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TRIP REPORT

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COOPERATIVE AGREEMENT FOR RESEARCH IN THAILAND

REPORT NO. II: VISIT TO CHULALONGKORN UNIVERSITY, BANGKOK,
THAILAND

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I. INTRODUCTION

This report consists of a discussion of findings and recommendations resulting from a four-week feasibility study of the developing College of Petroleum and Petrochemicals at Chulalongkorn University, Bangkok, Thailand in November 1991. Chulalongkorn University has advanced considerably toward establishment of the graduate College to produce students at a Master of Science level (and later a Doctor of Philosophy program will be instituted) with instruction from American university professors. A major part of the project is the development of an internationally recognized research program. Research is an especially important part of the program because it must be an integral part of graduate study in science and engineering, and an internationally recognized program is necessary to develop continued interest of American university faculty in teaching and cooperative research at Chulalongkorn University.

A 16-story building for the College of Petroleum and Petrochemicals and the University Research Institute for Metallurgy and Materials Science is approximately 50% completed (7-stories have been allocated to the College). In addition, the Government of Thailand has awarded B6,000,000.00 (\$240,000.00) for scientific analytic and testing equipment and B4,500,000.00 (\$180,000.00) for purchase of petrochemical engineering pilot plant equipment.

Tentative agreement for provision of faculty and other services has been obtained from three major universities in the United States: the University of Oklahoma, the University of Michigan and Case Western Reserve University. A

memorandum of understanding was drafted and will be completed after review by the three American universities; plans for signing of the final document by the Presidents of Chulalongkorn University and the three American universities are being laid for March 1992 which is the anniversary of the establishment of Chulalongkorn University.

Bangkok, its suburban area and the Eastern Seaboard of Thailand are rapidly developing industrial areas. The development is occurring in large industries that have international affiliations where the English language is the principal language of business. There is a critical shortage of graduate engineers who speak both the Thai and English languages. Realizing this serious condition, the Government of Thailand encouraged development of a new engineering college at Chulalongkorn University which would produce scientists and engineers in the disciplines of plastics and petrochemicals that are skilled in English language as a means of communication. Students entering the College of Petroleum and Petrochemicals are expected to come largely from the undergraduate programs at Chulalongkorn University, but 25 % of the student body will be reserved for students from other Asian countries. A one month intensive English language and computer laboratory study is planned to increase the students' level of English language proficiency to the point where they will be capable of taking classes from American professors.

Students completing undergraduate engineering programs, with a Bachelor of Science degree, are considered by the process industries as the *keepers of technology*. These represent the largest number of engineers and are responsible for ensuring

that existing technology is used productively; that is, they maintain or advance productive capabilities through the effective use of existing technology. Students completing a graduate level program for a Master of Science degree are the middle-level engineers and are considered as the *designers of technology*. Their training equips them to participate in the design, development and construction of new technology for use by the *keepers of technology*. At the top of the triad are the Doctors of Philosophy (and MS who have ascended into management) who are a relatively small number of *decision makers* responsible for determining the objectives and approaches to be used by the other groups. At the moment, the industries in Thailand are in the stage of design, development and construction and therefore there is a very serious shortage of engineers at the Master of Science level and little, or no, need for the decision makers; however, when the growth period settles the industries will look to research, innovation and change in order to maintain their competitive margins. When this occurs in the next five years or so, there will suddenly be a rise in the demand for Doctors of Philosophy. The plans for the College of Petroleum and Petrochemicals at Chulalongkorn University are a little behind the demand for the Master of Science graduates because there is presently an acute shortage of these engineers; but, the shortage will persist for a decade or more as the area continues to develop. Chulalongkorn University is planning to introduce a Doctor of Philosophy Degree program in the College of Petroleum and Petrochemicals beginning in 1995 which will place the graduates right into the rising demand for the *decision makers*.

This feasibility study in Thailand was conducted by holding interviews with

government officials, industrial managers, business groups, various departments of the Chulalongkorn University, and review of budget and curricula needs. The findings indicate that the government, industry and university communities are all favorably disposed to development of the college as it is envisioned. Financial assistance from USAID is required to initiate the program and sustain it for at least two years, after which it will be financially self sustaining. Proposals for curricula and research evolution were developed. In addition, a recommended budget for USAID was prepared and completed by Mr. Owen Cylke, Director, Association of Big Eight Universities.

II. DISCUSSIONS WITH GOVERNMENT, INDUSTRY AND UNIVERSITIES

Government Officials (listed at end)

We (Mr. Owen Cylke and myself) were cordially received by the government officials (Appendix I) who responded favorably to our principal question of government support for the College. They were all solidly behind the idea of creating an engineering college using the Sasin College of Business as a model so that students graduating with MS and PhD degrees would be well versed in English and would have the prestige of being taught by professors from outstanding American engineering universities. They were somewhat concerned that the demand for such engineers far exceeds the supply already and graduates from this College will not be available until 1995 when there probably will be a peak in the demand for well trained, English speaking, practical engineers, and they felt that this could result in loss of momentum for industrial growth in the area.

They expressed an awareness that international politics and economics are playing an increasingly important role in the energy and minerals industries. They felt that the results of restructuring of economic bases will cause relocation of energy and mineral production from the United States and other industrialized nations to the so-called Third World Countries. Consequently, many more mining and engineering graduates will need to come from these countries, or graduates from the so-called Developed Countries will have to spend their professional careers in industries that transcend national borders. Therefore, they felt that the universities in Thailand should begin educating and operating more in an international context

that they tend to do, and graduates should be prepared to function as international citizens because industries locating in Thailand are indeed international companies that ignore the boundary demarcations of nations. They were concerned that students graduating from the College at Chulalongkorn should recognize that scientific and engineering factors alone no longer serve as the only basis for decisions made by multinational, international, corporations. Instead, an assessment of the social, political and economical conditions of the nations is more and more becoming an integral part of the investment decision process.

In effect, the government officials were in favor of establishment of the College with the interaction of professors from the United States, and perhaps other countries later on as the system develops. They felt that the internationalization of the engineering curricula would produce engineers with an appreciation of international cultural, political and economic relations, and hence the establishment of the College is very much needed in Thailand.

Their comments are reenforced by the fact that the government has furnished funds for a new building to house the College and has provided B10,500,000.00 for scientific and engineering pilot plant equipment thus far.

Industries (listed at end)

The petroleum based industries are growing rapidly: Shell Oil Co. and ESSO are doubling the sizes of their refineries and CALTEX has just signed agreements to construct a large refinery (200,000 barrels per day capacity). Shell and ESSO have interests in Arabia and Indonesia which will furnish the continual supply of crude oil

required. CALTEX has business interests in Oman which will be the principal source of their crude oil. So far in Thailand a small amount of oil has been discovered in the northern provinces and a considerable amount of offshore gas is currently the real basis for the rapid industrial growth. However, where gas is found sooner or later the oil companies discover oil reservoirs and exploration is gaining momentum in the entire region.

