association: Thai-Japan and Thai-Nichi University); one Thai-Japanese higher education program; one research institute (the National Science & Technology Development Agency) and, one sector-specific private sector association (the Thai Auto-Parts Manufacturer Association). We also cover one case study of a leading local 1st and 2nd tier supplier (Somboon Group) which has extensive interaction with both local 3rd-tier suppliers and customers (automotive assemblers).

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1. Thailand Automotive Institute (TAI)

1.1. Background

The Thailand Automotive Institute (TAI) was established by Cabinet resolution on July 7, 1998 with the aim of strengthening co-operation between the government and private enterprises for the enhancement of competitiveness of the Thai automotive industry. As a result, TAI is a *sector-specific* promotional and intermediary agency for the automotive industry. Administratively, TAI is not a part of the national bureaucracy but comes under the Industry Development Foundation set up by the Ministry of Industry. Therefore, the organization's administration is rather flexible. It is not subject to the rules and regulations of the ordinary government agencies and state enterprises. TAI's governing committee, headed by the Permanent Secretary of Industry, comprises representatives from the government and private sector, as well as academics. The committee is responsible for defining operational objectives and scope of work, and supervising the management of the institute.

1.2. Resources

TAI has around 100 employees. Only around 10% of them have masters degrees. The rest (90%) have bachelor degrees or lower. Within this group, around 30 have engineering degrees (mostly mechanical and industrial engineering). Twenty (technicians) have vocational qualifications. The rest are support staff with social science backgrounds.

In terms of its budget, TAI received direct funding from the government only for the first 5 years from its inception. After that, it was expected to be a self-financed agency. In reality, TAI has to ask other government agencies in the Ministry of Industry (namely, the Office of Industrial Economics, the Permanent Secretary's Office, the Department of Industrial Promotion) for funds on a project by project basis, or else undertakes projects proposed by these agencies. In essence, therefore, TAI has budget difficulties.

1.3. Official Mission

(1) To research and recommend guidelines, policy, strategic plans, and measures to develop the automotive industry, as well as to solve the problems related to production, technology, human resources and marketing in this industry.

(2) To support the operations of various organizations in both private and government sectors to facilitate the achievement of industry development goals; namely, productivity improvement, design, research and technology development, product standards and testing, human resource development, information database, and others.

(3) To liaise and cooperate with various organizations and both domestic and overseas institutes for automotive industry development

(4) To provide services to enterprises in the area of databases, product testing and inspection, training, working skill development and certification

(5) Other assigned tasks

1.4. Roles and Activities

In practice, TAI performs the following roles:

(1) Study and Analysis

The Institute compiles, studies, and analyzes data, information and related situations, which are used as supporting data for recommendation, guidance and warning to the private sector, or directly and indirectly related organizations in the automotive industry. This will enable those organizations to plan their operations in both the short and long terms, and to recommend guidelines for policy, invasive industrial planning and direction for automotive industry development.

The most prominent study conducted by TAI is the Master Plan for the Thai Automotive Industry. So far, TAI has been commissioned by the Office of Industrial Economics under the Ministry of Industry to draft two master plans for the industry. The first master plan covers 2002-2006, and the second one covers 2007-2011. TAI

started the drafting process by organizing a CEO Forum. Though it seemed to be engaging with the private sector, key participants were from the subsidiaries of transnational corporations in Thailand, not from their headquarters. It has therefore been difficult to get clear commitment from the TNCs to implement what was set out in the plan. Also the master plan was too comprehensive, and tries to satisfy everyone for political reasons. No clear priorities were been set, i.e., what should be done first? Ironically, the most significant policy decision recently, that is, to pick the 'eco passenger car' as a product champion (in addition to the one-ton pick-up truck) was not specified in the plan.

(2) Development of Parts Manufacturers

TAI has defined competitive capability building of the parts manufacturers as one of its important tasks. The Institute has provided consultancy to improve production processes and organization management, led by its experts and engineering teams with expertise in each area. Moreover, the Institute has co-operated with international experts and organizations to solve problems in the product development and production processes of parts manufacturers.

TAI has a database of 2000 parts manufacturing companies. TAI would like to upgrade the technological and innovative capabilities of these companies through its consultancy and testing services (through its testing centre in Bang Pu, close to Bangkok). Most of its activities in this regard consist of testing whether components and parts produced by these companies are up to international standards (hence, qualifying to be exported or to be part of the value chains of TNCs). This task is critical to Thai parts manufacturers which do not have expensive and sophisticated testing facilities in house. Nonetheless, due to lack of funds and personnel, TAI cannot do much in terms of upgrading the capability of these companies to meet such international standards.

(3) Personnel Development

TAI provides both public and in-house training and capability testing, with concentration on the content required by the automotive industry, such as productivity, quality systems, administration and management. The Institute also provides the system to certify the capability of people in the following critical areas of the automotive industry: metal fabrication, metal moulding, plastic injection, and lathe and milling machine operation. The training and capability testing are both theoretical and hands-on. Capability certification helps to promote personnel development systematically, and enhances the acceptance of personnel capability standards. At the same time, the parts manufacturers in this industry are able to reduce cost and increase their competitive capability.

The most important human resource development program organized by TAI is the Automotive Human Resource Development Program (AHRDP). This is a joint collaboration between Thailand and Japan. Apart from TAI, the Federation of Thai Industries also joined the program. The Japanese side was led by the Japan International Cooperation Agency (JICA), the Japan External Trade Organization (JETRO) and the Japanese Chamber of Commerce (JCC). The program aims to upgrade the capability of local parts manufacturers. Its mission is centred on enhancing Thai automotive workforce capabilities through a large-scale "train the trainer" program, and establishing a skills certification framework. Eventually, graduates of the program should be able to train other people in their companies or their supplier networks. Four leading Japanese companies participated in the program by providing training experts and course materials: these were Toyota (the Toyota Production System), Honda (mould and die technology), Nissan (scheme for skill improvement), and Denso (manufacturing skill and mind management). The training covered theoretical knowledge, hand-on skills, and attitude. Thai university professors were also invited to teach theoretical courses. The parts manufacturers (both foreign owned or joint venture and local) needed to shoulder some costs either in kind or in cash. Executives of these companies had to show commitment to the program and send qualified people to participate. They were required to share their knowledge and skills with other companies and allow others to visit their factories.

All in all, this is a remarkable program. It has created a pool of talented trainers and has improved awareness of the importance of human resource development in the sector. However, results in terms of the actual upgrading of Thai automotive workforce are ambiguous. Some companies, especially larger ones, set up training centers or training courses after joining AHRDP. Uptake was less enthusiastic for smaller companies. TAI also conducted a follow-up investigation only once; one year after the program had ended. During the economic and political crisis recently, some trained technicians have left the industry to work in unrelated business with no requirement of using automotive skills.

TAI has proposed a second phase of AHRDP, and worked hard to have the program included in the recently-signed Japan-Thailand Economic Partnership Agreement (JTEPA). The new phase will focus more on higher and more comprehensive levels of knowledge and skill in the engineering and R&D activities which are necessary for upgrading the Thai automotive industry in the global value chain. Nevertheless, the project has not yet been carried out due to political conflicts both at international and domestic levels.

The qualified success of AHRDP highlights the important role of an 'intermediary' in facilitating the collaboration of key players in the sector. TAI has performed a crucial role in bringing TNCs, parts manufacturers (both local and foreign-owned), Thai universities and other government agencies to work together for the overall benefit of the industry. It has somewhat successfully bridged different expectations and interests and overcome a high level of mutual distrust among the players mentioned. This is a rare phenomenon in Thailand, whose national and sectoral innovation systems are largely weak and fragmented, and where trust among companies, and between companies and other actors such as government agencies and universities is generally low.

1.5. Policy Implications

The case of TAI has a few interesting policy implications.

1. Having an agency specifically taking care of promotion and upgrading of the sector is very important. It is not enough to have only a general agency looking

after the overall development of all industries. Each industry has a different path of development, requires different policy support and needs to have an agency that truly understands the industry and is committed to its promotion.

2. Organizational set up and budgetary supports are also crucial for the effectiveness of a sector-specific industrial development organization. TAI's ambiguous status, as either a government agency having a policy formulation mandate and/or a truly flexible private organization, makes it difficult for it to initiate policies and coordinate with large players in both the public and private sector (especially TNCs). This is a question of authority and creditability. Also the lack of annual direct government budgetary support makes it difficult for TAI to perform "public good" activities necessary for the technological upgrading of firms in the sector, such as providing important but expensive training in critical skills and knowledge which cannot be privately accessed by most local firms, and initiating R&D programs in the fields critical for the survival and value chain upgrading of the industry (e.g. hybrid and/or electrical vehicles and parts). Instead, TAI has to survive in the short run by offering services which easily make money but may not be so critical for long-term upgrading, and are in direct competition with private service providers. Also TAI have had to join projects initiated by other government agencies. Some of these projects might not match the key missions of TAI, nor be a high priority for the automotive industry. Therefore it is important that TAI should receive sufficient continuous budgetary support from the Thai government (for example, as a percentage of the value-added it can generate for the industry). Its official organizational status should also be clarified and strengthened in the eyes of large government and private-sector players in the industry. This needs to be studied further and publicly debated.
3. The role of *intermediary* is very significant. Such a sector-specific development agency not only performs policy initiation roles but also policy implementations, requiring interactive collaboration with key players in the sector. The effectiveness of an intermediary organization also depends on the authority, politically and financially, and creditability of the agency. This needs to be taken into account by the policy makers.

