Engineering Education in Asia—the Thailand Example

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Abstract

Since 1985 the number of Bachelor level engineering degrees produced annually in selected Asian countries has increased by more than 60 percent and the yearly production of engineering doctorates has increased by more than 300 percent. The Thailand model is presented as an example of the quality and direction of engineering education in Asia. Thailand is a leader in the observable Asian shift in emphasis to doctoral level engineering education. It is suggested that Asia in general and Thailand in particular are becoming ever more important members of the global engineering education community and that opportunities for collaboration should not be overlooked.

Introduction

A penchant for science and engineering by Americans of Asian extraction has drawn attention for some time. It has been pointed out, for example, that minorities tend to be a much smaller proportion of scientists and engineers in the United States than they are in the total U.S. population. Asians, however, in 1997 comprised 10 percent of scientists and engineers in the United States although they were only 4 percent of the U.S. population.[1] Students from Asian countries tend to dominate the rest of the world on standardized achievement tests in mathematics and science.[2] The number of bachelor level engineering degrees in the U.S. peaked in about 1985 at around 77,000, declined by nearly 20 percent to about 62,000 in 1991 and has remained at about that level until the present. During that same period the number of bachelor level engineering degrees produced in selected Asian countries increased by more than 60 percent from about 200,000 to over 325,000. Engineering BS degrees in the U.S. comprise only about 5 percent of the total number of BS degrees granted in the country.[1] That percentage is generally much higher in Asian countries. For example, in Thailand about 13 percent[3] and in Japan about 19 percent[1] of the BS level degrees granted are in engineering.

Recently Asian countries are placing greatly increased emphasis on doctoral level engineering programs and degrees. Between 1985 and 1997 the number of doctoral degrees granted in engineering in selected Asian countries increased by about 300 percent from 2,000 to 8,000 per year.[1] Nearly 50 percent of the doctorates in engineering awarded by U.S. institutions now go to residents of foreign countries[4], many of whom are Asians. Clearly something in the culture and/or the development stage of the countries involved is driving these very interesting trends.

The first author of this paper recently spent a one-semester sabbatical in Thailand as a Fulbright Senior Scholar and was invited to visit Colleges of Engineering throughout the country. This provided an appreciation of the determination by government officials and academic administrators and faculty to support top quality engineering education. The second author of this paper is Head of the Department of Mechanical Engineering at Kasetsart University in Bangkok. We have elected to describe briefly the status of engineering education in Thailand as an example of what is happening in Asia.

Geographically located on the Southeast corner of the Asian continent, Thailand is rapidly growing in significance and importance to the Western world. Thailand has a population estimated at 62.3 million in 2000 and occupies a land area roughly equal to France.[5] The visitor is confronted with a panorama of stunning contrasts. Tourism marketing tends to highlight the ancient temples, exquisite palaces, working elephants, quaint hill tribes, and pristine beautiful beaches, while Bangkok, with a population exceeding ten million, presents every aspect of a modern bustling traffic-jammed city. Golden Arches, KFC's, and 7-Eleven's on nearly every street and Coca Cola and Pepsi products in every supermarket and street vendor cart provide a small-world-after-all reassurance.

Towering skyscrapers, elegant hotels, glitzy shopping malls, great soaring interchanges, and seemingly endless kilometers of multi-level elevated super expressways, criss-crossed with skytrains makes one wonder at the developing country designation. Empty, unfinished shells of ambitious office towers and condominiums, often with the immense construction cranes still in place, dot the landscape as stark reminders of the abruptness and severity of the economic collapse of 1997.

A long dynasty of Kings extends into the present democracy. King Rama IV or King Mongkut (1851-1868), portrayed to the world in the movies *The King and I* and *Anna and the King*, was an exceptional scholar and the first Thai monarch to be openly receptive to Western influence. His son, Rama V or King Chulalongkorn (1868-1910), made very dramatic strides in bringing Siam into the modern world by abolishing slavery, establishing a modern communications system, reorganizing the government into ministries, and developing education, including a school for English studies. His son, Rama VI, was educated at Eton and Oxford.[6]

Subsequent monarchs continued to improve the educational system following the Western model of universities. In 1932 faced with economic and political fallout from the worldwide depression, a new democratic form of government was established with an elected prime minister and parliament while retaining a constitutional monarch. The name of the country was changed from Siam to Thailand, meaning "Land of Freedom." The present King, Rama IX or Bhumibol Adulyadej, is a much loved and respected leader, regarded as being very wise and visionary and the world's hardest-working and longest-reigning monarch.[6] Extraordinarily well-educated, the King values learning and is decidedly pro-education. This is reflected both in Thai government policy and in the attitude of the Thai people. Education is widely accepted as the foundation for sustainable development and for preparing all people to become productive in a knowledge-based society. It is striking that 95 percent of all Thai children between the ages of 3 and 5 are enrolled in pre-school.[7]

The K-12 System of Education

The National Education Act of 1999 introduces sweeping reforms and guarantees every student the right to 12 years of schooling.[8] Students and their parents may choose between the Thai national education system and a variety of international systems including the British National Curriculum, typically American curriculums and the very demanding European International Baccalaureate curriculum. Students in the national public system study English for a least 7 years[4] and there is an even greater emphasis on English in the international schools.