Managers of the industrial plants (Appendix I) all had basically the same comments to our questions of the demand for engineers, the type of engineer desired, and their support for the Chulalongkorn proposed College of Petroleum and Petrochemicals. The current demand for engineers far exceeds the local supply and hence they are reaching to other countries to meet their requirements.

According to the plant managers, it is apparent that the industries in Thailand must achieve competitive positions in the international market; therefore, they are asking for engineer who: (1) have a working knowledge of English as well as a second language whether this second language is native or acquired, (2) the graduating engineers must have a better understanding of human relations and cultural differences between nations and regions in order to work in the international market, (3) more cross-disciplinary technical knowledge is required to understand the complex interrelated engineering technology of modern industrial facilities, and (4) the new engineers should have the ability to self educate to keep up with changes in equipment, electronic control and systems engineering. They are looking for engineers with more ability to make original designs and design modifications

including experience with technical equipment through pilot plant studies or industrial internships of a few months to a year. They like the ideal of industrial internship during the break between school years because this would provide exposure to the industrial culture. Repeatedly we heard that they wanted engineers with three basic attributes that summarizes the discussions: (1) foremost was the need for engineers with "hands-on experience" gained through internship or pilot plant studies that could quickly grasp the complexities of modern industrial plants, (2) second in requirements were engineers with a good command of English language skills and the ability to forcefully express his/her own ideas in everyday plant personnel interactions, and (3) an engineer who could fit into the international corporate structure of the petrochemical industries.

In asking about their support for the Chulalongkorn University endeavor, we asked directly if they would furnish open scholarships to students admitted to the College of Petroleum and Petrochemicals. The response was varied. A few of the industries agreed that they would furnish one or two open scholarships, but they seemed reluctant to make a definite commitment. Some would prefer to offer a bonded scholarship which would obligate the student recipient to work for the company for a number of years after graduation. In one case, the Company Manager went so far as to say that they would consider a scholarship if the student worked first for the company for three to six months so that they could evaluate his performance before offering the scholarship. Since the amount of money involved in offering a scholarship is so low, relative to the income of these large plants, it is

difficult to understand their reluctance to offer scholarships because the demand for engineers is very high and the requirements expressed by the industrial managers are beyond the scope of the present institutions in Thailand. Perhaps it may be a situation of "overdose" from too many requests from other universities in the area. Because of this obvious resistance, the University should establish a public relations person to begin the search for scholarships and other funds that will be needed as soon as possible.

In addition to the questions of academic training, we requested their response to the idea of using the scientific and pilot plant equipment of the College to establish an administration that would provide services of analysis, chemical standards and research. All industrial plants must have back-up analyses of plant quality control samples conducted periodically by outside laboratories to corroborate the analytic capability of the plant laboratory. This is done because slight changes in procedures that are made for convenience in laboratories tend to introduce inherent errors in analyses. The plants also need an outside source of chemical standards because internal standards tend to deviate over a period of time carrying a built-in error that begins to multiply and cannot be detected because of masking by inhouse procedures. In asking where this was done now, we found that it was generally done outside of Thailand because of lack of a lack of local testing laboratories. Shell Oil Co. is using the resources of Holland, but they were not satisfied because of the long time-lag in responses. The same was true for ESSO which was using company laboratories in Houston, Texas. Consequently, they stated that they would be very pleased to have

such a facility established at Chulalongkorn where results could be obtained on a timely basis and assistance would be available for any analytic problems that might surface.

Research would be a more complicated issue because of its inherent proprietary nature. In some cases they might wish to use pilot scale equipment to test changes of plant operating conditions. And, under certain unusual conditions they might enter into a secrecy agreement and have some research conducted at the university.

Asian Institute of Technology

This institute is drawing students from all over Asia and therefore has a continuous English language program of instruction (for the two year duration of an MS program) in addition to a one-month pre-entry intensive course. Their experience is that the one-month course is not sufficient to develop proficiency in English for graduate study.

The curricula is agriculturally oriented to develop practical engineers that can have an immediate beneficial impact on the culture, economy and resources of Asia. They use large-scale equipment for teaching which allows direct transfer of research developments to the community with special emphasis on agriculture, aquaculture and hydraulics.

They employ a full-time faculty with a strictly enforced policy of "publish or perish" by using 2 to 4 year contracts (depending on rank). If a professor does not meet their expectations, or is not recommended by their peers, his/her contract simply will not be renewed.

King Mongkut Institute of Technology at Thornburi

This institute offers an MS degree in engineering which is largely based on study of pilot plant operations for food and biotechnical industries. The focus is on the study of design, fabrication, installation and operation of plant equipment in order to promote transfer of industrial technologies from advanced countries. It is anticipated that the pilot-plant based studies will promote industrialization which will increase the value of agricultural products and natural resources.

The university also provides technical consulting to local industry and the Thai government, provides training of industrial plant technicians and presents short courses in agriculturally based plant technology and management.

The faculty is composed of 12 PhD, 6 MS or ME and 5 studying abroad for PhD. The faculty research activities give a good representation of the emphasis on instruction at the Institute: biochemical engineering, combustion engineering, food engineering, petrochemical engineering, waste utilization, and material, and membrane technology.

Sasin Institute of Business Administration

The Sasin Institute is a joint venture of Chulalongkorn University, the Kellogg School of Management of Northwestern University and the Wharton School of the University of Pennsylvania. It was chartered as an independent institution of education of Chulalongkorn University on September 15, 1982. All instruction is conducted in English by faculty members of American universities who are responsible for the quality of instruction and certification of the students. Thus the

diploma is signed by representatives of Northwestern and Pennsylvania Universities.

They teach two courses per day for a period of 6 weeks. I was concerned about the cognitive time needed for technical courses, which are sequential in nature, being sufficient if the College of Petroleum and Petrochemicals adopted to policy of completing graduate engineering courses in one month (teaching only one course per day). Discussions with students at Sasin Institute, however, dispelled this concern; they all said that this presented no problem to them at all, and in fact they preferred having the concentrated courses to the alternative of spreading them over a three or four-and-a-half month period (quarter or semester systems).

Concerning English language study, the students were perfectly capable of conversing in English and the procedure to develop this used at Sasin Institute was to have a one month intensive course in English prior to the opening of classes and then follow with English training that was placed on their transcript but without credit. English instruction is divided into: (1) rapid reading, (2) note taking, (3) openness of expression, and (4) case presentations.