2. Chulalongkorn University's Programs on Automotive Engineering

2.1. Background

The Mechanical Engineering Department of the Faculty of Engineering at Chulalongkorn University was the first university offering specific study programs in automotive engineering, beginning in 1996. It started with a bachelor's degree conducted in Thai. The program has been quite small with only 15 students per year. In 1997, the department followed up by initiating the Automotive Design and Manufacturing (ADM) bachelor's program in English. This program was larger, with 100 students. Due to high tuition fees and demanding admission criteria, the number of students in the English program has now come down to forty. With the establishment of the International School of Engineering at the faculty in 2005, the master's degree in automotive engineering began. The number of foreign students in the English programs is about 10%.

2.2. Resources

There are five professors in the automotive program, and another two from the standard mechanical engineering programs can also participate in teaching.

2.3. Mechanisms and Strength of Knowledge/Technology Linkages with Firms

In terms of education, the teaching programs have had close collaboration with Toyota. Toyota helped in drafting curriculums, a rather unusual practice for Thai universities. It also provided both up-to-date equipment and instructors especially in the specific courses, such as automotive manufacturing, which required insightful and practical knowledge and experience. Toyota managers frequently take turns to teach classes. Most linkages with private firms are with the Toyota Group. However, other companies also have relationships with the programs but they are not as intensive, interactive, and frequent. For example, Isuzu has provided no-obligation scholarships to master's students. Several automotive paint making firms have also sent their employees to teach in a paint-related subject. Interestingly, in response to recent

investments in design and development activities by Japanese TNCs in Thailand, the teaching content, especially in the English program, has lately changed to focus more on knowledge and skills for design and development. There has therefore been a co-evolution of what is being taught at the university and what is going on in the industry, which does not usually happen in Thai universities.

Research collaboration with the industry, both with car makers and parts suppliers, is very limited. However, companies are contracting research from departments and research institutes of universities on the topics of polymers and developing new materials.

The Thailand Society of Automotive Engineering (TSAE) co-located at the automotive program centre of Chulalongkorn University was set up in 1997. It is a bridging organization between firms, government agencies and academics. Professors of the programs play an active role in the activities of the society. The activities include diffusing technical knowledge by organizing seminars, helping companies in adjusting to standards, working with public organizations like TAI, and, through its monthly meeting, facilitating cooperation between members. The society also provides training in quality systems (ISO 9000, QS 9000, TQM, TQC), productivity improvement, jigs & fixtures , CAD/CAM/CAE, supervisory skills, and cost reduction.

2.4. Results of linkages

Interestingly, the best students graduating from the programs tend not to work for automotive companies, even TNCs. They prefer either to work in well-established and promising Thai firms, such as the Siam Cement Group or for TNCs in other industries, both in Thailand and abroad, such as oil exploration companies (e.g. Chevron and Schlumberger) which can offer much high salaries. Even though automotive TNCs like Toyota and Honda have started their design and development activities in Thailand, this group of elite students still have other more attractive alternatives. Also automotive factories, located far away from the city centre, do not offer the comfort and lively lifestyle expected by the top graduates. This is another reason why they do not want to work in the automotive industry.

Regarding the quality of graduates, Chulalongkorn University graduates have strong theoretical backgrounds. They also do not have the English language problems of other graduates of Thai universities, although even the Thai programs use English text books. Of course, the reading and writing skills of these graduates are better than their speaking skills. The big problem is the lack of creativity of these graduates, a prerequisite for climbing up the value chain to the development and research activities which the Thai authorities want to see. The programs have acknowledged this problem and responded by changing teaching styles in some courses, becoming more problem-based, i.e., encouraging critical thinking and active participation from students.

2.5. Obstacles of Linkages

One major obstacle for developing such a specialized program as automotive engineering is the rigid regulations imposed by the Commission of Higher Education (CHE) and the Council of Engineers (a professional association having authority to issue the certificate necessary for an engineering career). CHE's regulations require all programs to study several basic subjects (social sciences and humanities) which are not related to automotive engineering. Therefore there are limited time slots in the curriculum for specific courses specialized in automotive engineering, especially if the programs are to have focus on preparing students for R&D activities. The Council of Engineers, on the other hand, requires students to study several out-dated subjects which are not useful at the present but are compulsory for getting a professional engineering certificate.

Another obstacle is the different expectations between universities and firms regarding the working ability of graduates. Many local firms expect that students can work immediately they graduate. However, most Japanese firms do understand the relity of the situation. They expect students to have enough theoretical engineering knowledge. The practical knowledge and skills they need will be trained in-house, either through formal or on-the-job training.

In addition, discontinuous government support can also affect the linkages between universities and firms. For example the department purchased equipment from government funds, to be used for research cooperation with the private sector.

Government, did not provide funds for maintenance. Therefore equipment is available but not in use.

2.6. Policy Related Issues

1. It is rather obvious that more flexibility is needed in curriculum development for new programs aimed at rapid technical change and changing demand from the industry. Both education and professional authorities should therefore play a facilitator and not only a regulator role.
2. In this regard, the role of intermediaries in facilitating interaction among key actors in the industry is also critical, since these actors have different expectations and time horizons. Intermediaries can be either public (such as the Thailand Automotive Institute) or private (for example TSAE).
3. Continuation of policy support both in terms of attention and budget, is necessary for collaboration between firms and universities, especially in the case that universities alone cannot shoulder the high costs of purchasing and maintaining equipment.
4. A professor of the program felt that better division of labour between universities teaching and doing research in the automotive industry should be a point of concern. The idea of having designated centres of excellence specializing in different areas of automotive engineering in different universities should be seriously considered. Funds and equipment could be allocated to each university according to its specialization. As a result, a university would be a node for collaboration with other universities in terms of teaching and research in a specific designated area.

3. King Mongkut's Institute of Technology, Ladkrabang

3.1. Background

King Mongkut's Institute of Technology, Ladkrabang (KMITL) was established in August 1960 as the Nondhaburi Telecommunication Training Center with cooperation from the Government of Japan. The institute has changed its name several time and became King Mongkut's Institute of Technology, Ladkrabang in 1986. KMITL aims to provide education and research in science and technology, as the foundation of the development of the nation. Currently, KMITL offers both undergraduate and graduate programs in 7 faculties and 4 colleges, which are: the Faculties of Engineering, Architecture, Industry Education, Science, Agricultural Technology, Information Technology, and Agro-Industry, and the International College, the College of Nanotechnology, the College of Data Storage Technology and Applications, and the Administration and Management College.

The Faculty of Engineering was the first faculty in KMITL. It has been the core of KMITL since it was the Nondhaburi Telecommunication Training Center in 1960. Nowadays, the Faculty of Engineering offers bachelor's degree programs in Telecommunications Engineering, Electrical Engineering, Electronics Engineering, Computer Engineering, Control Engineering, Mechanical Engineering, Civil Engineering, Agricultural Engineering, Chemical Engineering, Food Engineering, Industrial Engineering, Information Engineering, Mechatronics Engineering, Instrumentation Engineering, and Automation Engineering. The Faculty of Engineering also has master's degree programs in Telecommunications Engineering, Electrical Engineering, Electronics Engineering, Computer Engineering, Control Engineering, Mechanical Engineering, Civil Engineering, Agricultural Engineering, Chemical Engineering, Industrial Engineering, Information Engineering, Instrumentation Engineering, Microelectronics Engineering, Construction and Management Engineering, Biomedical Electronics Engineering, Automotive Engineering, and Automation Engineering. In addition the Faculty of Engineering also offers 3 PhD programs in Electrical Engineering, Mechanical Engineering, and Chemical

Engineering. The Automotive Engineering program is a joint program with National Science & Technology Development Agency (NSTDA) and Tokyo Tech, and is explained as a separate case. This case will discuss the relationship that KMITL itself has with the automotive industry.

3.2. Resources

There are around 20 professors in the Mechanical Engineering Department and about 100 undergraduate students. KMITL cannot check how many people have worked in the automotive or related industries after graduation. but, it is estimated that around 25% of the graduates go to automotive or related industries.

3.3. Mechanisms and Strength of Knowledge/Technology Linkages with Firms

Even though KMITL does not have an automotive engineering program, apart from the joint program with NSTDA and Tokyo Tech, KMITL has an automotive club. This club has joined the Student Formula SAE Competition every year. This competition is organized by the Society of Automotive Engineers, Thailand, to encourage students' interest in designing racing cars. This competition is international, and this year took place in Japan. The racing car developed by KMITL finished in 6th position and received the Best Cost and Best Design Awards.

During the development of the racing car, students from the automotive club worked closely with many firms in the automotive industry and received financial support through sponsorship. The key sponsors were Suzuki, providing the engine for the car, and Cobra who supported the use of carbon fibre material and also allowed students to work side-by-side with its employees. The total cost of developing the racing car is more than a million Baht (around 33,300 US$).

KMITL has a very close relationship with Cobra. Cobra makes surfboards and windsurfers using carbon fibre material imported from Germany, and mainly exports its products to other countries. Cobra aims to expand its scope into automotive parts, but it has neither knowledge nor experience in designing automotive parts in carbon fibre. Cobra therefore wished to gain know-how from research with KMITL through the

racing car program. KMITL students designed the parts using CAD and also simulated the strength of the parts. The simulation of carbon fibre is challenging, because carbon fibre is a new material and no one knows in detail the simulation parameters of carbon fibre.

Another close relationship that KMITL has with an automotive firm is the relationship with Suzuki. Suzuki fully sponsors its engine for the KMITL racing car team as well as sponsoring the research done by professors at KMITL. One of the research projects is to create an engine that can use 100% ethanol. In general, an engine using 100% ethanol has a problem when starting at a low temperature. A KMITL professor has found how to modify the Suzuki engine so that it can be started, using 100% ethanol, at 0 degrees Centigrade. After the research finished, KMITL invited the president of Suzuki Thailand to learn about the research. In the case of the racing car, the racing team was able ask Suzuki for any engine or parts they needed, and Suzuki Thailand would order from Japan for them. Many times the racing team modified the engine, and it broke down. Suzuki were also able to study the weak points of the engine, and the reasons for breakdowns.

