No. 1

BASIC DESIGN STUDY REPORT
ON
THE PROJECT
FOR
EXPANSION OF THE ENGINEERING INSTITUTE
FOR RESEARCH AND DEVELOPMENT
IN CHULALONGKORN UNIVERSITY
IN
THE KINGDOM OF THAILAND

AUGUST 1990

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to a request from the Government of the Kingdom of Thailand, the Government of Japan has decided to conduct a Basic Design Study on the Project for Expansion of the Engineering Institute for Research and Development in Chulalongkorn University and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Thailand a survey team headed by Dr. Shigeo Ozono, Professor, Department of Precision Machinery Engineering, Faculty of Engineering, the University of Tokyo, from April 16 to May 3, 1990.

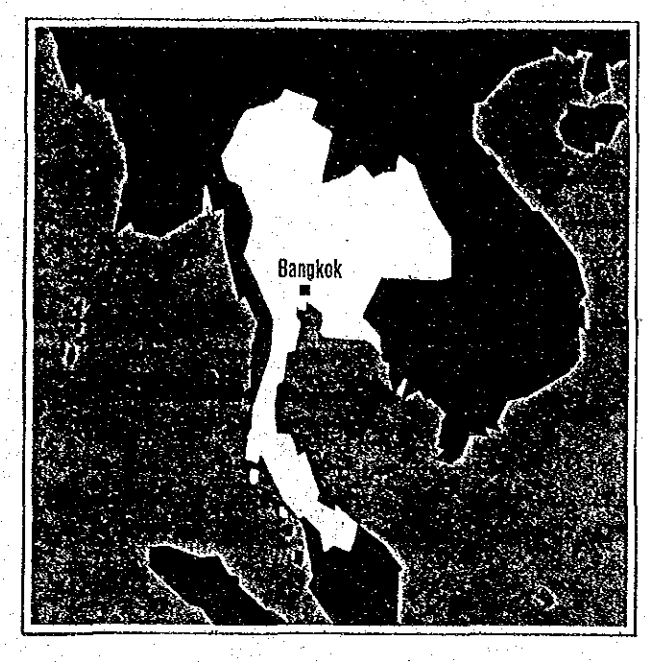
The team exchanged views with the officials concerned of the Government of Thailand and conducted a field survey in Bangkok area. After the team returned to Japan, further studies were made. Then, a mission was sent to Thailand in order to discuss the draft report and the present report was prepared.

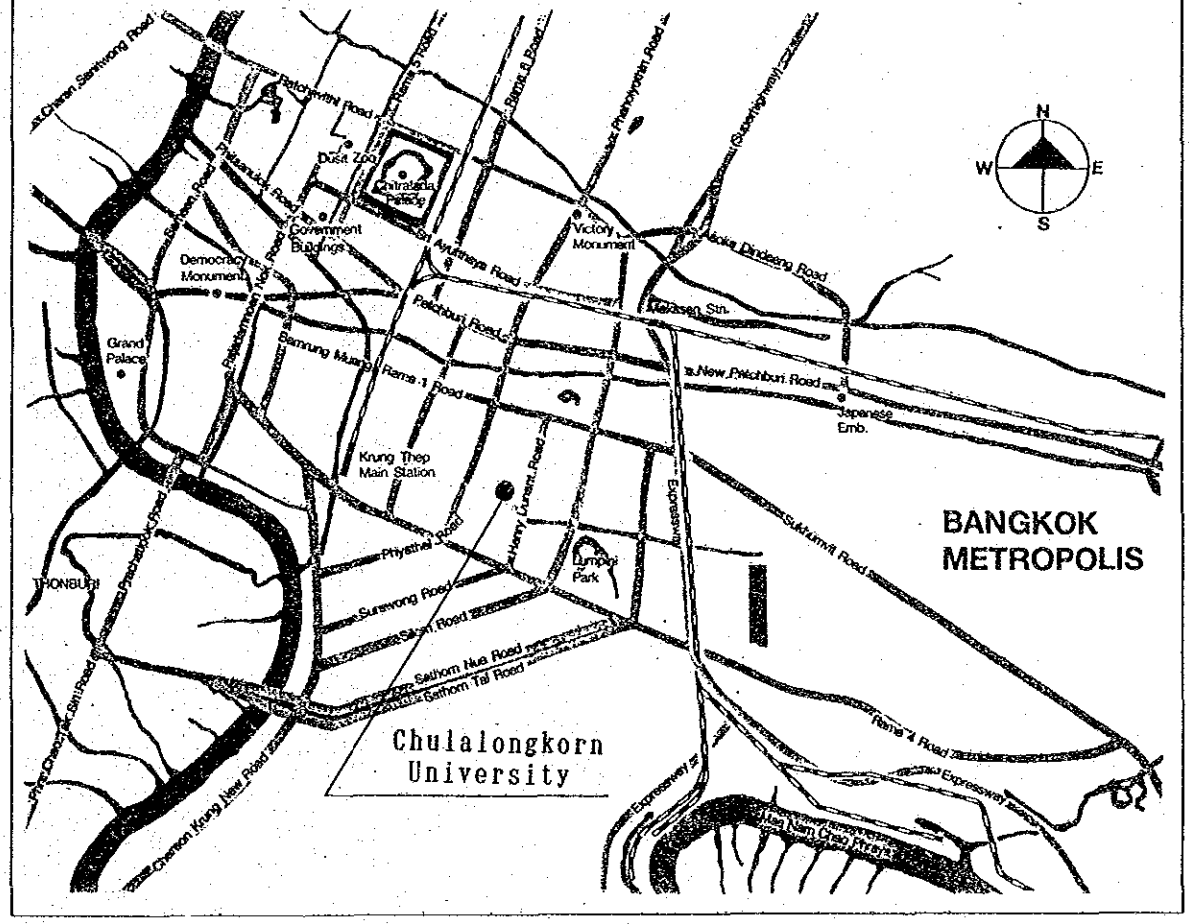
I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Kingdom of Thailand for their close cooperation extended to the teams.