The professors find that teaching the 6-week compressed course is very demanding, but the students found that they could handle the courses without difficulty.

They maintain quality in teaching by careful evaluation of each of the teaching faculty and simply do not invite those that do not receive adequate ratings to return.

The curricula offers majors in two fields of business: international business and finance in marketing etc. A one-week pre-course in mathematics and a 20-hour

pre-course in computer use are provided along with a 40-hour English usage and writing course.

Chulalongkorn University Departments

Departments of Petroleum and Chemical Engineering. The Departments of Petroleum and Chemical Engineering were strongly opposed to the creation of the College of Petroleum and Petrochemicals because they felt that its creation would dilute their programs into oblivion. They are principally undergraduate teaching Departments, but they have gradually introduced Master of Science and now Doctor of Philosophy degree programs. Their financial base for introduction of graduate studies is practically non-existent and they feel that the development of the College will insure that they will not receive favorable treatment with respect to funding in the future. A review of their laboratories and equipment for graduate studies indicated that these are totally inadequate at this time. I cannot see how they could develop a creditable graduate program if these dismal conditions persist. Although their text books are in English, all teaching is in Thai and the students cannot understand spoken English. Therefore, these departments are not meeting the expressed demands for the types of engineers required by the industries today.

These two departments were initially invited to joint in the development of the College. In anticipation of their participation, the name "Petroleum" remains a part of the College name although the College will not presently produce petroleum engineers (there is some indication that after a two year period of successful operation, the College will introduction petroleum engineering therefore they do not

wish to change the name of the College).

Department of Chemical Technology. There is also a strange Department of Chemical Technology, which seems to be a duplicate of chemical engineering. This Department is far more dynamic than the first two mentioned. The faculty are fully in favor of establishing the College of Petroleum and Petrochemicals and many are already actively assisting. They feel that they will be able to continue with their strong undergraduate program and also interact with the College by presenting academic programs and conducting research. This Department also has an MS/PhD program on a very small scale but they seem to have acquired sufficient financial resources to conduct the program on a small scale. Their graduate laboratories and equipment, however, are inadequate (by American standards). They use the analytic capabilities of the University Equipment Center for their research and have acquired several industrial research grants. The scientific equipment of the Equipment Center is well maintained but the resolution of some of the key pieces of equipment is not sufficient to place research based on this equipment at the frontiers of international research today.

Chulalongkorn Equipment Center. Establishment of the Equipment Center began in 1981 to provide a central location for expensive, sophisticated, scientific equipment and services in order to avoid costly duplication and to develop special expertise in the use of this type of scientific equipment. The Center is administered as a separate department providing services for research, teaching and facilities (machine shop, glass blower, electronics, etc.). The **Analysis Division** contains:

Nuclear Magnetic Resonance equipment, Scanning and Transmission Electron Microscopes, Mass Spectrometer, X-ray Fluorescence and X-ray Diffraction instruments, Chromatographs, Emission Spectrometer, and some "wet-chemistry" analytic capability. The **Facilities Division** maintains: a Machine Shop, Glass Blowing Shop, Electronics Laboratory, and Sample Preparation Laboratory.

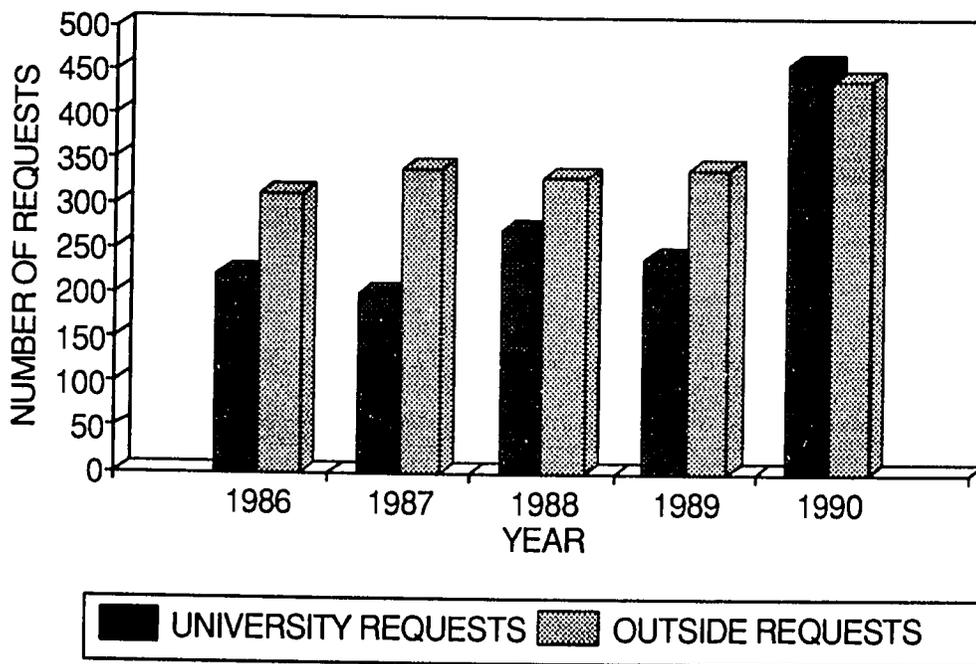
Generally, samples are submitted to the Equipment Center and the results are returned to the faculty. Faculty may use the equipment themselves on a prescheduled basis but they receive few requests for this. Students are not allowed to use the equipment.

From the standpoint of economics, this system makes good sense, but it can be a monolith in operation. My own experience has been that centralized services are slow, impersonal, and unresponsive to special needs of research that frequently reach beyond the capabilities of routine analysis. It has a detrimental influence on quality research and teaching for graduate students who must learn the operation and limitations of analytic equipment. Although my own experience is negative, the faculty at the University expressed general satisfaction with the operation and utilization of the Equipment Center. About 60 % of the Center's work is devoted to faculty generated requests, and the rest is offered as services to industrial and government institutions with a demand that far exceeds the capacity of the staff and equipment to fulfill. Figure 1 shows the rising demand for services from the University and from sources outside of the University. The Center also offers several courses (labeled Research Equipment I to VI) which are offered to graduate students;

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SCIENTIFIC EQUIPMENT CENTER

Figure 1. Analytic Services Performed



these courses describe the principles and operation of the instruments followed by laboratory experiments.

Most of the equipment is used in a routine manner for analytic purposes and do not have sufficient resolution for advanced, specialized, research at the frontiers of internationally recognized research.

The rising demand for services from outside of the University; that is, from industry and government, shown in Figure 1, indicates that there exists a considerable demand for scientific testing services that can be addressed by using the scientific equipment and pilot plant of the College of Petroleum and Petrochemicals for this purpose. This would result in a source of considerable revenue that can be used to maintain the highest level of quality in the instrumentation at the College thus assisting in bringing, and maintaining, their research up to internationally accepted standards.