The relationship that KMITL has with Suzuki is close because the advisor of the automotive club graduated from the same school in Japan as the president of Suzuki Thailand. At the time when the president of Suzuki Thailand first came to Thailand, the professors in Japan recommended this KMITL professor to the president.

Beside the racing car, KMITL also has an automotive lab to test engines. KMITL is one of four establishments in Thailand that have the infrastructure and equipment to run theses tests; the others are PTT Public Company Limited, the Thailand Automotive Institute, and the Pollution Control Department. An example of the equipment used is the chassis and engine dynamometer.

3.4. Results of Linkages

From the relationship that the racing team of KMITL has with Cobra, Cobra can produce new products from carbon fibre, such as steering wheels. However, most of the developed products are made-to-order parts. Cobra was able to learn how to design products and to simulate carbon fibre from working with KMITL. Suzuki were able to

study the reasons why their engine broke down from the racing car project, and also to study the new technology stemming from the research done by KMITL, using the Suzuki engine.

3.5. Obstacles to Linkages

An obstacle to the linkage that KMITL found with Suzuki is the language and cultural barrier. Most Japanese firms cannot use English well, and the same is true of Thai people. It is therefore hard to communicate in order to understand complex situations. Culture is also a problem. Japanese people tend to be very disciplined, while Thai people are usually not. Also, Japanese people have different ways of saying the same thing in different situations.

Another problem is that most of the time the university expects to get help from the firms without giving anything back. In order to attract firms to do research with the university, it also needs to be professional and to have something that the firms want, such as some specific infrastructure or knowledge.

These problems are being tackled through an informal lecture. The racing team advisor graduated in Japan, so he understands the Japanese culture and language quite well. He is able to advise his students about the cultural gap and how to deal with Japanese firms.

3.6. Policy Related Issues

The problem of the relationship between the university and firms is that there is no Thai car maker or big Thai firm that can design a car. It is hard to deal with the Japanese firms because the Japanese firms do not want to share their technology, but it is much easier to deal with Thai firms such as Cobra.

The universities need to have better equipment/machines than the firms. This is the case in other countries. The firms will do joint research, or hire the universities to do research, only if the universities have better equipment or skills to do it. However, this is not likely to happen in Thailand because the budget for the universities in Thailand is

very limited. If the professors need equipment, they have to build it and do its maintenance themselves.

4. King Mongkut's University of Technology, Thonburi

4.1. Background

King Mongkut's University of Technology, Thonburi (KMUTT) was set up as Thonburi College of Technology on February 4, 1960 as the first technological college in Thailand responsible for producing industrial technicians with the highest level of secondary schooling. In 1971, Thonburi College of Technology was merged with North Bangkok College of Telecommunication Technology to become King Mongkut's Institute of Technology, Thonburi and later changed the name to King Mongkut's University of Technology, Thonburi.

KMUTT has a vision of commitment to the search for knowledge. It is determined to be at the forefront of technology and research, to maintain the development of morally correct and proficient graduates, to seek success and honor in order to be the pride of the community, and to strive to become a world-class university.

KMUTT consists of the faculties of engineering, science, industrial education and technology, the schools of information technology, architecture and design, t bio-resources and technology, energy, environment and materials, liberal arts, the graduate school of management and innovation, and the institute of field robotics. The main sector that deals directly with the Thai automotive industry is the department of mechanical engineering and the department of tools & materials engineering.

4.2. Resources

The department of mechanical engineering provides education from bachelor's degrees to doctoral degrees in mechanical engineering and related fields. The mechanical engineering department has around 30 lecturers. There are around 500

undergraduate students, 80 master's students, and 20 PhD students. Of 30 professors, about 5 are connected with the automotive industry.

Another related department is the tools & materials engineering department. This department has around 20 lecturers. There are about 500 undergraduate students. Half of them are in the tools major and the other half are in the material major. The department also has around 20 master's students and 7 PhD students.

4.3. Mechanisms and Strength of Knowledge/Technology Linkages with Firms

The mechanical engineering department provides two courses that are directly related to the automotive industry. These are the automotive technology course and the internal combustion engine course. Even though the industry has a role in designing the curriculum, the curriculum of mechanical engineering does not have room to customize its teaching to specific industry requirements because more than 90% of the courses are set by the Council of Engineering. Students can choose only two free elective courses during the whole four years of study. Besides, when the students graduate they rarely use what they have learnt about automotive engineering because most of the automotive industry in Thailand focuses on production of parts. Design and engineering or research has just started and is mostly carried out by TNCs. Therefore it is the goal of the department that its graduate will be a diversified mechanical engineer who knows all the basics and can go to any industry. For master's and PhD students, the focus will be based on the topic of their thesis and dissertation.

The tools and materials department, in this case, has stronger linkages with the automotive industry than the mechanical engineering department, since moulding is a key activity in the production part of the industry. The relationship between the tools and material department and the automotive industry is through students' internships, research projects, and consulting work and most relationships are long-term. By volume of work, around 80% of the work the tools and material department has done was with the automotive industry.

Most research projects that the tools and material department have done with the automotive industry were through PhD dissertations. This type of work usually involves 1st tier suppliers such as the Somboon group. The topic of the PhD dissertation

comes from a problem that the firms face. In general, the firms support the research by providing materials and infrastructure. The capital usually comes from a government agency in terms of a scholarship or research funding. The department also works with 2nd tier and 3rd tier firms through the master's theses and undergraduate senior projects. Besides the research, the department also has a linkage with the firms through cooperative education since the students need to work in a firm as an employee for one semester or more. Around 80% of the students go to the automotive industry during this period.

Even though KMUTT has done research with the automotive industry, most research is on process improvement. There is no product development research. The department cannot register patents on the research outcome. Therefore, the department cannot license their findings, and also has no problem on intellectual property rights with the industry.

Another method of collaboration is through the professorial exchange program. KMUTT allows its professors to work in an industry for a period of time in order to bridge the gap between the university and the industry. However, the result is not as successful as the plan because the Thai automotive industry is mainly a manufacturing sector and a professor cannot learn much besides day-to-day operations. Moreover, the knowledge and capability of firms and the professors are limited because the university does not have high-technology infrastructure, as used in the industry in developed countries, and neither do the firms.

These connections between the firms and the university have arisen through personal contact and government programs. NSTDA has come up with the Industrial Technology Assistance Program (ITAP) project, linking the university and the industry together by working as an intermediary. From interviewees' perceptions, ITAP could significantly help the university to build linkages with the industry. KMUTT also has a unit to coordinate with firms. However, this unit works passively, mainly acting as a delegator to assign projects to departments when a firm makes a request. This unit does not carry out marketing, nor does it go to the firms to seek projects.

4.4. Results of Linkages

Less than 25% of the graduates from the mechanical engineering department join the automotive industry. Working with the tools and material department, firms can improve their efficiency and reduce defects as a result of advice from the university.

4.5. Obstacles to Linkages

The university and the firms have different understandings about research projects. The firms think that research projects are always about product development. Moreover, there is a research timeframe problem. When firms come to the university, they tend to have a critical problem which exceeds their capability to solve. They want results within a week or two, and the university cannot do that.

The professors also have difficulties when working with the firms. Research projects that the professors engage on with the firms are hard to turn into publications due to the characteristics of the research, and the confidentiality that the firms insist on. KMUTT provides salary increases based on the research projects that the professors carry out with the firms. However, to be promoted to associate professor and full professor, only the publications are counted.

4.6. Policy Related Issues

1. Government should assign responsibility and strengthen a university to become the center of excellence in a particular of field of expertise/technology. It should provide continuous financial and infrastructure support (as it takes a long time to build an excellence centre). Without being a really ‘excellent’ centre on something, a university cannot help industry much.
2. The criteria for promotion of academic staff to assistant professor, associate professor, and full professor should encompass research projects that the professors engage on with the industries irrespective of publication.

3. The Council of Engineering should loosen their rules on the curriculum and let each university design its courses to match their goals, whether to be a general or a specialized school.

5. The Sirindhorn International Thai-German Graduate School of Engineering (TGGS), King Mongkut's University of Technology, North Bangkok (KMUTNB)

5.1. Background

TGGS is a joint institution established by RWTH Aachen University in Germany and KMUTNB, in order to transfer the RWTH Aachen Model of Graduate Industry-oriented Engineering Education, Technology Innovation and Business Development to South East Asia. The TGGS project was initiated in 1996 and started its first M.Sc. courses in 2001. Since 2009, TGGS has accepted Southeast Asian students into the program. Currently, TGGS has around 20 full-time faculty members

RWTH Aachen is the largest university of technology in Germany, and one of the most renowned technical universities in Europe, with around 32,000 students and 300 full Professors and Chairs. About 83% of its students are in engineering, natural sciences and human medicine. In Aachen, around 5,000 international students and scientists benefit from the internationally recognized world-class courses and lab facilities. Traditionally, nearly all RWTH students register directly for their master's degree. In addition, RTWH Aachen has around 3,000 research assistants enrolled in Ph.D. work, and the total amount of external funding acquired (from industry, federal Government and the European Commission) was 193 million Euros in 2008. RWTH Aachen achieved top results in the German Federal Excellency Initiative, obtained the status of being an Elite University (resulting in extra funding of around 165 million Euros.) The industry-oriented profile of RWTH Aachen is due to the fact that nearly all of its Engineering Chairs and Full Professors have typically 10 to 15 years of industry experience, and students are enrolled very early in mini-projects, part-time research

support jobs, industry internships and research-oriented master's theses. Within RWTH Aachen, numerous affiliated institutes (operating like companies) have been established and, since 1985, about 1,000 technology oriented spin-off companies have been founded with the University's direct or indirect support, in the region in and around Aachen. Last but not least, 25% of all engineers with a doctoral degree in German industry are graduates of RWTH Aachen University.