August, 1990

Kensuke Yanagiya
President
Japan International Cooperation Agency





LOCATION MAP

SUMMARY

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The Kingdom of Thailand (hereafter referred to as Thailand) has realized a remarkable economic development in recent years. The share of the industrial sector in its overall economy has shown a steady growth. There has been a rapid increase of direct investment by manufacturing industries from Japan and NIEs to Thailand, and the foundations for industrial development been firmly laid as industrialization progresses.

Traditionally an agricultural nation, Thailand has been highly dependent on imports not only for capital goods but also for raw materials, intermediate goods and energy. The weakness of its finished products in terms of international competitiveness in respect to quality and cost has meant that imports have been excessively large and this has created unfavorable trade imbalances. The central role of the export industries in the industrial sector was given emphasis in the Sixth Five Year National Economic and Social Development Plan. In order to promote the nurture of the mechanical, electrical/electronic, and metalworking industries forming the keystone to industrial technology and its development, a major task is the training of human resources to support the development of an industrial nation.

The present situation of higher technical education in Thailand in the face of the above social and industrial development and the progress of industrialization is insufficient. Not only are the higher educational institutions unable to meet the present demands of industrial sector for science and engineering graduates but their capability for developing engineers possessing the necessary expertise to carry out independent research is not sufficient. Experimental and training equipment is especially lacking in such fields as computers, electronics, materials and production engineering. Therefore, at present there is a tendency to give too much emphasis to an academic bias in the educational programs and application capabilities of the students need to be given more weight. The Faculty of Engineering of Chulalongkorn University possesses the highest level of education and research capacity in Thailand and has achieved a positive record in its supply of human resources qualified to direct the industry of the nation. However, its equipment requires urgent upgrading if it is to meet fully the above demands of the nation and industry.

Against the above background, the expansion project was drawn up to reinforce functions in the areas of precision engineering of the Engineering Institute for Research and Development (EIRD) of the Faculty of Engineering (hereafter

referred to as the EIRD Expansion Project). This project aims to upgrade the quality of engineering, research and education and to develop human resources capable of upgrading production technology. This upgrading in turn will ensure the general improvement of industrial technology and industrial diversification, and raise the level of production technology in line with the government policies, especially for reinforcing the competing power of exported industrial products. A request was made for support of the EIRD Expansion Project in the form of a grant aid from the Japanese government for the provision of equipment required by the above Expansion Project (hereafter reffered to as the Project).

In response to the above request, the government of Japan decided to conduct a basic design study on the Project, and Japan International Cooperation Agency (JICA) dispatched a study team to Thailand from April 16 to May 3, 1990 to conduct a survey on the basic design of the Project. The team confirmed the background and details of the request and investigated the executing organization for the Project. In addition to discussions with members of Chulalongkorn University and others concerned, it carried out a survey on industry and other related matters in Bangkok.

The following is the summary of the survey results:

(1) EIRD integrates and coordinates the research activities of the Faculty of Engineering of Chulalongkorn University. The research staff of the Faculty of Engineering form the EIRD, and actual research activities are carried out by teaching staff and the students of each department. The objectives of these research activities are : (a) to develop and spread technology necessary to the industrial sector, (b) to further and promote technology necessary to national development, (c) to train engineers who support industrial sector, placing emphasis on applied research for upgrading the quality of industrial technology.