UNISEARCH

This organization was established in 1986 to act as an advisory organization to government and industries that are in need of research, testing, planning, training seminars and management services from the University. They also offer computer software consulting for procurement and installation of software, and computer security. They prepare contracts for research and other services and oversee the administration of the services. They are modeled after, and affiliated with, UNISEARCH of New South Wales University, Australia. They also have business ties to organizations throughout Asia.

In effect, UNISEARCH was established to assist industries and government organizations by finding appropriate faculty members to work on various technical, scientific, problems and business economic surveys. As shown in Figure 2, the large majority of the work (73%) consists of research and consulting. UNISEARCH now has a staff of 30 personnel and has begun discussions that might lead to a break with their ties to the university (which shares in the profits) in order to establish themselves as an independent business.

The current number of projects that are being processed is 103 with a combined value of 25.2 million Baht, Figure 3, and the growth continues to rise; hence, the initiative to break with the university and become established as an independent business organization.

The success of UNISEARCH is another indicator that the scientific equipment and pilot plant of the College could be organized under a separate administration for service to government and industry. This apparently has the potential to generate a considerable amount of income for the College of Petroleum and Petrochemicals.

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Fig. 2. UNISEARCH Project Distribution

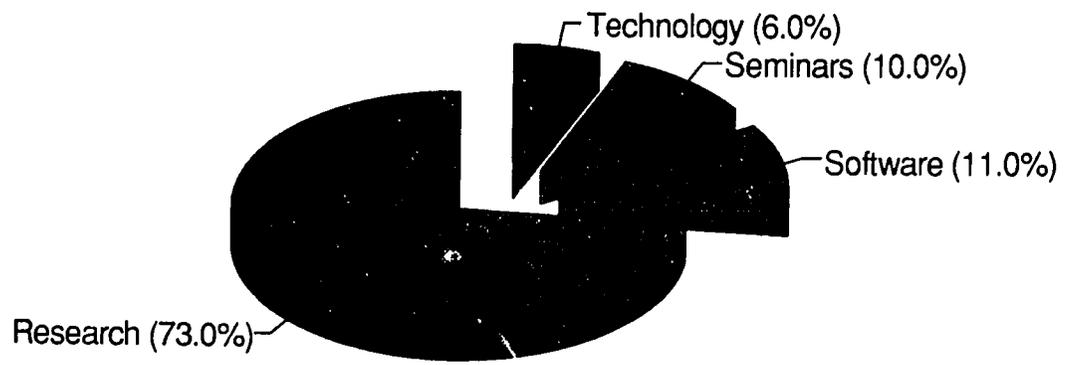
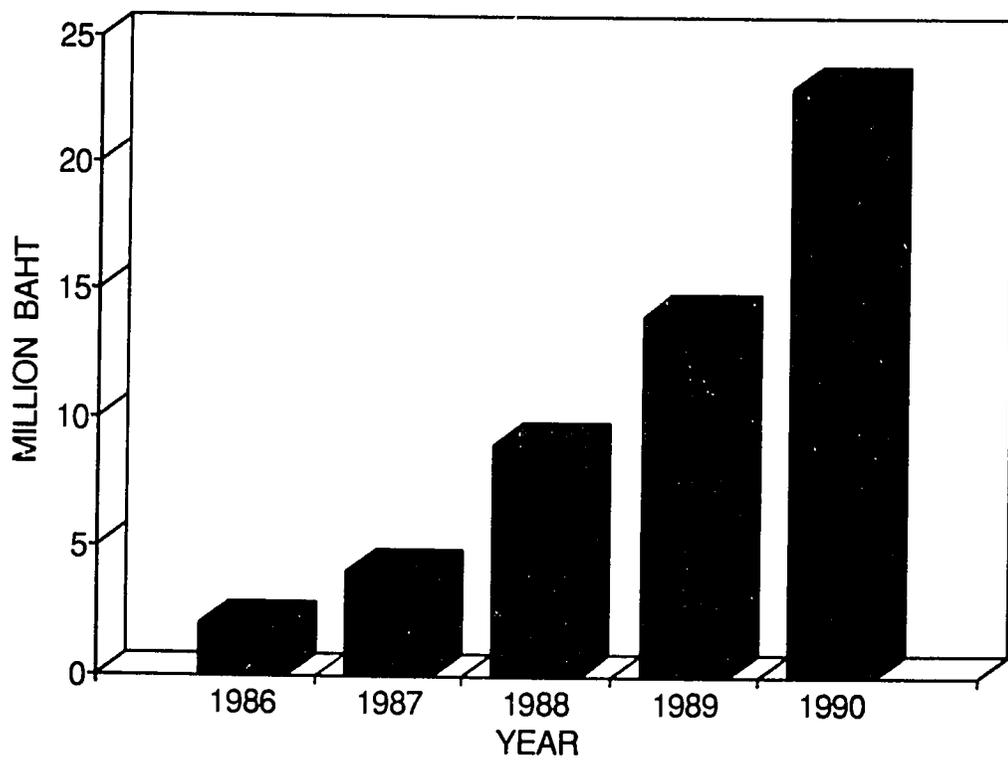


Fig 3. Growth of UNISEARCH



III. CHULALONGKORN COLLEGE OF PETROLEUM/PETROCHEMICALS

The College

During the decade 1980, Thailand experienced remarkable economic growth resulting from modernization and industrialization in and around the capital city of Bangkok. The traditional base of the economy was agriculture, but this has changed to industries based on petroleum and its products bringing with it other associated industries. Since the economy was originally based on agriculture, the rapid industrialization brought with it a large demand for technical personnel that were not available in Thailand. Consequently the industrial enterprises resorted to importing large numbers of foreign engineers (more than 3,000 since 1988). The industry continues to grow at a very rapid rate and hence the demand for engineers far exceeds the supply.

The government of Thailand has thus instituted several programs at existing universities to address this demand for engineers. Chulalongkorn University launched a program that would produce polymer/petrochemical engineers at the Master of Science level (and later Doctor of Philosophy) who would have English language communication skills and would carry the prestige of being taught by outstanding American University faculty. This initiative would begin to address the shortage of polymer/petrochemical engineering required for the growing petrochemical industry on the Eastern Seaboard of Thailand. At the moment two oil refineries are doubling their capacity and a another company is constructing a new refinery with sources of crude oil from the Middle East and Indonesia. The plastics industry is

constructing a new plant to prepare polymer monomers from heavy fractions of petroleum (aromatics) since the present monomer plant only uses the light ends (ethane, propane and butane) from gas fields in the Gulf of Thailand. At present Thailand only has a very small field producing crude oil in the northern provinces but the big international companies have an active exploration program in place; so it is quite possible that oil reservoirs may be discovered in the near future.