KMUTNB has more than 50 years experience of cooperation with Germany, has adopted elements of the German system for many years, and has grown to be a university since 1986. Today, KMUTNB is one of the largest technical universities in Thailand with more than 20,000 students.

RWTH Aachen first approached Rajamangala Institute of Technology (RIT) to create a joint program. However, RIT had limited capability in terms of lab infrastructure and qualifications of the faculty. RWTH Aachen Then approached KMUTNB and an agreement was signed.

TGGS is an autonomous International Graduate School of Engineering within KMUTNB and has its own autonomous Thai-German administration. TGGS aims at the R&D-oriented education of engineers (M.Sc. and Ph.D. level) and consequently at technology innovation and associated business development in Thailand. TGGS serves as an example for new, industry-oriented structures in the Thai higher education system, and has an effective system of engineering education, technology development and research. For RWTH Aachen and its network of collaboration in Thailand, TGGS will become the main hub for R&D and business development in Southeast Asia.

TGGS milestones have been:

1996	Letter of Intent signed by RWTH Aachen on developing a new "Thai-German Graduate School of Engineering" in Thailand, based on the RWTH Aachen Model of engineering education
1997	Core network with KMITNB, RIT, RWTH Aachen, BMBF, MWF NRW, MUA Thailand, the Embassies and the first industrial sponsors established
1999	Memorandum of Understanding between RWTH Aachen, KMITNB, RIT,

	and DIHT (GTCC Bangkok)
2001	Launching of substantial project support through DAAD, start of first M.Sc. courses at TGGS in Mechanical Engineering Simulation and Design
2004	TGGS Contract of October 22 (25 million Euros budget 2006-2011), Foundation Stone of 11-storey TGGS building
Since 2005	Privilege granted TGGS to carry the name of HRH Princess Maha Chakri Sirindhorn
Since Mid 2006	Transitional TGGS offices in KMITNB New Research Building, recruiting of TGGS permanent academic staff started, total of 80+ staff to be recruited by 2009
2007	Completion of TGGS building and move into new offices, TGGS Co., Ltd. registered , purchasing of first basic equipment for TGGS started, name of Thai Partner changed into KMUTNB
2008	TGGS Co., Ltd. received its Bol Certificate , TGGS Autonomy and TGGS Council established officially, extension of labs and start with R&D projects
2009	Delivery of significant R&D equipment for the Technical Groups, first larger batch of students from Southeast Asia (Vietnam, Malaysia, Indonesia, etc.)
2010	First German-ASEAN (GAST) Conference on Mass Transport Technologies

The mainstream activities of TGGS can be categorized into three areas. The first is provision of industry-oriented engineering education following the RWTH Aachen Model by, providing international M.Sc. courses including block lectures by RWTH professors, cooperative engineering education with project-oriented internships, training and guidance of Thai Lecturers/Researchers in Aachen, and human resource development, scholarships, and alumni activities. The second aspect focuses on technology innovation through the expansion of collaboration links with industry in Thailand and Germany for Thai M.Sc. and Doctoral students, third-party funded R&D projects, development of state-of-the-art TGGS labs and research activities, technology-upgrading for Thai industry, and build up of TGGS as a platform for R&D projects in the whole of Southeast Asia. The last aspects is business development through the expansion of and support for Thai-German industry links, establishing technology spin-

offs in Thailand, business development in new technical fields, and links and resources in Bangkok used to create joint Thai-German business development projects.

Currently, TGGS offers 8 international M.Sc. and 4 international Doctoral Programs based on the RWTH Aachen Model. The M.Sc. programs offered are Mechanical Engineering Simulation and Design, Automotive Engineering, Production Engineering, Chemical and Process Engineering, Materials and Metallurgical Engineering, Communication Engineering, Electrical Power and Energy Engineering, and Software System Engineering. All programs are taught in English by professors from RWTH Aachen University and local professors with Ph.D.s from abroad. For the Ph.D. program, TGGS can offer degrees in Mechanical Engineering, Electrical Engineering, Materials Engineering, and Computer Engineering. However, in order to be accepted as PhD students, RWTH Aachen University must also approve candidates. Up to now, RWTH Aachen has not approved any Ph.D. candidates.

The administrative body of TGGS consists of representatives from both KUMTNB and RWTH Aachen. TGGS has one German director and one Thai director. Each program also has one Thai and one German program coordinator.

In close linkage with its German Industry Network in Thailand and with IHK (CC) Aachen, TGGS not only interacts with industry for internships and engineering projects, but also as a communicator, supporting business development and recruitment of qualified Thai graduates. TGGS has a broad network of partners including well-known companies in Thailand and Germany e.g. Siemens, SAP, Bayer, ABB, BMW, Daimler, FESTO, TUV Rheinland, and Siam Cement Group.

TGGS also established the TGGS Company Limited as the legal platform for international accounting, management and contracting, transfer of financial and human resources (R&D lab equipment) and for flexible handling of R&D projects with financial and IP issues, particularly for projects with the industry. Thai and German Directors are also directors of TGGS Co., Ltd. Similar to the concept of the affiliated institutes of RWTH Aachen, TGGS Co., Ltd. provides mechanisms to allow TGGS to act without the bureaucratic ties of the Thai Government System, and to implement the RWTH Aachen Model with all its entrepreneurial aspects in Thailand

TGGS also set up the German-Thai Engineering Technology Alliance (G-TETA) through an alliance between TGGS/RWTH, Siemens and the Thai-German Institute

(TGI). G-TETA aims to increase the participation of German companies in technology and infrastructure projects, and to enhance in a sustainable manner the development of local know how in manufacturing and engineering in Thailand. Possible technology areas in the focus of this alliance are transportation, drives and automotive, renewable energies (wind turbines, solar, new fuels), wireless communications, ICT and medical technology. A first project proposal, made to the Royal Thai government in 2009, is participation in the governmental infrastructure/mass transit plan for Bangkok, where Siemens has already a proven record and long experience of building and maintaining mass transit systems. In conjunction with this project, TGGS plans to build up a 4-semester M.Sc. Course on "Mass Transit Engineering" based on the practice and research-oriented M.Sc. course "Traffic Engineering" already implemented at RWTH Aachen.

TGGS has also developed joint activities with other German institutes in Southeast Asia such as the German Institute of Science and Technology (GIST) in Singapore, the Swiss-German University (SGU) in Indonesia and the Vietnamese German University (VGU) in Vietnam to enhance scientific networking in this region. Since November 2009, the 3 institutions TGGS, GIST and SGU have organized the German-ASEAN Science and Technology Network (GAST) in order to establish the German TU9 Model of Education and Research in the Asia-Pacific Region. A common German-ASEAN Conference on Mass Transport Technologies (focus on railway technology) was arranged for Bangkok, Jakarta and Singapore in May 2010, supported by the German Federal Ministry of Education and Research (BMBF)

5.2. Automotive Engineering Program

The Automotive Engineering program at TGGS was started in 2004 and focuses on industrial R&D practice and on modern manufacturing processes for vehicles and their subsystems. This program is supported by one of the world's leading departments of Automotive Engineering, "ika" at RWTH Aachen University, which also closely collaborates with companies like BMW, Daimler, Siemens, as well as Asian and American manufacturers. The program also contains elements to enhance the students'

ability to lead and coordinate project teams and to strengthen their skills of scientific documentation and communication.

The course structure was developed by RWTH Aachen University. The course is mainly industry-oriented, practice-based and developed from the knowledge and experience gained from the research done by RWTH Aachen University. The courses offered in the Automotive Engineering program include Automotive Engineering I-III, Structural Design of Vehicles, the Combustion Engine, Mechatronics and Vehicle Acoustics. The school also provides German language classes for students. Outstanding students also have opportunities for internships and thesis preparation in Germany. Based on their record, only one student per year is selected for an internship and thesis in Germany. Most of the time an internship in Germany for work at RWTH Aachen but working on an industrial problem because RWTH Aachen has a strong relationship with the industry.

The course structure of the Automotive Engineering program at TGGS is as follows:

1st Semester – Automotive Engineering I, Automotive Engineering II, Structural Design of Motor Vehicles, Internal Combustion Engine I, Selected Topics in Automotive Engineering, and Elective or German Language I

2nd Semester – Automotive Engineering III (Automotive Systems & Production), Mechatronics in Vehicle Engineering, Vehicle Acoustics, Automotive Engineering Lab I, Automotive Engineering Lab II, and Elective or German Language II

3rd Semester – Management and Economics, Industrial Internship (18 weeks), and Seminar

4th Semester – Master's Thesis

Automotive Engineering I explains the basic design concept of the car, power demand, transmission, engine, brake, *etc*. Automotive Engineering II is about the dynamics of the car, the mechanics, horizontal and vertical dynamics of the car, etc. Automotive Engineering III is about the production line for the vehicle. For their lab work, students will study in the lab of College of Industrial Technology, KMUTNB with faculties from College of Industrial Technology. The Management and Economics

course is to teach students on industrial and production management and economics, economical feasibility studies, etc.

The differences between the Automotive Engineering program of TGGS and other institutes are unknown because this comparison has not so far been made. However, the Automotive Engineering program at TGGS concentrates on the design concept of all parts and subsystems of the vehicle, not only the function of each part. In other words, TGGS focuses on "know why" instead of "know how".

The goal of this program is for graduates to work in either production or R&D departments of automotive firms because staff on the production line needs to understand the design concept in order to solve problems on the line.