(2) Together with policies for promoting industrialization and increasing local content, the industrial sector of Thailand have now reached a stage where they can proceed to improve their technologies through their own efforts on the basis of technology introduced from abroad. At present, however, only a limited number of engineers are equipped with the designing capacities for parts, materials and systems needed for self-supported development. The development capacity of industries is weak. The industrial sector therefore requires the guidance and support of the universities (a) to reinforce the training of engineers quantitatively and qualitatively, and (b) to strengthen its capacity to develop production

technology.

(3) The EIRD Expansion Project aims to reinforce the research and development capacities of the electrical, metallurgical and mechanical engineering departments of the Faculty of Engineering of Chulalongkorn University. Almost all the existing equipment used in these departments is out of date. New and up to date equipment is required for the education of engineers capable of developping production technology demanded in the fields of electrical/electronics, machinery and metalworking industries.

In the light of the above situation, the plan of the Project has been drawn for the engineering equipment needed to realize objectives of the EIRD Expansion Project. The outline of the Project is as follows:

(1) Executing Agency: Faculty of Engineering of Chulalongkorn University

(2) Activities of the Project :

1) Research and development of application technology in the fields of CAD technology, materials engineering and system automation
2) Education of undergraduates and postgraduates
3) Education and training of engineers engaged in industries

(3) Selected equipment:

The requested equipment is generally considered necessary for training of engineers through research and development activities. But its priority has been evaluated from the viewpoint of Japanese government as a grant aid project. Priority has been given to equipment which is highly necessary as a basis for research in the fields concerned and is closely related to the production technology facilities already introduced in industry. Equipment requiring a high level of operational competence and maintenance was chosen if Thai party has an appropriate training program for operation and maintenance.

(4) The equipment will be installed on the 1st and 2nd floors of Building 3 and in the present EIRD building of the Faculty of Engineering. (The existing equipment placed on the 1st floor of Building 3 will be moved up to the 2nd floor, and the classrooms on the 2nd floor will be relocated on the expanded part of the 4th floor.) The 4th floor is being expanded pausing no problem for placing the equipment.

The equipment to be provided by the Project is as follows:

Equipmemt	Quantity
1. Equipment for CAD/CAM	
Engineering Workstation (EWS) System	1 set
1) CAD for electronics circuit design	EWS 5 sets
2) CAD for metal mold design	EWS 2 sets
3) CAD for system automation	EWS 3 sets
2. Equipment for Materials Engineering	
Equipment for Metallurgical Engineering	
1) Surface analyser - ESCA	1
- AUGER	1
2) Universal tensile tester	1
3) Precision surface and profile grinder	1
4) CNC EDM (engraving)	1
Equipment for Electronics Materials	
1) Molecular beam epitaxy (MBE)	1
3. Equipment for System Automation	
1) Cylindrical coordinate type robot	1
2) Scare type robot	1
3) CNC lathe machine	1
4) CNC machining center system with NC programming tool	1 set
5) CNC milling machine	1
6) Tool grinding machine	1

Works for the Project are to be divided as follows between the parties of Thailand and Japan. Scope of works to be done under the Japanese grant aid include the supply of equipment, the delivery of them to the sites, their installation, wiring in rooms and adjustments and testing of equipment after installation as well as consultant services relating to the detailed design and supervision of the Project. The Thai party is to be responsible for extensions and remodelling of the building, electrical works, water supply and waste water treatment facilities, air conditioning facilities, and fixtures inside laboratories.

The costs for the work undertaken by the Thai party will total approximately 7.05 million Bahts (approximately 42 million yen).

Two months will be needed for the detailed design, and ten months for the procurement of equipment.

The maintenance costs involved in the Project as direct expenses on equipment, will be approximately 4.42 million Bahts (approximately 26 million yen) annually, which must be secured in the annual budget of the Faculty as running costs.

The following benefits are expected to result from implementation of the Project :

(1) Reinforcement of the education of the engineers demanded by industry.
(2) Reinforcement of the role of the University in pioneering for research and development of industry.
(3) Activation, stimulation and qualitative upgrading of technical education.
(4) Expansion of the technical services offered to industry.

The activities, executing and maintenance systems of the Project are evaluated as follows:

(1) The Project encompasses research, educational and training activities in the fields of precision engineering technology. The Project is considered to be in accordance with the expressed intention of the Thai government to upgrade production technology for industrial development.

(2) With regard to the executing system of the Project, the committee of the Project and steering committee are to be formed by the Faculty members carrying out the Project under the leadership of the Dean of the Faculty of Engineering, which are judged adequate to the Project objective.

(3) With regard to maintenance system, the competence of the teaching staff and technicians who operate the equipment to be provided is satifactory, and an expansion and training of personnel is being planned. By choosing equipment whose manufacturers are conducting maintenance services in Thailand, adequate maintenance will be assured. However the maintenance funds must be secured by the Faculty of Engineering of Chulalongkorn University.