The Graduate School of the University opened Master of Science degree programs in 1985 in polymer and petrochemistry with the cooperation of faculty from the other Engineering Departments. They have graduated 36 students thus far. This became known as the College of Petroleum and Petrochemicals which was restructured in 1988 along the lines of the Sasin Institute of Business Administration. Several Master Theses of the College of Petroleum and Petrochemicals were reviewed and are listed as Appendix II.

The Government provided funds from construction of a 16-story building (with 7 stories for exclusive use by the College) and has added 6 million Baht for scientific analytic equipment and 4.5 million Baht for purchase of pilot plant equipment. The remaining stories of the building were designated for use by the University Research Institute for Metallurgy and Materials Science. The building is scheduled for completion by August 1992.

The key feature of the College is to establish it with cooperation from American universities which are asked to provide the teaching faculty for the College for two years after which Thai faculty will begin teaching courses in English until a balance

of 50 % is reached between American and Thai faculty. This is a deviation from the Sasin model which continues to be staffed exclusively by American professors. A second deviation is required by the fact that it is absolutely necessary to have an on-going scientific research program associated with the MS/PhD program. They plan to have the American faculty assist in development of an internationally recognized research program through advice and cooperation research. The Thai faculty of the Petroleum/Petrochemical College would develop and maintain the research program from the initiation of the College.

Professors of the College were planning on having the American professors each recommend at least three projects for Master of Science research which would then be administered by the Thai faculty. In my discussions with the present faculty of the Petroleum/Petrochemical College, I pointed out that this procedure would never lead to development of a "world class" research program with acceptance anywhere outside of Thailand; instead, faculty members would have to develop their own research interest and program for which they would obtain advise and cooperative research projects from the American faculty. Students would then be taken in to work on specific parts of a much broader research program. Students should be encouraged to make presentations of their parts of the broader program at regional annual conferences and eventually the research will develop to the point where papers could be accepted by the most respected journals of science and engineering.

I was asked to prepare a draft of a joint participation agreement between Chulalongkorn, Oklahoma, Michigan and Case Western Reserve Universities. I have

added this as Appendix III because you may wish to use in some form as a separate document. This agreement includes all of the points contained in the Memorandum of Understanding for the Sasin Institute which was signed by Chulalongkorn, Northwestern and Pennsylvania Universities. In addition agreements concerning the development of research have been added, refer to Appendix III.

The agreement includes cosignature of the diplomas by all of the participating universities. Therefore, a copy of one of the diplomas issued by the Sasin Institute is included as Appendix IV.

Curricula

The faculty have developed proposed curricula with two distinct paths: **polymer engineering** and **petrochemical engineering**, Table 1. Entering students would spend one month on three entry courses: English language usage, computer laboratory and petroleum chemistry, but other than these three entry course there would be no commonality between the two engineering degrees; in addition a set of unrelated electives were designated.

I suggested two alternative curricula that contain: (a) common courses and (b) paired common electives (Tables 2 and 3). In addition, it is suggested that the analytic and pilot plant equipment be placed under an administration designed to provide technical services for the industries, assistance to faculty and students, and to oversee the maintenance of all scientific/engineering equipment, Table 4.

Also it is suggested that the lectures presented by the American faculty should be video taped and made available to the students through monitors maintained in

Table 1. Curricula proposed for the College of Petroleum and Petrochemicals by faculty of Chulalongkorn University.

POLYMER ENGINEERING

I. PRELIMINARY ENTRY COURSES

Technical English

Computer Laboratory

Petroleum Chemistry

II. CURRICULUM FOR POLYMER ENGINEERING

Polymer Science

Polymer Synthesis

Polymer Processing

Polymer Characterization

Physical Chemistry of Polymers

III. ELECTIVES (choice of any three)

Polymer Physics

Rheological Properties of Polymers

Applied Polymer Science

Composite Materials

Biomaterials

Environmental Control

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Table 1 - continued

PETROCHEMICAL ENGINEERING

I. PRELIMINARY ENTRY COURSES

Technical English

Computer Laboratory

Petroleum Chemistry

II. CURRICULUM FOR PETROCHEMICAL ENGINEERING

Transport Phenomena

Chemical Reactions

Thermodynamics

Chemical Engineering Calculations

Production/Processing

III. ELECTIVES (choice of any three)

Process Simulation

Equilibrium State Operations

Catalytic Systems

Corrosion Engineering

Natural Gas Processing

Polymer Science

Engineering Management

Waste Management and Technology

Table 2. First modification of the curricula. Each modification is explained in the text.

POLYMER ENGINEERING

I. PRELIMINARY ENTRY COURSES

Technical English with Introduction to Pilot Plant

Computer Laboratory

II. CURRICULUM FOR POLYMER ENGINEERING

Courses Common to Polymer and Petrochemical Engineering

Petroleum and Petroleum Products Characterization

Petroleum Reactions (synthesis/kinetics of polymers and petrochemicals)

Courses exclusive to Polymer Engineering

Polymer Synthesis

Polymer Characterization

Polymer Processing

Physical Chemistry of Polymers

III. ELECTIVES (choise of any two related courses)

Engineering Management

Waste Management/Technology

Polymer Physics

Rheological Properties of Polymers

Applied Polymer Science

Composite Materials

Biomaterials

Pilot Plant Fermentations of Biopolymers

Table 2 - continued.

PETROCHEMICAL ENGINEERING

I. PRELIMINARY ENTRY COURSES

Technical English with Introduction to Pilot Plant

Computer Laboratory

II. CURRICULUM FOR PETROCHEMICAL ENGINEERING

Courses Common to Polymer and Petrochemical Engineering

Petroleum and Petroleum Products Characterization

Petroleum Reactions

Courses exclusive to Petrochemical Engineering

Transport Phenomena

Chemical Engineering Calculations/Simulation

Thermodynamics

Chemical Catalysis

III. ELECTIVES (choice of any two related courses)

Equilibrium Stage Operations

Process Simulation

Catalytic Systems

Pilot Plant Operation

Engineering Management

Waste Management/Technology

Natural Gas Processing

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Table 3. Second modification of the curricula. Each modification is explained in the text.