5.3. Resources

TGGS has around 20 full-time faculty members. TGGS plans to have at least 3 full-time members for each program. Faculty members must have direct knowledge and experience of their field, not just the knowledge gained from books. However, for the Automotive Engineering program, TGGS has only 2 full-time members of staff. One has a master's degree in Automotive Engineering and a Ph.D. dissertation on automotive brake systems while the other has expertise in general Mechanical Engineering but received his Ph.D. from RWTH Aachen under a scholarship which requires him to work for KMUTNB for a period of time.

The Automotive Engineering program at TGGS is able to accept 15 students per year. However, there are only 6-7 applicants each year due to the language barrier, because this course is taught in English and also requires an English proficiency level equivalent to TOEFL 550 or higher in order to gradate, and to the tuition fee which is considerably higher than for other domestic institutes. Even though TGGS provides a partial university scholarship to almost all students, the financial issue is still a problem.

Most students have an undergraduate degree in mechanical engineering or related subject because the master's degree courses do not provide the basic foundation knowledge that is covered in the bachelor's degree. The lecture notes are also a barrier for students with other undergraduate backgrounds because the notes are based on the research profile of RWTH Aachen and there is also a language barrier.

5.4. Mechanisms and Strength of Knowledge/Technology Linkages with Firms

TGGS has limited relationships with the private sector. The firms do not have a role in designing the course structure in the first place because all courses are developed by RWTH Aachen University. However, TGGS has received suggestion from the firms and adjusted the program accordingly later.

All master's theses must concern real industrial problems. In order to ensure that students know the problems of the industry, every student needs to do an internship with the firms to study the real industry, and select one problem to be the subject of a master's thesis. However, there is a problem that when students work in industry, they generally do so for longer periods than just the internship, which delays their studies.

The advisors for the master's theses are not limited only to TGGS faculty members. Students can select their advisor from other institutes if they know that topic well, and are qualified to be an advisor for a master's thesis.

To ensure that all faculty members are active in research and have linkage with industry, all faculty members are required to do research. The measures for evaluation of faculty members are the number of publications, teaching hours, and research funding. Consulting projects in industry have been TGGS research projects an example of a consulting project was measuring the efficiency of additives to reduce oil usage. TGGS also have registered patents and have licensed them out to firms, but this is rare.

TGGS also provides seminars and training for local firms. In some cases, when the professors from RWTH Aachen University come to Thailand to give lecture, TGGS also invites representatives from the firms to attend the sessions.

5.5. Results of Linkages

More than half of the students work as lecturers. The rest works in industry. The graduates who work in the automotive industry mainly work in 1st tier, 2nd tier and 3rd tier firms such as the Somboon group. No one has yet been selected to work with a carmaker such as Toyota or Honda. The reason is that Toyota only hires workers with bachelor's degrees, and then provides internal training.

5.6. Obstacles to Linkages

Most of the firms that TGGS is dealing with are small and medium-sized local firms. They do not usually consider research as an essential factor, except to solve problems. In many cases the firms try to avoid hiring the university to do research by asking for very detailed proposals which then has all information they need to do the work by themselves without paying to the university. When the firms do decide to work with the university, payments are usually late. Another problem is that firms sometimes want a certificate from TGGS but are reluctant to follow all criteria. They then try to cut corners by negotiating with TGGS not to test on all the criteria.

5.7. Policy Related Issues

In order to help TGGS to do research with firms, the government should act as a middle man to match the firms' demand with the skills and capability of each university, coordinate the research project among both parties, and also handle all legal issues including the type of contract, the method of payment, the schedule and the deliverables, etc.

6. Technology Promotion Association (Thailand-Japan)

6.1. Background

The Technology Promotion Association (Thailand-Japan) or TPA was established, as a response to anti-Japanese sentiment in 1973, by Japanese alumni and people who had been trained in Japan with the Association for Overseas Technical Scholarships (AOTS). Mr. Sommai Huntrakul, who later became Finance Minister, was the president of the TPA Committee. The TPA was supported by Professor Goiji Hosumi, the former president of the board of the Japan-Thailand Economic Cooperation Association. Despite receiving Japanese support, the TPA's internal management was conducted solely by Thais. The purpose of the TPA is to be the center for promoting knowledge, and disseminating and transmitting new technology to Thai personnel for the growth and advancement of the Thai economy and industry. The TPA received donations from Japan without any pre-conditions to manage the operation of the TPA for 36 years. The donations stopped in the 2009.

The TPA has five main activities:

1) Training, seminars, consultancy, especially for SMEs. The most notable program is the 'industrial doctors' (shindan sha) developed in cooperation with the Department of Industrial Promotion (DIP);

2) Language and cultural school, offering Japanese, Thai, English, and Chinese courses;

3) Calibration and metrology services conducted by mostly Japanese-trained Thai staff-mainly for private companies (some being automotive assemblers);

4) Publication on technology and quality (30-40 volumes/year);

5) Web-based training and certification, especially for skilled technicians.

The TPA's total revenue is around 450 million Baht (around 15 million US$). The main sources of revenue are from language and cultural school, seminar and training, consulting, and calibration.

6.2. Thai-Nichi Institute of Technology (TNI)

Based on industrial experience gained from many consulting projects, the TPA wants to distribute this knowledge to new generations. It therefore established TNI in 2005 to provide education in order to develop people with specialized technological knowledge to work in Thai industries. Financially, TNI was started with funds from TPA (around 50 million baht or 1.6 million US$). The rest (150 million Baht or 5 Million US$) had to be borrowed, with the TPA offering guarantees, Donations also came from Japanese companies through the Japanese Chamber of Commerce, and as direct support from some Japanese companies in Thailand such as Toyota and Honda. The objectives of TNI are:

- To provide education at undergraduate and graduate levels in the fields of science, technology, social sciences and humanities, focusing on practical knowledge
- To be a leading academic institute in the area of research and development, and to create modern knowledge continuously
- To be a center of competent academics and consultants of the nation as well as to promote cooperation of high level knowledge research, to strengthen the role of researchers in creating enterprise and industry in Thailand
- To transfer technology from Japan and other countries by linking with academic institutes, governmental and private organizations in Japan and other countries so as to create cooperation by exchanging in terms of experts, research and development programs, educational training and study tours to other countries
- To provide academic services to society, such as short-term courses, training, consultancy for industrial entrepreneurs as well as the exchange of knowledge in technology with entrepreneurs, administrators, engineers and industrial technicians
- To encourage activities which help preserve the arts and culture of Thailand and Japan

Japanese firms also provide almost all the scholarships and the equipment and infrastructure of TNI.

TNI offers bachelor's degrees in engineering, information technology and business administration, and a master's degree in business administration. The bachelor's degree in engineering offers majors in Automotive Engineering, Production Engineering, and Computer Engineering. For the Automotive Engineering major, the course structure is developed from a Japanese Automotive Engineering course structure and from Chulalongkorn University. TNI also offer Japanese courses to its students. The program focuses on the practice based work. TNI also plans to offer a doctoral program in future.

6.3. Resources

The TPA is now financially independent (from the Japanese) and has around 300 full time and part time employees. TNI has accepted around 1000 students in total every year, which make the total number of students currently studying in TNI around 5000. The first group of graduates was 73 people and al worked or pursued further degree in Japan after their graduation.

6.4. Mechanisms and Strength of Knowledge/Technology Linkages with Firms

The TPA provides consulting services (the famous Shindan sha Program) to medium and large-sized local firms. The majority of the consulting projects are done with the Department of Industrial Promotion (DIP) as the direct customer. DIP assigns the TPA to provide consulting services to local SMEs in Thailand to improve their productivity and efficiency. The type of consulting mainly uses Shindan (industrial doctors) to diagnose the problems faced by a company and subsequently arrange further problem solving projects if the firm wants them.

TNI has very strong connections with 24 Japanese firms. TNI received donations from Japanese firms through the Japan Chamber of Commerce without any pre-conditions. The donations have been so large that TNI has had a positive income since its first year. In addition, TNI also received extra funding from Japanese firms in terms

of scholarships, equipment, machines, infrastructure, etc. With these strong connections, the majority of TNI's students do their internships with universities and companies in Japan.

TNI also has plans to provide consulting and training services to firms although this project is still at an early stage.

Through TPA's long training and consulting experience with private companies, TNI has high potential to be a very industrially oriented university. This will differentiate TNI from other Thai universities. At present, however, TNI and TPA are not working very closely together, although the aspiration does exist to systematically link the two together. TNI has just started up and is currently focused on drafting its curriculum and structuring its internal management.

6.5. Results of Linkages

Following consulting projects by TPA, local firms have gained benefits in terms of reducing cost, improving product and process quality, and also enlarging market size.

In the case of TNI, students have opportunities for internships in firms in Japan, due to the strong linkage that TNI has with the firms. Many students also work with Japanese firms after graduation, because of this connection.

6.6. Obstacles to Linkages

One problem that TPA faces is its customer. DIP is the TPA's largest customer. Since DIP is a government body, DIP's decisions on whether to hire TPA or not can be changed from year to year according to its budget. This situation makes the income of TPA very volatile.

6.7. Policy related issues

It is quite obvious that government should support a private association like TPA to act as intermediary and technical provider to companies. The support of government should be firm and continuous. A private university with hand-on knowledge and

experience such as TNI should also be promoted. It should be held aloft as a successful model of developing a private education institute with strong linkages with industry. Government support programs in higher education should also integrate initiatives in setting up private higher education institutes. Government promotion for excellence of public higher education institutes should support and leverage initiatives of the private sector, rather than alienating them.