The Project is expected to result in considerable and varied benefit, as is shown in the overall examination outlined above. The Project will develop and train personnel resources, and in consequence well support further development of the industrial sector of Thailand. It is therefore considered justifiable and appropriate to implement a grant aid to the Project. Moreover, the systems already established in Thailand for the management and supervision of the Project are considered to be quite sufficient and no problems are expected to arise in this connection. It is necessary, nevertheless, that building works proceed without any delay and that operation and maintenance budgeting for provided equipment be secured.

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APPENDICES

CHAPTER 1 INTRODUCTION

CHAPTER 1 INTRODUCTION

The Thai government has drawn up the project for expansion of the Engineering Institute for Research and Development, the Faculty of Engineering of Chulalongkorn University established in 1978. The EIRD Expansion Project aims to reinforce the functions of EIRD in the precision engineering fields, and to train the engineers in these fields. This Expansion Project will help Thailand meet the challenge of the increasingly advanced and diversified industrial technology of recent years, upgrade its own standards of industrial technology, and strengthen the competitive strength of its manufacturing exports. The Thai government has therefore made a request to the Japanese government for grant aid for the necessary equipment to the EIRD Expansion Project.

In response to the above request, the government of Japan decided to conduct basic design study on the Project, and Japanese International Cooperation Agency (JICA) dispatched basic design study team under the leadership of Dr. Shigeo Ozono of the Department of Precision Machinery Engineering, Faculty of Engineering, The University of Tokyo to Thailand from April 16 to May 3, 1990. Their official title was "Basic Design Study Team on the Project for Expansion of the Engineering Institute for Research and Development in Chulalongkorn University". The members of the study team and schedule of the same are shown in Appendix-2 and 3 respectively.

An exchange of the Minutes of Discussions noted as Appendix-1 took place on April 25,1990 between Dr. Shigeo Ozono, team leader of the Basic Design Study Team and Dr. Tavee Lertpanyavit, Dean of the Faculty of Engineering, Chulalongkorn University. The contents of field survey are to investigate 1) objective of the Project, 2) management system for the Project, 3) details for the request and their confirmation, and to visit to relating organizations and factories. Upon return to Japan after the field survey repeated discussions were held with relevant parties in order to determine the justification of the Project, its appropriate scale, systems for operation and administration, and to elaborate the various aspects involved in an effective assistance. After thorough examination to choose equipment, the draft final report for basic design study were drawn up.

The draft final report explanation team headed by Dr. Takateru Umeda of the Department of Metallurgy, Faculty of Engineering, the University of Tokyo were dispatched from July 8 to 15 to explain and discuss on the draft final report. Based on the result of discussion, the Basic Design Study Report has been

drawn up.

CHAPTER 2 BACKGROUND OF THE PROJECT

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2.1 Socio-Economic Situation and Development Plan

2.1.1 Outline of Socio-Economic Situation

Since the implementation of its First Five Year National Economic and Social Development Plan (1961-1965) to the present Sixth Five Year Plan (1986-1991) still in progress, Thailand has continued to follow the principles of a free market economy. Aiming for a conservative and balanced operation of the economy rather than rapid economic development, the government has continued to place importance on the provision of social infrastructures and furthered a policy of leaving industrial development to the private sector. The government has therefore tended to shy from large scale projects and has adopted a particularly prudent policy with regard to maintaining its financial balance and foreign loans. It has not adopted policies such as those of many developing countries for a rapid industrialization but rather has promoted a moderate industrialization focused on light industries in view of limits on its technical levels and capital.

In the light of the above background, the Thailand economy has achieved a spectacular development in recent years because of effective realization of private sector energies and government implementation of improvements in social infrastructure provision. The share of the industrial sector has steadily increased and by 1988 while agriculture only accounted for 17% on a GDP basis the manufacturing and construction industries represented a 30% share. Further, Thailand's potential as a production center has been reappraised and direct investment from Japan, Taiwan ,Hong Kong,etc. has shown a rapid increase. This will accelerate further the industrialization of Thailand in the future and this is expected to contribute greatly to economic development.