POLYMER ENGINEERING

I. PRELIMINARY ENTRY COURSES

Technical English with Introduction to Pilot Plant

Computer Laboratory

II. CURRICULUM FOR POLYMER ENGINEERING

Courses Common to Polymer and Petrochemical Engineering

Petroleum and Petroleum Products Characterization

Petroleum Reactions (synthesis/kinetics of polymers and petrochemicals)

Waste Management/Technology

Courses exclusive to Polymer Engineering

Polymer Synthesis

Polymer Characterization

Polymer Processing

III. ELECTIVES (choise of any two related courses)

Engineering Management

Engineering Economics

Polymer Physics

Rheological Properties of Polymers

Applied Polymer Science

Composite Materials

Biomaterials

Pilot Plant Fermentations of Biopolymers

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Table 3 - continued

PETROCHEMICAL ENGINEERING

I. PRELIMINARY ENTRY COURSES

Technical English with Introduction to Pilot Plant

Computer Laboratory

II. CURRICULUM FOR PETROCHEMICAL ENGINEERING

Courses Common to Polymer and Petrochemical Engineering

Petroleum and Petroleum Products Characterization

Petroleum Reactions

Waste Management/Technology

Courses exclusive to Petrochemical Engineering

Transport Phenomena

Chemical Engineering Calculations/Simulation

Thermodynamics

III. ELECTIVES (choice of any two related courses)

Equilibrium Stage Operations

Process Simulation

Catalytic Systems

Pilot Plant Operations

Engineering Management

Engineering Economics

Natural Gas Processing

Polymer Science

Table 4. Possible organization of an Industrial Service Administration.

ADMINISTRATION (organized under the Dean of the College)

Administrator/Secretaries

Chemists (as required by demand)

Pilot Plant Operating Technicians

Instrument Repair and Technical Assistance

Chemicals/Parts Stock

FUNCTIONS OF THE INDUSTRIAL SERVICE ADMINISTRATION

- o Technical assistance to faculty and students
- o Assistance with faculty/industry contracts (administration, accounting, purchasing, etc)
- o Assistance to students for instrument operation and design of special project equipment
- o Responsibility for analytic and pilot plant equipment with priority to faculty and student work
- o Arrangements for industry/faculty consultation
- o Analysis of industrial samples
- o Preparation and maintenance of industrial chemical and material standards (as required by demand from the industries)
- o Conduct of industrial pilot-scale testing and research
- o Advertising and public relations

the library.

English language instruction is very important and cannot be over-stressed; it is required because:

- a. Classes will be taught by American professors as courses compressed from one semester (4.5 months) to one month,
- b. Text books and laboratory manuals will be in English,
- c. In industry, English is now the language of business and technology.

Reports are in English, all manuals are in English, training and briefing seminars are in English, and operating instructions are given in English.

An audio/tape system in the library could also be used to provide for continual English study.

Explanation of Suggested Curricula Changes

Waste Management/Technology: This new course is introduced because waste management and pollution control from industries has become an overbearing, world-wide, problem that is almost always treated as if there is no solution to the problem. All organic compounds, however, are susceptible to chemical/biological degradation to the point of being environmentally compatible. Ignorance of the technology and economics of waste treatment leads to environmentally incompatible discharges by industries and municipalities.

Common Courses: Because polymer and petrochemical engineering are closely related (both are based on petroleum feed-stocks) it is feasible to select initial courses which are common to both engineering disciplines. Having common courses

introduces several important advantages over the use of entirely different curricula for each of the engineering disciplines, namely:

- a. The number of American faculty that will be required to teach the courses will be diminished from 16 to as low as 10 or 12. This reduction in required teaching staff is important for this program because the number of professors making up the faculties of American university engineering departments is only around 10 to 20. Therefore, the absence of faculty members creates a strain within their respective universities for teaching, research and service. Consequently, the requirement for a small visiting faculty base for the College of Petroleum and Petrochemicals will ease the burden of furnishing sufficient faculty to staff the program.
- b. Placing all of the students in a few common course at the beginning of their postgraduate study will create a network of bonding between them which will be perpetuated later in industry where such bonding facilitates business and technical transactions.
- c. Larger initial classes will facilitate assimilation and use of English for study and social activities.

Grouping Electives: If elective subjects are grouped so that the two or three courses available to the student must be taken in closely related topics, the student will gain some degree of specialization in the general topical area. For example, a student who is particularly interested in industrial engineering management would be guided into taking courses which are specific to management functions such as:

engineering management, engineering economics, waste management, etc. The same holds true for other topical areas such as the physical chemistry of plastics, polymer physics and rheological properties of polymers.

Use of a Pilot Plant: A pilot plant furnishes the intermediate stage between small scale (milliliters/grams) synthesis and blending of chemical and industrial scale operations (liters/kilograms). In some cases it is not possible to design an industrial chemical process unless sufficient data has been gained from intermediate, pilot scale, experiments. The pilot scale reactors allow accurate assessment of energy and mass transfer rates, reactor design, optimization of process yields, mathematical simulation, and economic evaluation. One cannot design a plant without these data.

The pilot plant is an integral part of applied and basic industrial research. The applied aspect is frequently stressed because pilot plants are principally employed to determine scale-up design data for plant construction; pilot plants, however, furnish tools for every basic chemical engineering research subject such as dispersion, chemical reaction kinetics, reaction energy requirements, catalytic functions and activities, mixing parameters, etc.

Whether the pilot plant is used for applied or basic research depends on the nature of the problem and the ingenuity of the researcher. A pilot plant furnishes a unique capability which is absent in most universities because of the manner in which engineering equipment is generally acquired (as required by individual professors for specific research projects) and the mistaken opinion that a pilot plant can only be used for applied (trial/error) type research.

Innovative use of a pilot plant will extend it beyond the scope of inhouse use to industrial service for new development, proposed changes of operating conditions and to evaluate waste technology. It also can be used for technology training for industrial business managers and for training of industrial technicians. Thus a pilot plant in a university setting has a broad field of applications.

The pilot plant also may be used in conjunction with technical English language instruction for students entering the program as an introductory course.

Research: Have the Thai professors develop specific areas of research interest for specialization and then review all literature to develop a research program. Have American faculty review and give advice to the Thai professors, and especially try to develop some kind of cooperative research effort.

The students should conduct parts of the on-going Thai professor's research with advice and review by the American faculty and whenever the opportunity occurs, have the students make presentations of their parts of the research at local and regional conferences. Funds should be available for Thai professors to make presentations of their work at international conferences.

IV. APPEAL OF THE COLLEGE TO AMERICAN FACULTY

There are several reasons that make this an appealing venture for American University faculty:

1. Excellent financial reward and an opportunity to visit an interesting area of the world.
2. Participation will gain recognition for the University in a venture of high profile in a rapidly developing area of the world.
3. Participation will afford the opportunity to direct fully paid PhD students to the American Universities.
4. It will afford the opportunity for foreign student exchange.
5. Participation in the program may be used as a platform from which to launch other forms of training in the region; for example, short courses, conferences, continuing education, etc.
6. Participation will provide access to pilot plant research facilities that are not available in most American Universities.
7. Opportunity for long-term affiliation with industry in Thailand which is growing at a very rapid pace.