As may be expected there are vast differences between the school systems in modern Bangkok and in those of the northern rural farm districts and hill tribes. It has been suggested that if Bangkok were treated as a country, reported average student performance on standardized science and math achievement tests would rank among the very top along with Singapore and other similar Asian city-states.

In October and March of each year, the Ministry of University Affairs conducts entrance examinations for those high school graduates desiring to attend the University.[9] In addition, individual universities usually arrange for additional screening tests and admit only a certain number of students into each program. The students leaving the k-12 system selected to enter engineering in Thailand appear to be very well prepared.

The University System

The Thailand Ministry of University Affairs supervises 65 institutions of higher learning, including 24 public and 41 private, with an overall enrollment of one million students and around fifty thousand faculty and administrative staff.[10] Of the teaching staff at these institutions, 27.4 percent have PhD degrees and 53.5 percent have Masters degrees.[7] Thirty-six of these 65 universities have colleges or faculties of engineering granting about 10,000 engineering degrees annually.[3]

These colleges of engineering all appear to be in a growth mode. Thailand enjoyed a rapidly expanding economy during the early 1990's. Heavy national and international investment in infrastructure and commercial enterprise led to a perception that the country faced a serious shortage of engineers. One estimate in 1995 placed the demand for new engineers at 15,000 per year and the supply at 6,000 per year. This generated a goal of doubling the number of engineering graduates in certain disciplines such as electrical, mechanical, and computer engineering. New engineering buildings were built on almost every campus offering engineering degrees. Government fellowships supported large numbers of young engineering faculty in doctoral studies abroad with the proviso that the recipients bring their enhanced expertise back to Thailand. The initial wave of these students has now returned with Ph.D. degrees from the most prestigious engineering schools in North America, the UK and Europe.

While university faculties are highly respected, the salary structure dramatically lags that of the industrialized world. Promotion to the rank of professor has been controlled by the Ministry of University Affairs. There are very few full professors of engineering in the entire country. This is expected to change as the Education Act of 1999 grants greater autonomy to local units and as

aggressive young PhD faculty increase research and publication output. Table 1 provides a snapshot-in-time listing of engineering degree programs in Thailand.[3]

Table 1 Engineering Degree Programs in Thailand

Department	B.S/B. Eng	M.S/M. Eng	Ph.D./D. Eng
Aerospace Engineering	Y		
Agricultural Engineering	Y	Y	Y
Automotive Engineering	Y		
Biochemical Engineering	Y		
Biomedical Engineering		Y	
Ceramic Engineering	Y		
Chemical Engineering	Y	Y	Y
Civil Engineering	Y	Y	Y
Computer Engineering	Y	Y	Y
Electrical Engineering	Y	Y	Y
Electrical and Communication Engineering	Y		
Electromechanical-Manufacturing Engineering	Y		
Energy Engineering		Y	
Environmental Engineering	Y	Y	Y
Food Engineering	Y	Y	Y
Geological Engineering		Y	
Industrial Engineering	Y	Y	Y
Information Technology Engineering	Y		
Instrumentation and Control Engineering	Y		
Irrigation Engineering	Y	Y	Y
Manufacturing Engineering	Y		
Mechanical Engineering	Y	Y	Y
Mechatronic Engineering	Y		
Metallurgical Engineering and Material Science	Y	Y	
Mining and Petroleum Engineering	Y	Y	
Naval Engineering	Y		
Nuclear Technology Engineering	Y	Y	
Plastic Engineering	Y		
Polymer Engineering	Y		
Rural Engineering	Y		
Safety Engineering		Y	
Surveying Engineering	Y	Y	
Telecommunication Engineering	Y		
Transportation Engineering	Y	Y	
Water Resources Engineering	Y	Y	Y
Totals	31	20	11

Not listed are some innovative efforts to form multi-disciplinary programs such as the Aerospace Engineering and Business Management dual degree program at Kasetsart.

Undergraduate Engineering Curriculums

Thailand's Council of Engineers (COE) accredits undergraduate curriculums in Civil, Electrical, Industrial, Mechanical and Mining Engineering.[11] Table 2 shows a comparison of the COE accredited Mechanical Engineering curriculum at Kasetsart University with the ABET accredited Mechanical Engineering curriculum at Utah State University in Table 2.