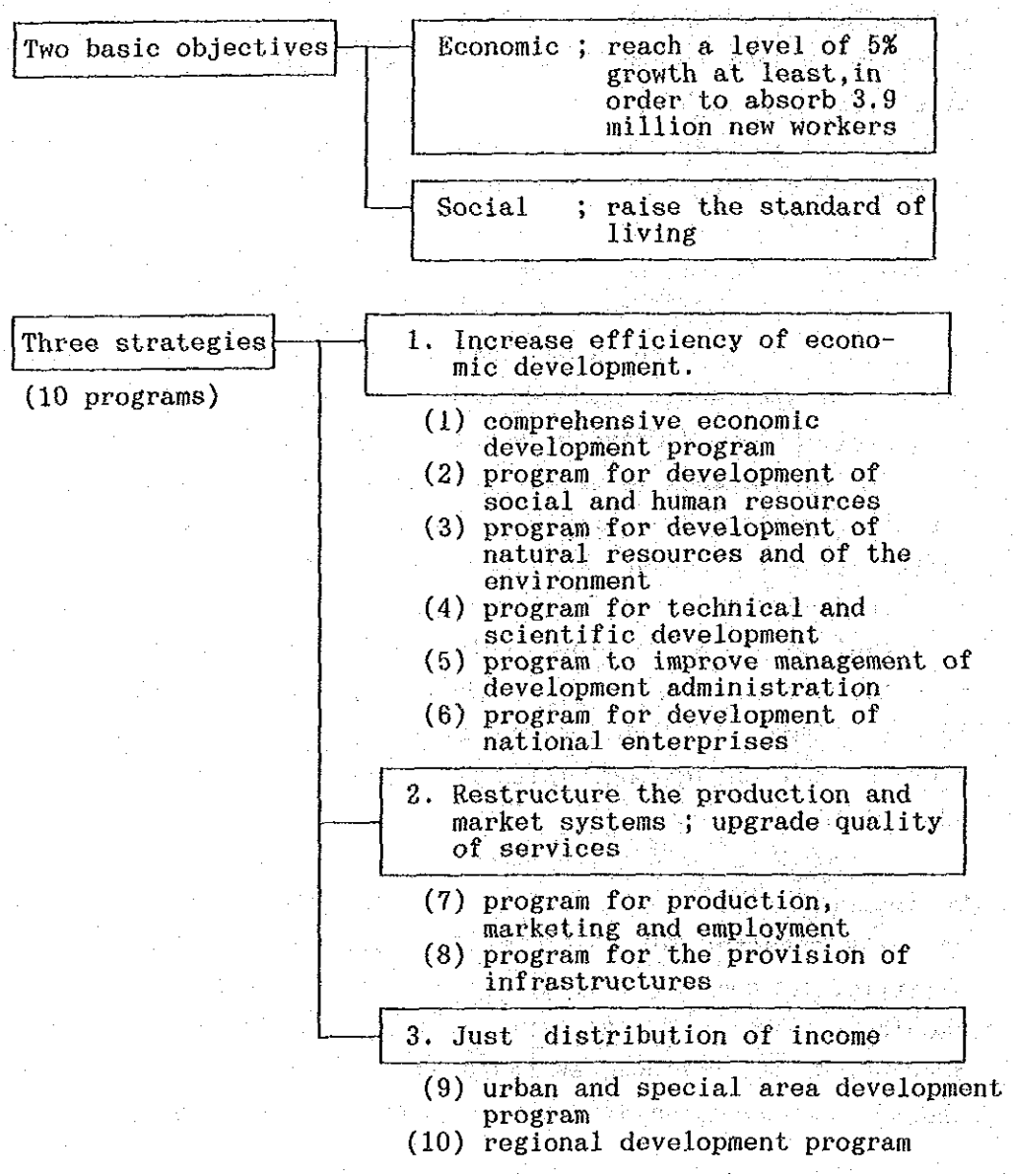
On the one hand, as the base of the economy has been agricultural in nature a constant international deficit has resulted from the instability of international market prices, the increasing trend to protectionism regarding agricultural products, fluctuations in international currencies,etc. Further, as there has been a continuing fiscal deficit caused by inadequate tax system provisions and the growth of budget

expenditure. These conditions have forced the Thai government to take action and the Sixth Five Year National Economic and Social Development Plan has placed major emphasis on the amelioration of these problems.

2.1.2 Sixth Five Year National Economic and Social Development Plan

National development in Thailand is being pursued in line with the present Sixth Five Year Plan (1986-1991). The following is an outline of the Plan;

(1) Basic objectives, strategies and development policies of the Sixth Five Year National Economic and Social Development Plan



(2) Major economic objectives of the Sixth Five Year Plan

annual economic growth rate	5.1%
growth rate of agricultural production	2.9%
growth rate of industrial production	6.6%
growth rate of mining production	6.4%
rate of inflation	2.3%
private sector investment	8.1% increase
population	1.3% increase

The programs among the 10 listed above which are closely related to the Project are (4) the program for the development of science and technology, (7) the program for production, marketing and employment. The outline of these is as shown below.