V. RECOMMENDATIONS

1. That Dr. Ray Daniels, Chemical Engineering, University of Oklahoma, be appointed coordinator to assure that the College is fully staffed with appropriate American faculty.
2. The College should employ a consultant for purchase of state-of-the-art scientific and pilot plant equipment. The pilot plant equipment must be developed around a specific flow-through size, otherwise there will be gross miss-match in the size of different pieces of equipment.
3. Three of the best professors would be sent to the three American Universities for 6 months training on research initiation and teaching. These three must make a good impression at the American Universities because they will be the first representatives of Chulalongkorn University and therefore must be the best possible.
4. Use the analytic and pilot plant equipment to establish an Industrial Service Administration under the Dean of the College of Petroleum and Petrochemicals. They would address industries' needs for testing, standards and research.
5. Couple entry-level English language to an introduction to the pilot plant in order to develop better technical English.
6. Adopt at least 2 common, beginning, courses and use electives as groups of similar courses to afford some degree of specialization for the students.
7. Introduce a course on Waste Management/Technology which is common to

both engineering disciplines.

8. Establish a PR office to promote the College for scholarships and to advertise the Industrial Service Administration.
9. Lectures presented by American faculty should be video taped and made available to the students in the library.
10. The College Thai professors should be encouraged to develop an areas of research of personal interest that the American professors can assist in as advisors and with cooperative research.
11. Funds should be available for the Thai professors to make presentations of their research work at international conferences.

APPENDIX I**LIST OF PERSONS INTERVIEWED**Chulalongkorn University

- Dr. Charas Suwanwela, President, Chulalongkorn University
- Dr. Kamchad Mongkolkul, Director, Petroleum and Petrochemical College
- Dr. Kroekchai Sukanjanajtee, Deputy Director, Associate Professor, Petroleum and Petrochemical College
- Dr. Marjan Botman, Professor, Petroleum and Petrochemical College
- Dr. Nauanphun Chantarasiri, Petroleum and Petrochemical College
- Dr. Suwabun Chirachanchai, Petroleum and Petrochemical College
- Dr. Sujitra Dhumrongvaraporn, Professor, Petroleum and Petrochemical College
- Dr. Eharoen Hongsrithong, Adjunct Professor, Petroleum and Petrochemical College
- Mr. Pomthong Malkum, Professor, Petroleum and Petrochemical College
- Dr. Pattarapan Prasassarakkich, Professor, Petroleum and Petrochemical College
- Dr. Chintana Saiwan, Professor, Petroleum and Petrochemical College
- Dr. Prasom Sthapitanonda, Adjunct Professor, Petroleum and Petrochemical College
- Dr. Noppadon Cheamsawat, Assistant Professor, Chairman, Department of Chemical Engineering
- Dr. Sirijutaratana Civavisaruch, Professor, Department of Chemical Engineering
- Dr. Lek Uttamasil, Director, Metallurgy and Materials Science Research Institute
- Dr. Wilrom Vajragupta, Deputy Director, Metallurgy and Materials Science Research Institute
- Dr. Quanchai Leepowpanth, Professor, Department of Mining Engineering
- Dr. Sarithdej Pathanasethpong, Professor, Department of Mining Engineering

APPENDIX I -continued

- Dr. Yothin Tongpenyai, Professor, Department of Mining Engineering
- Dr. Spongse Nimkulrat, Assistant Professor, Department of Civil Engineering
- Dr. Thavorn Vajrabhaya, Dean of the Graduate School
- Dr. Somsak Damronglerd, Director, Department of Chemical Engineering
- Dr. Phichai Tovivich, Professor, Department of Chemistry
- Dr. Charuay Boonyubol, Professor, Department of Electrical Engineering
- Dr. Tatchai Sumitra, Dean, Faculty of Engineering
- Dr. Jirdsak Tscheikuna, Professor, Faculty of Engineering
- Dr. Sunibhond Pummangura, Director, Science and Technology Research Equipment Center
- Dr. Wiwat Mungkandi, Vice President for International Affairs
- Dr. Salag Dhabanandana, Vice President for Research Affairs
- Dr. Toemsakdi Krishnamra, Director, Sasin Graduate Institute of Business Administration
- Dr. Prasit Prapinmogkolkarn, Director, UNISEARCH
- Dr. Sucharit Koontanakulvong, Deputy Director, UNISEARCH
- Government Officials
- Dr. Chantavit Sujatanond, Director, Foreign Relations Division, Ministry of University Affairs
- Dr. Sippanondha Ketudat, Ministry of Industry
- Mr. Sivavong Changkasiri, Permanent Secretary, Ministry of Industry
- Dr. Phaichitr Uathavikul, Minister, Office of the Prime Minister
- Dr. Wichit Srisa-an, Permanent Secretary, Ministry of University Affairs

APPENDIX I - continued

Dr. Phisit Pakkasem, Secretary General, Office of National Economic and Social Development Board

Universities

Dr. Alistair North, President, Asian Institute of Technology

Dr. Nicanor C. Austriaco, Director, Continuing Education, Asian Institute of Technology

Dr. Ricardo P. Pama, Professor, Structural Engineering, Asian Institute of Technology

Dr. Fredric W. Swierczek, Associate Professor of Management, Asian Institute of Technology

Dr. Chaiyost Tangsathitkulchai, Associate Professor, Chemical Engineering, King Mongkut Institute of Technology in Thonburi

United Nations

Mr. Fabrizio Ossella, Deputy Regional Representative, United Nations Development Programme

Mr. Alan Doss, Regional Representative, United Nations Development Programme

Industries

Mr. Graydon H. Laughbaum, Jr, President, UNOCAL

Mr. Charles R. Williamson, Vice President of Exploration, UNOCAL

Dr. Woraphat Arthayukti, Director of General Affairs, UNOCAL

Mr. Joseph O. Roy, Refinery Manager, ESSO

Mr. Sobhon Homcheon, Administration Division Manager, ESSO

Mr. Kangsadal Boeprasert, Technical Manager, ESSO

Mr. Smit Tiemprasert, Logistics Director, ESSO

APPENDIX I - continued

- Mr. Charuek Hengrasmee, Human Resources Manager, ESSO
- Mr. Jerry L. Loupee, Managing Director, HMC Polymers Company
- Mr. Surak Sujaritputangoon, Quality Control Supervisor, HMC Polymers Company
- Mr. Somporn Lieardkanchana, Technical Superintendent, HMC Polymers Company
- Mr. M.R. Sarisdiguna Kitiyakara, Chairman, Shell Companies in Thailand
- Mr. B. Lotgering, Refinery Coordinator, Shell Co. of Thailand
- Mr. Kamolchai Pattarodom, President, National Petrochemical Corp.
- Dr. Pramote Chaiyavech, Director, Technical Department, National Petroleum Corp.
- Mr. Wirojana Tantraporn, Director, Premier Global Corp.
- Mr. Somnuk Suriyakul, Plant Manager, Eternal Plastics Co.
- Mr. Chalot Sripicharn, Director, World Environment Center
- Mr. Thomas A. Seale, Executive Director, American Chamber of Commerce