7. NSTDA - Tokyo Tech - KMITL

7.1. Background of Tokyo Tech

Tokyo Institute of Technology (Tokyo Tech) was established by the Japanese Government in May 1881 as the Tokyo Vocational School, then was renamed Tokyo Technical School, Tokyo Higher Technical School, and then became Tokyo Institute of Technology in 1929. Nowadays Tokyo Tech provides undergraduate degree programs in Sciences, Engineering, and Bioscience and Biotechnology, as well as graduate degree programs in Science and Engineering, Bioscience and Biotechnology, Interdisciplinary Science and Engineering, Information Science and Engineering, Decision Science and Technology and Innovation Management. As of May 2008, Tokyo Tech has 1,719 staff, 4,911 undergraduate students, 3,448 master's students, and 1,566 doctoral students. From these, 1092 students are international students from 77 countries. Tokyo Tech also has academic cooperation agreements with around 30 countries all over the world, including Thailand.

7.2. Background of Joint Program in Automotive Engineering between Tokyo Tech, National Science & Technology Development Agency (NSTDA), and KMITL

The joint degree program in Automotive Engineering started when Tokyo Tech set up an office in NSTDA. It was willing to have a collaboration agreement with Thailand because of a change in the Japanese university funding system, where one criterion for funding is to have an international linkage. At that time, Tokyo Tech approached NSTDA because NSTDA had infrastructure, labs, and was also doing research, so it would be beneficial for NSTDA and Tokyo Tech to offer a 2-year master's degree program. Students could use the labs at NSTDA and NSTDA could also have research assistants. However, there is a condition that NSTDA must provide scholarships, including tuition fees and living costs, to all students. Tokyo Tech and NSTDA decided to start with 2 programs – Automotive Engineering and ICT.

Because NSTDA is not an educational institution, it cannot under Thai law grant degrees. Therefore, they need to partner with the university. For the automotive engineering program, NSTDA made an agreement with KMITL and for the ICT program with King Mongkut's University of Technology Thonburi.

Students who want to follow a program must apply through a Thai university, which is KMITL for the automotive engineering program. Professors are from both Tokyo Tech and KMITL. Professors from Tokyo Tech will come to Thailand using their funding and teach block courses in Thailand. Students will learn not only the theory but also from the experience of the professors from Tokyo Tech, because professors from Tokyo Tech have tremendous experience working in the automotive industry before becoming professors.

In this program, the first year lecturers come from both Tokyo Tech and KMITL. In the second year, students need to do research with advisors from all 3 parties – Tokyo Tech, KMITL, and NSTDA. There is no internship in this program, but students need to work with NSTDA. The research topic can be anything related to the automotive industry, which is very broad and includes almost all functions such as materials science, industrial engineering, mechanical engineering, energy, electrical and electronics, and communication.

The first group of students started their program in 2007. However, many students dropped out during the first year due to KMITL's management system and the English language barrier. KMITL solved the language barrier problem by requiring that students must be able to communicate in English in order to be eligible to enter into the program. This greatly reduced the English problems of new students.

KMITL also wants to expand the program into PhD degrees, but the interviewee from KMITL believed that it is hardly possible for this to happen because from this master's degree program, Tokyo Tech gain benefits because they can cream off top students to study for PhDs with them in Japan.

7.3. Resources

Currently, there are around 30 – 40 students in the program. There are only around 10 graduates as yet but this number is expected to increase significantly this year because the first year will reach the deadline of its 4-year study time limit. KMITL assigns professors from mechanical engineering to teach this program, involving around 20 people.

7.4. Mechanisms and Strength of Knowledge/Technology Linkages with Firms

The linkage between this program and the industry are mainly through the theses that students have to do in their 2nd year. The topic of the research usually comes from projects that NSTDA researchers are working on. Currently, most students are working in topics related to materials science with researchers in National Metal and Materials Technology Center (MTEC). Another group is working on engine tests, and alternative fuels such as ethanol. A final group is working with National Electronics and Computer Technology Center (NECTEC) on control systems. An example of the research is the design of component parts and interior parts. However, the direction of NSTDA's research has recently shifted to electronics and electrics so the researches of new groups of students will focus more on electrical and electronic systems and related projects.

Graduates from this program usually work in the automotive industry, research institutes or pursue a higher degree. Examples of positions and employers of the graduate are as follow:

1. Mr. KeerasutSuttanarak. Currently working in Engineering IT, DENSO Insternational Asia Co., Ltd.
2. Mr. SakdaThongchai. Currently working as a coordinator/assistant researcher at The Joint Graduate School of Energy and Environment (JGSEE), King Mongkut's University of Technology Thonburi
3. Mr. YokNusom. Currently working as an engineer at ECO-Products Development Laboratory, MTEC
4. Mr. ManopMasomtob. plans to study for a doctoral degree in Germany
5. Mr. WatcharapongSirikul. Currently working as an engineer at Kijjak Co., Ltd.

7.5. Results of Linkages

The result of the linkage from this program is in the form of the research. Because the thesis topic comes from the projects that researchers at NSTDA are working on, the result of the linkage is in the form of the progress of the research. But the effect on the automotive industry is dependent on how NSTDA researchers utilize these results.

7.6. Obstacles to Linkages

The problem that this program is facing is that most projects are problem solving, not pure research projects. Therefore, it is hard for students to use it as a master degree thesis. Therefore, the first group of students had to direct their research into the energy field, instead of direct automotive engineering.

The second problem is that this program requires students to have published something in order to graduate. However, the professors from Tokyo Tech are not available all the time. They only come to Thailand for about 2 weeks, which makes it hard for students to get in-depth advice. Moreover, the research projects that are mainly problem solving projects are hard to turn into the publications due to the characteristics of the research and the need for confidentiality.

Another problem is that the funding from NSTDA to provide scholarships to students is drying up. Based on the plan, the responsibility to fund this program will be shifted from NSTDA to National Science, Technology, and Innovation Policy Office (STI) but STI has no interest in automotive engineering and mainly prefers to collaborate with France and Germany. The change may affect this project as well as the relationship between Thailand and Japan. Tokyo Tech has also changed their president and if the financial results are poor, Tokyo Tech may decide to change their direction.

7.7. Policy Related Issues

1. Continuous government financial support for such a good program which has enabled Thai universities to leverage the knowledge of a leading Japanese counterpart should be institutionalized.
2. Apart from the thesis, there should be an independent-study option for master's students focusing on problem solving for Thai automotive suppliers. Of course the study must make an academic contribution to meet the requirements of a master's degree.

8. National Science and Technology Development Agency

8.1. Background

National Science and Technology Development Agency (NSTDA) was created by the Science and Technology Development Act of 1991 to conduct, support, coordinate, and promote efforts in scientific and technological development in the public and private sectors. NSTDA consists of 5 centers – the National Center for Genetic Engineering and Biotechnology (BIOTECH), the National Metal and Materials Technology Center (MTEC), the National Electronics and Computer Technology Center (NECTEC), the National Nanotechnology Center (NANOTEC), and the Technology Management Center (TMC). One sector that is in the focus of NSTDA is the automotive sector.

8.2. Development of NSTDA's Automotive Cluster Program

The Automotive Cluster Program at NSTDA was initiated in 2003 as a top-down policy of the Thaksin administration. It aimed to enhance the competitiveness of Thailand in certain sectors such as food, fashion, medical services, and automotive engineering, along with the capability to develop the industry. At that time, design was perceived as the weak point of the Thai automotive industry. Considering its resources, NSTDA and its network had the potential to research and improve the capability of the firms in finite element design, casting, stress treatment, spray hardening, etc., thereby improving the Thai automotive industry. The private sector also played a role in development of the automotive cluster program at NSTDA, through the Thai Automotive Institute.

8.3. Resources

The automotive cluster program has around 30 full-time equivalent employees. Most full time staff are engineers with a bachelor's and/or master's degree, mainly in mechanical engineering. The automotive sector of NSTDA also has fewer than 10 PhD employees, who are mainly in middle and top management positions. However, if all partners and all nodes are included, there are more than 100 people involved in the automotive sectors. Partners mentioned here consist of employees of the Thailand Automotive Institute and professors from universities such as Chulalongkorn University, Thammasat University, King Mongkut's University of Technology, North Bangkok, King Mongkut's University of Technology, Thonburi, and King Mongkut's Institute of Technology, Ladkrabang

8.4. Mechanisms and Strength of Knowledge/Technology Linkages with Firms

At the time when the automotive cluster program was set up, NSTDA provided training in basic finite elements to new employees of the Toyota Technical Center Asia Pacific (TTCAP), before they went for training in Japan. However, this training was only a one-time event because after that Toyota conducted its own in-house training based on this course. After that, this finite element team has spun off to become an "incubating" profit center under the name "Design and Engineering Consulting Center (DECC)" to provide finite element consulting and training to all industries, not specifically to the automotive industry. Their main income comes from consulting projects. For the automotive industry, DECC mainly provides services to local firms, mostly in the 2nd and 3rd tiers. NSTDA has provided about 20 million Baht (or around 1.3 Million US$) as a seeding fund for DECC. Currently, DECC is still under incubation due to financial constraints. One reason that DECC is still under the care of NSTDA is that the head of DECC is a professor, and does not fully push the organization as a for-profit business.

Besides DECC and finite elements, NSTDA have also done research in control systems and Electronics Control Unit in NECTEC and also the Intelligent Traffic System (ITS) which aims to increase driving safety and make driving more efficient. One example of the products coming from these labs is the Governor Box (G-Box) that

records the speed and the location of the vehicle, and which can be used in a gasoline tanker, for example, to track if the drivers drive off their route and sell gas to other people.

Recently, NSTDA was awarded a contract by TTCAP to carry out research on making interior parts from natural products and used tires. NSTDA got the contract because of its infrastructure, such as labs. TTCAP provides all the funding and NSTDA provides the labour. This project just started last year and is still active.