The Program for the Development of Science and Technology

This program is to establish the science and technology which is prerequisite to an upgrading of production and industrial capacities. It also aims at augmenting the international competing power of industry through the application of science and technology. In concrete terms, the following strategies are envisaged:

1) the development and training of human resources in the science and technology fields which match with demands of future economic structure
2) the effective employment of human resources with a technical formation, the upgrading of the quality of these resources and the rein forcement of training of human resources in areas of strong demand
3) support via appropriate measures to increase the results of national research and development activities especially in such areas which require further promotion such as mechanical engineering, materials engineering, electrical and electronics engineering, computer technology,etc.
4) effective technology transfer to serve economic development and technical progress

The Program for Production, Marketing and Employment

This plan for the restructuring of production and sales systems undertaken to enable a more flexible response to the changing world econom-

ic situation aims at the reduction of the unfavorable deficits in trade balance and the current account balance of payments, to expand employment, and reduce the gaps in income distribution.

One strategy put forward is a diversification of industrial production. This is particularly directed towards promotion of those industries which form the industrial foundations of future development and the technical basis of existing agricultural processing, light, regional and in fact of all industry. These key industries include machining industries, metal working industries and the electrical and electronic industries. Thailand has achieved the development of its assembly industries to date through its promotion of the final products of import substitution industries. In the Sixth Five Year Plan it will proceed with the increase in local content production of parts and promote development of the machinery, metalworking, electrical and electronic industries.

The Sixth Five Year Plan is expected to realize a historic shift in Thailand's economic and industrial structure aiming at development into a newly industrializing country. However, unlike South Korea or Taiwan, Thailand on the basis of a traditional agriculture aims to become a NAIC (new agro-industrial country). By 1991, the Plan's final year, it is aimed to have achieved a $ 1,200 GNP per capita and for manufacturing industries to have a share of GDP superior to 25%. The future image of Thailand is as a newly industrialized country with a balanced development of agriculture, industry and service industries.

As the economy proceeded more favorably than anticipated by the Thailand government an interim reevaluation of the Sixth Five Year Plan took place in 1989. The following revised proposals were published; (1) the economic growth rate was raised to 7.5% (1989-91), (2) inflation was to be held within 5%, (3) the ratio of external debt was to be kept within 4% of the GDP.

2.2 Situation of Industrial Sector and Higher Technical Education

2.2.1 Industrial Policies and Present Situation of Industrialization

Proposed and passed in 1961 the Investment Promotion Act was most significant for the industrialization of Thailand. Once this came into effect a remarkable development of the Thai economy was achieved

thanks to the inflow of overseas investment, the activation of private sector energies and the improvements effected in governmental provision of social infrastructures. Further, the recent trend of Thailand as potential productive base and direct investment from Japan, Taiwan and Hong Kong has rapidly increased. Although primarily an agricultural country initially, by 1988 as against the 17% share accounted for by agriculture the manufacturing and construction industries had already reached a 30% level share on the GDP basis. Thailand has a long tradition as an exporting nation of primarily agricultural goods, or of primary commodities like tin. It is only over the last twenty years that a fundamental industrialization has been attempted. Further, the main background forces giving momentum to Thailand's recent and remarkable industrialization include industrial investment by (1) foreign investment capital beginning with Japan with capital and technology and (2) overseas Chinese who has been traditionally controlled the Thai economy. The Thai industry is mainly assembly industries and has a problem to depend on technology and material to foreign countries.

The Thai government manifested its unchanged adherence to an active policy furthering industrialization in the Sixth Five Year Plan which incorporates measures for improvement of the problem outlined above. The various industries and enterprises show great energy and initiative in facing this challenging and difficult situation.

2.2.2 Outline of the Related Industries

Bearing in mind the present industrial background in Thailand the following is an outline of (1) the electrical and electronic industries (2) automobile industry and (3) metal mold industry which is related to the object of the present basic design study:

(1) Electrical and electronic industries

In the recent context of an increasingly strong Japanese yen and with the increased costs of production in the NIEs, added to the political stability of Thailand, its plentiful supply of cheap labor and incentive measures for foreign investment, there has been a stimulation of investment interest from Japan, Hong Kong, Taiwan, the USA and West European countries. The number and sums of foreign investment increase annually especially among electrical and electronic products manufacturers. At present there are 50 large manufacturers and more than 400

companies of the small and medium size. Items produced are varied over a wide range and include general domestic electric and electronic devices (televisions, radio-cassettes, electric fans, refrigerators, air conditioners, electric lighting, micro-wave ovens, electric typewriters, facsimile machines, electric calculators,etc.). The local content ratio of parts increases annually and it is expected that local production of the main parts now met with imports will ensue in the next 2 or 3 years. In order to increase the local content the Thai government has initiated investment incentives and provides administrative guidance. The local production of the cathode ray tube of television receivers was begun in 1989. Demand for domestic appliances shows a steady annual increase of about 10% (especially in 1987 and 1988 increases of 15-20% were recorded). Increases are expected to continue favorably in the future and the diffusion of electrical appliances to general households, the rise in average incomes, development of new overseas markets, etc are expected to augment increases. There are in total 7 foreign companies engaged in IC and other electronic parts production (5 American companies, 1 South Korean and 1 Japanese company). Electronic industries show a smooth development. As the completed IC parts are all exported this sector has a high export rank and is an important source of foreign earning.