APPENDIX II

REVIEW OF THESES

Several theses of the College of Petroleum and Petrochemicals were reviewed and are listed below. The theses were within the standards (or a little above) of those produced at the University of Oklahoma as far as: (1) use of English and composition, (2) organization, (3) literature review, (4) laboratory work and (5) theoretical and philosophical discussion of experimental results. The work, however, was not advanced enough for publication in top professional journals; a definite advance of scientific knowledge was not there. Most MS theses, however, that I have reviewed and many PhD dissertations are on the same level. So they are definitely at the top of the quality I would expect for MS theses.

The following theses were reviewed:

- Asawaworarith, Porntip, 1990. "Synthesis of Styrenic Imbiber Beads by Suspension Polymerization". MS Thesis, Polymer Science, Chulalongkorn University (Professor Suda Kiatkomjornwong)
- Chailitlero, Chukiat, 1990. "Determination of Dispersion Coefficients for Gas flowing through a Molecular Sieve Carbon Packed Bed". MS Thesis, Petrochemical Technology (Professor Woraphat Arthayukti).
- Janwattanakul, Voravit, 1991. "Degradation of Pototsensitized Polyethylene Film" MS Thesis, Petrochemical Technology, Chulalongkorn University (Professor Pattarapan Prasassarakich).
- Kotchan, Arunya, 1990. "Modification of Hard-sphere Equation of State for Thermodynamic Properties of Light Hydrocarbons". MS Thesis. Petrochemical Technology, Chulalongkorn University (Professor Pattarapan Prasassarakich).
- Sirisongthum, Narumol, 1991. "Graft Copolymerization of 2-Ethoxyethyl Methacrylate onto Liquid Natural Rubber using Metal Ion Redox Systems". MS Thesis, Polymer Science, Chulalongkorn University (Professor Supawan Tantayonon).

APPENDIX III**JOINT ENDEAVOR WITH AMERICAN UNIVERSITIES**

The concept is for participation of several prestigious American Universities in a joint endeavor to offer graduate studies in English leading to Master of Science degrees in polymers and petrochemistry at Chulalongkorn University in Bangkok, Thailand. The proposed participating universities are: the University of Oklahoma, the University of Michigan and Case Western Reserve University. Participation of the American Universities in this program with Chulalongkorn University is required to develop the academic and research program to internationally accepted standards of excellence. The key feature of the College concept is that the American Universities will provide members of their faculties to engage in teaching and research in close association with their Chulalongkorn University counterparts. Instruction in English will give the students access to world sources of information on polymer and petrochemical studies rather than being limited to the narrow sources of information usually drawn upon by Thai University students.

The first two years of the program will be devoted to development of Master of Science degree programs in Polymers and Petrochemistry beginning in June 1993 at the Petroleum and Petrochemical College of Chulalongkorn University. The program will be expanded to the Doctors of Philosophy in about two years (1995) as the academic and research program gains maturity.

The curriculum for the Master of Science will consist of 24 credit hours of class instruction and 12 credit hours of research. The research will be guided by a

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Chulalongkorn faculty member, but the visiting American faculty members will provide direct assistance to the research by review and advice, and will develop a long-term cooperative research program with the Chulalongkorn University faculty member in his/her principal area of interest.

The academic program for polymers will be structured principally from the current curriculum of the Department of Macromolecular Science of Case Western Reserve University at Cleveland, Ohio. The academic program in petrochemistry will consist basically of selected courses in chemical engineering that are being regularly taught at the American universities. Emphasis will be placed on petroleum and petroleum products as the source of primary chemical reactants.

The faculty of the American Universities will teach the courses at Chulalongkorn University and consequently they will be solely responsible for the teaching, maintenance of academic standards and grading of the courses. A Chulalongkorn University faculty member will be assigned to work with, and assist, American faculty during the four week period of teaching for each course. Courses taught by the American faculty will be compressed to be completed in four weeks, but students attending the class will devote all of their time to the single course beginning taught.

Development of an internationally recognized research program is a vital part of the College for recognition and for introduction of a doctor or philosophy program. Therefore, as mentioned above, each American faculty teaching at Chulalongkorn

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University will be requested to work with a Chulalongkorn faculty member and develop at least three thesis projects for student research, render substantive advice and develop cooperative research efforts for long-term programs. As the research program develops, several faculty members will have provided advice and information to the student thesis research; therefore, the examiners of the theses will always include a faculty member from one of the American Universities.

The degree granting university will be Chulalongkorn University; however, acknowledgement of major participation by the American universities will be made by the cosignature of the diploma by representative of the participating American Universities. Any university that wishes to leave the program is required to give two years of advance notice to allow time for adjustment and replacement.

At the end of the second academic year, qualified, fully acceptable (by the participating American university faculty) faculty of Chulalongkorn University will begin to fully enter the academic program by teaching classes using English language instruction. It is visualized that fifty percent participation of Chulalongkorn University faculty would be most beneficial for the program. To better accommodate the time schedule of American faculty, the academic year will begin in June and end in March the following year.

Chulalongkorn University will supply modern physical infrastructure including state-of-the-art laboratory and analytic equipment for teaching and research. A Chulalongkorn faculty member will be assigned to assist the American faculty in all

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aspects of the academic program. Chulalongkorn University will look after the general welfare of the American faculty and provide appropriate accommodations. The travel expenses and an appropriate honorarium will be provided to the visiting American faculty.



CHULALONGKORN UNIVERSITY

By Approval of The University Council
Has Conferred Upon

PIMTA TECHAKUMPUCH

Who Has Successfully Fulfilled All Requirements Prescribed By Its
GRADUATE INSTITUTE OF BUSINESS ADMINISTRATION

The Degree Of
MASTER OF BUSINESS ADMINISTRATION

With All The Rights And Privileges Pertaining Thereto
Given In Bangkok, Thailand, 24 March 1987

B. Rama

Chairman of Council

Kasem Suwanagul

Rector of the University

A. Krishnaaurey

Director, Graduate Institute of
Business Administration

John L. Kellogg

Dean, J.L. Kellogg
Graduate School of Management
Northwestern University

Russell C. Pelt

Dean, The Wharton School
University of Pennsylvania

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