Even though there are many projects with Japanese car makers the relationships are not going as well as they might because NSTDA does not serve them well enough and also cannot meet their needs in every aspect. However, the relationship between NSTDA and Thai SMEs is much better and the relationship is a long-term one because the local firms have to rely on the ability and infrastructures that NSTDA has. Additionally, the local firms and NSTDA have complementary knowledge. Local firms have years of experience based on trial and error, while NSTDA has in depth knowledge of theory. Based on previous projects with local firms, the absorptive capability of the local firms is not a constraint for the firms to improve their technology.

Beside the direct relationship that NSTDA has with the firms, it also has an indirect relationship with the firms through universities. NSTDA provides scholarships and funding to universities, if the universities have consulting projects with firms. However, not many projects have been submitted for this funding because professors have to rely heavily on the number of their publications for their career progress.

Additionally NSTDA also tries to develop the capability of universities to help the automotive industry. Besides funding, NSTDA tries to develop each university to become a center of excellence in specific areas to assist with particular problems such as Kasertsart University for tires, King Mongkut's University of Technology North Bangkok for molding, and Chulalongkorn University for surface treatment through the Thai-German Institute (TGI). Based on this plan, each university not only knows their own specialty well, but can also refer to other centers when their customers have problems.

8.5. Results of Linkages

The results from the consulting projects that NSTDA and universities provide for firms include lunching new products, reducing defects and costs and increasing productivity. Many firms have been able to move from no tier to 3rd or 2nd tier because they could improve their quality to the level of the firms in the tier.

An example of product improvement from the consulting projects done by NSTDA is the work that NSTDA has done with Thai Rung, a local 1st tier firm. NSTDA has worked on projects with Thai Rung to develop a limousine and also an armoured car as a future project.

8.6. Obstacles to Linkages

The first obstacle that NSTDA faced during the start-up period was the unclear mission of its automotive cluster program. At that time, NSTDA was asked (by government) to strengthen the automotive sector, with no clue on how to start or what could be improved. NSTDA solved this problem by consulting with the Thailand Automotive Industry Association and firms in the industry.

Currently, one key obstacle is that Japanese carmakers do not want to do research with NSTDA. NSTDA have tried to deal through the Thai management team of those companies but this did not work because the Thai management team of a Japanese car company is not a prime decision maker. The management team also does not know the details of research and design. They just know the broad picture. When talking with the employees in the plants, employees said that design is done from headquarters in Japan. The R&D department in Thailand is only responsible for fine-tuning and problem solving projects, not the core design of the part or the car.

Although NSTDA had many projects with Toyota in the past, the relationship between NSTDA and Japanese carmakers worsened because NSTDA did not treated them well enough and could not serve their needs. For example, Japanese carmakers asked NSTDA to do quality checks when there was a quality problem in the R&D process but NSTDA ignored them. These issues significantly affect the trust that

Japanese firms have in NSTDA. As a result, Honda does not want to deal with NSTDA and Toyota barely has business with NSTDA at present.

The NSTDA's project to provide funding to universities to support the firms also has problems. First, not many projects have been submitted for this funding because this research cannot be used to show the academic progress of the professors. In Thailand, professors' progress is measured through the number of their publications. However, these firm-supporting projects are hard to turn into publications due to the characteristics of the research and to its confidentiality. Additionally, when the funding is withdrawn, all projects and initiatives of the universities are stopped. This year NSTDA has a limited budget so it has decided to provide funding to only internal researchers.

Intellectual Property Rights (IPR) are also a problem. NSTDA prefers to have a co-research project with a firm because it measures its performance by using the number of patents filed, but the firms prefer to keep new ideas as trade secrets. Moreover, the patent application process is also slow.

The last problem is an internal problem of NSTDA. The direction of NSTDA lies in the person, not the institution. Recently, there has been a change in the organization structure of NSTDA, eliminating the automotive sector. The automotive industry reacted strongly toward this issue and it is still under discussion.

8.7. Policy related Issues

1. The mindset of the management team of NSTDA need to be changed in order to make them interested in the automotive industry. This can be done if the government sends a signal to NSTDA that the automotive industry is still a focus industry. Government might also make the National Science, Technology and Innovation Policy Office, the supra-ministerial body responsible for science, technology and innovation issues, focus more on the automotive industry. In addition, because the government structure in Thailand is a "silo" structure, the information flow between each government organization (for example between the Ministry of Industry which is responsible for automotive sector development and NSTDA) is very difficult.

2. To the performance measure for professors in the universities should be changed. Instead of measuring the number of publications, the measurement should e also take account of the impacts they can create in the industry.

9. Thai Auto-Parts Manufacturers Association

9.1. Background

The Thai Auto-Parts Manufacturers Association (TAPMA) was created with approval from the Ministry of Commerce on June 29, 1978. It is an association of auto parts manufacturing companies from the private sector, and aims to serve as the central voice for auto parts industrialists in the country in order to protect, support and develop Thai industries. TAPMA was also created to detect and address problems that hinder the automobile industry's development in terms of production technology efficiencies, raw material import difficulties and workforce challenges, especially attracting and developing skilled labourers and engineers.

9.2. Purpose of TAPMA

1. Support production enterprises in the automobile parts, components and tools industries, by partnering with the government for support
2. Support members by tackling problems and negotiating on behalf of members to establish common benefits for their enterprises and the sector as a whole. Monitor and follow the movement of the parts, equipment, tools and accessory markets, domestically and abroad, for the benefit of the country's economy and finances
3. Research the latest technical and production developments for parts, equipment, tools and accessory enterprises, and exchange and publicize this knowledge and news to members

4. Request from members statistics, documents or information concerning their enterprises, including parts, equipment and accessory projects with explicit permission from individual members
5. Support members in producing quality auto parts, equipment, tools and accessories that meet or exceed international standards and support production of these components to fulfill market demand. Also support research into and improvements in production and marketing processes
6. Enter into agreements for members detailing their roles (including do's and don'ts) in operating smooth and problem-free manufacturing plants for parts, equipment, tools and accessories
7. Negotiate and resolve conflicts between members, and between members and outside parties
8. Promote occasional harmonious and non-political sporting and social events
9. Engage in charitable activities for society and support members with welfare within the parameters of Act 22 under the 1966 Commercial Association Decree

9.3. Resources

Currently TAPMA has 528 companies on its membership list. Its members consist of all firms in the automotive parts and related industries, from 3rd tier to 1st tier.

9.4. Mechanisms and Strength of Knowledge/Technology Linkages

TAPMA is more like a lobbyist group, seeking favor from government. Its role as intermediary, connecting members to other actors in the automotive sectors, is rather limited. However, the association recognizes three major challenges that Thai automotive part manufacturers are facing. In the short term, reducing weight and reducing cost of their products is the key. In the medium term, the focus is on CO_2 emission and carbon footprint. In the long term, the automotive parts industry needs to adjust themselves for the new technology car such as electric and Hybrid cars. TAPMA and all its members need to carry out continuous R&D in order to cope with these challenges. Their linkages with universities or government organizations are effected

by each individual member, not by TAPMA, except on those issues related to government policy and government intervention. TAPMA also links with international automotive-related organizations in order to initiate projects or create trust in the Thai automotive parts industry. An example is setting international standards for automotive parts.

Another project is to increase the competitiveness of the Thai automotive parts industry. The current project is to set up product/process champions. At present the Thai automotive parts industry produces almost every part, and has used all processes, without a clear understanding of which products or processes the industry is good at. It is essential to identify special advantages and then ask for help from the government to initiate a policy of supporting this process/product champion.

9.5. Results of Linkages

The result of TAPMA's linkages with government bodies should be seen in terms of government policy to support the Thai automotive parts industry, rather than directly in the increasing technological capabilities of its members. An example of a result of the linkage is the setting of a domestic and international standard for automotive parts.

9.6. Obstacles to Linkages

There are some uncomfortable feelings between TAPMA and TAI (The Thailand Automotive Institute). Sometimes TAI does not like TAPMA's direct engagement in government projects, bypassing TAI. In terms of the relationships with universities that members of TAPMA have, the key obstacle is the different perception of the level of service that each party expects and receives. The industry wants universities to be total solution providers, while the universities limit their roles only to testing (of automotive parts sent by parts manufacturers) and providing services under limited scope.

9.7. Policy related Issues

These policy issues are mainly developed from what members of TAPMA say about what they expect the government to do.

1. Universities and government organizations should become solution providers or problem solvers, not only test and service providers because that is what the industries need and the universities and government organizations have better knowledge and infrastructure than the firms.
2. Each university should have an area of expertise, and someone should map the various areas of expertise to show which organization is an expert in each process or product. Currently the firms do not know who to go to when they have a problem.
3. The implementation of the tax reduction policy should be improved. Even though the government provides tax incentives for R&D projects done with or by the universities, the process of proving that this expense is for R&D is very difficult, and takes a very long time.

There is also an issue of the division of labour, and collaboration between a public intermediary like the Thailand Automotive Institute (TAI) and a private intermediary like TAPMA

10. The Somboon Group

10.1. Background

The Somboon Group is one of the biggest 1st and 2nd –tier automotive parts suppliers in Thailand. It was established in 1975 and aims to be to be a leader in automotive parts manufacturing in the ASEAN region, providing end-to-end services, and growing alongside its customers. 2007 sales were almost 6 billion Baht (or 200 million US$) and sales grew by more than 10% in every year since 2003. The Somboon Group consists of 4 companies; Somboon Advance Technology Plc (SAT), Bangkok Spring Industrial Co., Ltd. (BSK), Somboon Malleable Iron Industrial Co., Ltd. (SBM) and International Casting Products Co., Ltd. (ICP). Examples of major customers are Auto Alliance, Dana, GM, Hino, Honda, Isuzu, Kubota, Mitsubishi Motors, Nissan, Toyota, and Yongkee.