(2) Automobile industry

The Thai automobile industry benefiting from protectionist measures such as the privileges of the foreign investment and import duties developed on lines of an assembly industry of imported parts. At present, almost all of Japan's major manufacturers of two and four wheel vehicles have moved into Thailand. A policy to strengthen domestic production resulted in a continued increase in the ratio of local content and in 1987 this reached 54% for motor cars and 61 % for business vehicles, and in 1989 a 100% level of local content for one ton pick up trucks was attained. The devaluation of the Baht in 1985 and again in 1986, the increase in import duties, rapid rise in prices due to the stronger yen, all resulted in a temporary lull of the Thai automobile market which dropped at one point to an all low production level of 80,000 cars. However, with the recovery of the Thai economy after 1987 the market began to expand and is anticipated to reach a 130,000-140,000 units level for 1988-1989. A rapid increase in demand is anticipated hereafter, and in readiness the Thai industrial sector has begun to move into the area of large heavy mold production needed for car chassis production. In conjunction with new technical progress

the Thai automobile industry envisages the new prospect of 100% local production.

In connection with the above mentioned policy of the Thai government to increase local production a plan to realize the local production of engines now underway is to reach a 80% level of local content by 1993. Automobile manufacturers foresee an important role for Thailand as an export base by 1995-2000.

(3) Metal mold industries

In conjunction with the development of Thailand's machinery manufacturing industries there has been a stimulation of the metal mold industries, primarily for press and plastic parts. Investment, especially from foreign companies and primarily of Japanese manufacturers has become energetic . Of the 300 metal mold related companies there are about 60 which are predominant. Imports of metal molds are concentrated on large, complicated and precision molds, 60% of these imports coming from Japan. The importance of the metal mold industry as a supporting industry serving the export industries is well recognized and there is increasing interest expressed by the Thai Ministry of Industry in furthering the development of metal mold industries. (Thai government set up Metalworking and Machinery Industries Development Institute - HIDI - in 1987 with a grant aid from Japanese government, and this center contributes to the development of Thailand's industry.) Further, metal mold manufacturers can be roughly classified into the four groups of varying technical competence:

1) large scale companies involved in production of automobile parts, domestic electric appliance parts and plastic products which involve metal mold sector.
2) middle and small size companies engaged in production of molded plastic parts and press parts,etc. which have metal mold sectors.
3) special metal mold manufacturers of medium and high quality parts
4) special metal mold manufacturers of low quality parts

Group 1 consist largely of foreign affiliate companies which produce their own reliable and high precision metal molds. These possess an accumulated in house technology. The second group of middle and small size manufacturers undertake the integrated production of plastic products and press parts. Their mastery of metal mold working is not as sure as with group 1. The 3rd group of special manufacturers serve

the large foreign affiliates who are their customers and an expensive investment in equipment has been carried out in view of a mid and long term maintenance of improving quality. The fourth group of special manufacturers of low quality metal molds expect orders for inexpensive goods and an upgrading in terms of quality is unlikely. Even if the latest equipment is introduced, the problems of expertise acquisition and training mean that it is not used correctly.

(4) The technical level and expectations of the Thai industrial sector

Bearing in mind the facts found through factories visit at field survey, the technical level of the industrial sector of Thailand and its expectations regarding the training of engineers can be summarized as follows.

The Thai manufacturing industries for machinery and electrical products began on the basis of knock down production through joint ventures with foreign enterprises or through technical cooperation with them. At present the phase of domestic production of parts and materials is being followed through as part of national policy to increase local content. In the phases of knock down production and domestication of production equipment and technology are introduced from outside in the form of technology transfer. Thailand has not yet reached the stage of developing its own steel materials or semiconductors. Technology transfer has also initiated the processing of materials and assembly technology. However, the national policy of domestic production has created an autonomous production system for parts and materials. Thus proceeding forward from the phase of assimilation of production technology and expertise Thailand is now beginning to move into a phase where it adapts and reorganizes production technology to meet its own conditions.

With 100% foreign capital 100% exported product companies materials, production technology and technology transfer are all prevailing trends. However, in some case of Thailand financed or joint venture companies the initial start is made with an introduction of foreign technology but this is used as a basis on which processing methods and automation systems independently developed are devised. As the process of industrialization accelerates, these companies will inevitably increase in number and will contribute greatly to overall national development. But since the supply of engineers equipped with the necessary capacities for material and systems designing is small, the

capacity of the companies to develop their own technologies is limited.