Table 2 Comparison of the COE accredited Mechanical Engineering B.Eng. Curriculum at Kasetsart University and the ABET accredited Mechanical Engineering B.S. Curriculum at Utah State University

	Semester Credits	
Topic	**Kasetsart[12]**	**Utah State University[13]**
Mathematics	16	18
Chemistry	5	5
Physics	8	4 + AP 4
Freshman Design	0	2
Physical Education	2	0
Graphics – Drawing	6	2
Statics, Dynamics	6	8
Strength of Material, Mechanics	6	5
Material Science	3	3
Electrical Engineering	9	4
Thermodynamics, Fluids, Heat	12	12
Numerical Methods (Programming)	3	6
Instrumentation &Measurements	5	3
Machine Design	6	3
Vibrations	3	3
Manufacturing Processes	3	3
English	9	3
Thai Communication	3	0
Internship	240 hrs required	optional tech electives
Humanities/Social Sciences	12	21
Technical Electives	6	15
Free Electives	6	0
Capstone Project	2	5
Additional Required ME Courses Machine Shop, Mechanics of Machinery, IC Engines, Automotive Engineering, Refrigeration, Power Plant Engineering, Fluid Machinery, Automatic Controls	25	
Total Credits	150	126

There are several observations to be made regarding the comparison provided in Table 2. One obvious difference is the number of credits required. The 126 credits shown in the USU curriculum represent the upper limit for the BS degree as mandated by the Utah Legislature. The KU curriculum with 150 total credits permits 8 additional required major courses. There are significantly fewer humanities and social science general education type courses in the KU curriculum. This is somewhat offset by higher numbers in English and communications courses.

Not shown in the table but deserving mention is the level at which the courses are taught. The textbooks used in the core courses examined for this study were found to be largely interchangeable between curriculums and in several cases were identical. Rigorous textbooks written in English are the norm for the KU curriculum and some classes are conducted in English. In the Aerospace Engineering Program at KU, all courses are conducted in English.

In the less litigious Thai society, students have access to machine shops 24 hours per day in order to work on design projects. Student retention statistics are impressive. About 70 percent of freshman entering the ME program at KU complete the B.Eng. degree within 4 years and about 85 percent complete the degree eventually.

The math classes in both the KU and USU curriculums extend through Advanced Engineering Math including Fourier Series and Boundary Value Problems.

It is interesting that a 240 hour minimum internship under the supervision of a qualified senior engineer in industry is required in the KU curriculum. No credit is granted for the internship that counts toward the total of 150.

There is strong anecdotal evidence that graduates from Thai engineering schools generally do well in graduate schools anywhere in the world.

Professional Registration

The same Council of Engineering that accredits academic programs also regulates professional registration of engineers at four levels; Associate Engineer, Fellow Engineer, Charter Engineer, and Corporate Engineer. Registration as an Associate Engineer requires a degree in engineering with a minimum of a C grade in each of ten specified subjects plus passing an intensive two day course in each of the following areas: Ethics, Environment, Safety, Law and Skills.

Registration as a Fellow Engineer requires a minimum of three years as an Associate Engineer, the submission of a portfolio showing major responsibility on at least two projects, passing an exam and an interview. The Charter designation requires at least five years as a Fellow Engineer, responsibility for at least two major projects, and a satisfactory interview.[11]

Graduate Programs

There is great determination in Thailand to bring the graduate programs and level of research to the highest international standard. Here is an illustrating example: there are 276 members of the

faculty of engineering at KU. At the present time 99 of these young faculty members are studying at highly regarded schools abroad and will soon be returning with engineering doctorates to augment and complement those substantial numbers already back.

Graduate engineering degrees from the west are greatly respected; however, study abroad is relatively very expensive, and alternatives are being implemented. [14] An ambitious plan to dramatically increase the number and quality of doctoral degrees granted in Thailand had been under development for some time. Named the Royal Golden Jubilee Project to commemorate His Majesty the King's 50th year of reign in 1996, the project proposed fellowships to doctoral students studying at Thai institutions and included budgets supporting up to one year of study and research at collaborating universities abroad.

The economic crises created a situation where it became very difficult to continue to support students already studying abroad. Many returned home to resume studies in the Thai system. The Golden Jubilee Project lost some momentum, but the vision remains intact. There exists a clear understanding of the nature of the global engineering market. Both undergraduate and graduate curriculums in Thailand are changing to place more emphasis on global, cultural, and environmental awareness and on communication skills and international finance. [15]

Conclusions

The trends seem clear. Thailand and Asia are serious about engineering education and are rapidly advancing on many fronts. We see a major shift in the relationship between Asian universities and those in the West. There will be a greater emphasis on collaborative arrangements wherein students from Asian schools get more of their education at home, thus keeping costs down, while gaining language and cultural exposure by studying at a Western university for one or two semesters or perhaps up to a year. Similarly, in this global economy, dominated by global corporations, students from western universities would benefit by having evidence of exposure to Asian culture, customs and language in their portfolios. As curriculums become more interchangeable and research interests merge, opportunities for student and faculty exchange will increase.

Already, distance delivery of both courses and entire degree programs enables many people to reach educational goals while staying home. There may be a very interesting blend of strategies, but the value of personal face-to-face relationships will certainly make collaborative exchange part of engineering education's future. Sheer numbers dictate that Asia will be a major player in such collaboration.

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