SAT is a leader in drive shaft production in Southeast Asia, with factories in Samutprakarn and Rayong. Both factories are equipped with fully automated robots and advanced computer numerical control (CNC) machine lines and simulation systems software for bending fatigue testing in product development. SAT also has advanced testing machines, such as Static Torsion Testers, Rotation Bending Testers, and Fatigue Testers. The products that SAT produces include rear axle shafts, and inner shafts. Production in 2007 was almost 2.5 million pieces.

BSK has been operating for more than 45 years and produces leaf springs, coil springs, and stabilizer bars. BSK has the equipment with the latest technology for the production of high stressed and side force, left/right turn, high quality coil springs to serve all customers. BSK also produces high stressed solid stabilizer bars using fully functioning automatic hydraulic bending machines.

SBM and ICP have long experience as a ductile and grey iron casting foundry. Their main products are brake drums, brake discs, hubs, exhaust manifolds, flywheels and brackets. Their products are tested by full inspection in/out process lines, X-Ray, chemical composition evaluations, tensile strength testing, dimensioning by coordinate

measuring machine (CMM) equipment, finishing surface, and roundness checking of parts surfaces.

10.2. Resources

As of 2007, the Somboon Group had more than 2000 employees. Almost 700 employees worked for SAT, 450 for BSK, 750 for SBM, and 250 for ICP. Sales in 2007 were almost 6 billion Baht (or 200 million US$) of which the majority share came from SAT and SBM.

10.3. Technology Linkage with Suppliers and Customers

The Somboon Group outsources around 10-15% of its work to 3rd tier suppliers in order not to have to invest in some processes. In general, the suppliers have a quality and delivery problem. When the quality is not available, their products cannot be delivered. The Somboon Group helps these suppliers by sending engineering teams to their factories to help them find and fix their problems, such as with moulding or surface hardening. Overall, about half of the suppliers need this type of help from the Somboon Group.

The Somboon Group also helps its customers with technical problems. It aims to be a solution provider for customers. An example case involves brakes. Recently, there were more claims from the end users to the carmaker that their car was shaking when the brakes were used. The manufacturers of all parts of the brake system said that they had produced according to the blueprint. The car makers who assembled the brake by themselves, such as Mitsubishi and Honda, told the suppliers to figure out what the root of the problem was. The Somboon Group did the testing and provided a solution to their customers.

10.4. Mechanisms and Strength of Knowledge/Technology Linkage with Universities

The Somboon Group has many kinds of linkage with the universities and government organizations. One approach they have used is to hire a professor from a university as a consultant in a particular topic, such as mechanical design. The firm can gain knowledge through both the consulting and from the provision of training by the professor.

In terms of institutional relationships, most of the linkage projects are in testing and services where the relationship is loose and is conducted on a point-by-point, project-by-project basis without follow-up projects. An example is sending products to MTEC for testing. A better example is the case where the Somboon Group hired a professor at KMUTT to do research on surface hardening and casting of the mixture of aluminium and other metal to produce disc brakes. The best example, which is rare, is the relationship with Chulalongkorn University (CU). At that time, the firm imported the first low-pressure wheel-making machine into Thailand but no one knew how to make the moulds for low-pressure machines. A CU professor engaged fully in this project and the result was very successful.

The university network is also not formed. Most of the time, the consulting and service projects are one-time projects. Even though the firm may have another associated problem, there is no reference from one professor to another. Such a referral has happened only once but this was based on a personal contact that that professor had.

Measuring in terms of budget, only around 1-2% of the R&D budget that the Somboon Group spends annually is on relationships with universities and government organizations.

The Somboon Group also has technical relationships with international organizations. There are three cases of international technical linkages. The first case was about a couple years ago when a Japanese partner recommended that the firm conduct training using one professor from Osaka University. Another case was when the firm used a consulting service from an international organization. The consulting service was mainly in the form of email communication, and sending products for testing. The other type of relationship is hiring other firms for their technical advice

(TA), such as asking for help when the firm was developing a new process. However, these relationships are only advisory, not doing joint research. The TA relationship is, however, a long-term relationship. The Somboon Group has set up a team just to work with this TA in order to maximize knowledge transfer. However, the knowledge transfer method is mainly through on-the-job training, which is mainly an experience transfer.

Around 2 years ago, the Somboon Group decided to stop using TA and invested in spring design and production by themselves because the TA service was not satisfactory. At that time, customers worried about whether the Somboon Group could succeed or not. At the end, they succeeded, and now plan to provide TA to other firms in other countries who used the TA services from the same firm as the Somboon Group used before. However, since they stopped using the TA service, the linkage that the Somboon Group had with their Japanese customers has also gone. Therefore, the Somboon Group is planning to set up an office in Japan to develop closer relationships with the customers.

10.5. Results of Linkages

Because most of the linkage the Somboon Group has with universities and government organizations are in the term of testing services, their results are the testing results. However, there are some projects where the group contracts out research to universities, and obtains new processes that can solve existing problems.

10.6. Obstacles to Linkages

With its suppliers, there are no major problems, since Somboon normally outsources to long-term and trusted suppliers. If new processes are required and problems arise, Somboon can send in its engineering teams.

With universities, the key obstacle is that the firm and the universities do not understand each other. The Somboon Group believes that the professors in the universities have the knowledge and capability to do more than just the provide a testing service, and are eager to have long-term relationships with the universities to do

research, such as modifying processes when using the metal from India which has a different composition, or design the processes and products for cost and weight reduction. But usually the universities do not know what the firm wants, and the firm does not know what level of service the universities and government organizations want to offer.

Frequently recommendations from the professors cannot solve actual problems. This is because professors provide upstream, purely theoretical, knowledge, and do not know how to apply it to industry. A middleman is needed who can transform the upstream knowledge into an industrial application. Also, most professors only want to disseminate their existing knowledge, but do not want to fully participate in problem solving with the firm.

Finally, the firm does not know who to go to for each type of problem. All universities have broad knowledge and overlap with each other, and only some organizations are clear about what they are good at such as MTEC or DECC.

10.7. Policy related Issues

1. Universities and government organizations should consider becoming solution providers or problem solvers, not only providing testing and services. This is what the industry needs, and the universities and government organizations have better knowledge and infrastructure than the firms.
2. Each university should have an area of expertise, and someone should make an expertise mapping to show which organization is the expert in each process or product. Currently the firms do not know who to go to when they have a problem.
3. Thai industry needs more metallurgists. Currently it is hard to find metallurgists, especially those able to do process design. Even someone who knows the process usually knows only the injection process, not all processes. If we look at global trends, there is a move toward polymers. However, Thai industries are not there yet, and metallurgists are still needed. Therefore, the universities should develop more metallurgists to serve the industry.

4. Industries in Thailand usually talk about the broad picture, and want to do everything, but do not focus on any particular process. If there were a focus on a product champion, a process champion, or even a raw material champion and all parties agreed, relationships would be better.
5. A training center should be set up as a joint effort by the universities and the machine producers. Such a project has happened in Japan. In one area, where there is no machining, the universities set up a training center and the machine manufacturers provide machines for the center. The firms in that area can train in the new technology and new machines, and the machine manufacturers can sell their machines to these firms.
6. Thai universities should focus more on research that applicable to industry. The Japanese model can be used here. The Japanese public universities get funding only if they do research with industry.
7. Implementation of the tax reduction policy should be improved. Even though the government provides tax incentives for R&D projects done with or by the universities, the government's process for proving whether the expense of the firm really was for R&D is very difficult and time consuming.

11. Policy Recommendations

To strengthen the linkage among the industrial communities, universities, and agencies supporting the automotive industry in Thailand, policy recommendations can be integrated addressing the strategic issues for agency and institutional context development.

The policy recommendations supporting agency development can be emphasized in three areas as described below:

a. Awareness and Commitment: there should be a central agency playing strong roles as a conductor or intermediary, to link all parties representing industrial communities, universities, and research institutes together. This agency should be able to rally support and engagement from the members. The strategic objectives and actions of this agency should focus on mission-driven rather than activity-driven work.

b. Capability: the authority of the central agency should be clearly defined and funding should be sufficient to support the mission. This would allow the agency to take the initiative and lead the industry instead of simply proposing ideas, then seeking financial support before starting work. As a result, the agency could maintain its leadership position. Where the agency may lack expertise or resource, it should seek cooperation with other private agencies.

c. Incentive: to effectively utilize this policy, incentives should be provided to encourage an individual to actively engage in industry development as well as to promote collaboration among the members. For example, the performance of a researcher or university faculty member should be measured with proper key performance indicators (KPIs) and the incentive should be set based on the practicality of knowledge uses rather than academic output. Moreover, special tax benefits should be provided for the case where more than one party is involved in the activities.

The policy recommendations supporting institutional context development can be emphasized in two areas as described below:

a. Trust: this is the fundamental element needed for all parties to work together. To strengthen trust, the role and authority of the central agency should be clearly defined, and the agency must actively engage in driving the mission to lead capability development in the industry. Trust between or among party members should also be developed. The basic understanding of the priorities and limitations of each party is very important. For example, universities should be aware that "delivery time" is a critical factor for an industry. On the other hand, industry should also be aware that, in many cases, the limitation for universities is "resource mobility and funding". To avoid misunderstandings and conflicts between the parties, more opportunities for personal exchange should be initiated, so that members of each party can learn from each other from the direct experience being a part of one another.
b. Regulation: it is critical that regulations should be flexible and rapidly adjustable to match industrial and technological changes. The roles of an agency in charge of implementing regulations should shift from solely being a regulator to becoming both a regulator and promoter. The effectiveness of regulation implementation should be measured from result-based rather than activity-based indicators.

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