As noted above, the more advanced companies are endeavoring to push ahead with the development of production technology themselves but are hampered in this by the shortage of qualified engineers. It is not particularly difficult to introduce development technology from overseas but the lack of the engineers who will receive this hampers its introduction. Furthermore, companies do not possess the necessary capacity to carry out such development on their own. These industries therefore look for followings to the University, a) to provide the necessary training of engineers, b) to accept commissions for technology development services needed to the industries, and c) to assist companies for improvement of production technology.

2.2.3 Situation of Higher Technical Education

(1) Education system in Thailand

In accordance with the National Educational Program of 1977 the present educational system of Thailand was implemented as of May,1978. The prior school year system of 7-3-2-4 was changed to one organized on a 6-3-3-4 year cycle similar to the Japanese system (however, compulsory education is up to the sixth year of primary education). Attendance rates for 1986 were 95.76% for elementary education (first six years), 30% for middle school education (six years) and 7.7% for high school education (four years). The attendance rates have increased dramatically over the last 20 years and the educational budget accounted for 18.7% of the National Budget in 1987, representing a sum of 41.1 billion Bahts, next only to the budget for national defense.

Table 2.2.1 Thailand's National Education Budget (Fiscal years 1987)

unit; 1 million Bahts

Year	Total National Budget	Education budget	Breakdown of Government Offices concerned by Education budget		
			Ministry of Education	Ministry of Universities (secretariat) 16 universities	Others
1987	22,500.0	41,111.0	35,629.6	5,426.4 (73.4) (5,353.0)	55.0

The institutions of higher education in Thailand began with civil servant school (established in 1902) which were amalgamated to become Chulalongkorn University,the first University, in 1916. After the 2nd world war, the number of universities rapidly increased after the official announcement of the first national educational program in 1960. To date, in July,1988 there are 16 public universities (with a total undergraduate population of 620,000 which includes open university students, and 19,000 postgraduates) and 25 private universities (undergraduate population of 60,000 and 700 postgraduates). The rapid increase in universities has resulted in problems of inequalities of educational opportunity and the need to remedy regional disparities in education.

The Thailand government bearing in mind the above situation is currently engaged in the prompt establishment of a long term educational vision envisaging the changes needed to meet the challenge of the 21st century. In addition to making the technical education program of higher education a major point in the Sixth Five Year Plan, the following policies form the key points of the national educational program:

1) reinforcement of education to further the industrialization of Thailand, and a balanced development of regions
2) reevaluation of educational content to accompany the development from agricultural centered to industry centered economy
3) the creation of an educational program establishing an appropriate comprehensive curriculum encompassing science, technology, social development, culture and morality, and which achieves a shift of emphasis from a official sector orientated to an education emphasizing private sector management.

(2) Higher technical education

In particular the reinforcement of higher technical education is needed to respond to the demands of the times. In response to the recent industrial and social development of Thailand and to progress in industrialization a growing need for vocational education and higher education especially for science and engineering majors has rapidly increased. While the annual demand for new graduates in science and engineering has reached a level of 7,000 demanded, the actual number of graduates reaches only a level of 2,700, falling far short of the needs of the industrial sector. Particularly rapid in-

creases in demand are evident in the sectors of communications, electrical and electronics engineering, computers, industrial engineering, etc. The qualitative and quantitative inadequacy of experimental and practical equipment, mean that students receive a largely theoretical education and are not provided with occasions to strengthen their practical and applied abilities.

The eight state universities represent the higher educational institutions equipped with a faculty of engineering. The outline of each university is shown as Table 2.2.2.

The following public agencies also serve as educational instituions relating to advanced technology.

a) DIP (Department of Industrial Promotion)

- ISD (Industrial Service Division)
This was established with the assistance of the UNDP and comes under the authority of the DIP. It carries out training in the various technical fields and provides technology counseling and information services.

- TMDPC (Thai Management Development Productivity Center)
This was set up under the DIP with the cooperation of the Thai government and the ILO. It is primarily concerned with the training of managers and administrators and the provision of consulting services.

b) TTC (Technical Transfer Center)

- This was established within the Ministry of Science, Technology and Energy. Its role is to coordinate activities of various technical institutions etc. and to promote technology transfer.

c) TPA (Technical Promotion Association, Thailand-Japan)

- This was set up with the aim of promoting and improving the science and technology of Thailand. It carries out seminar courses and engages in various activities of technical assistance for manufacturing industries.

Table 2.2.2 Engineering Faculty of State University in Thailand

University	Estab-lished	No.of Dept.	No. of Student Undergraduate	Postgraduate	No. of Enrolment
		*	(1986)		(1988)
Chulalongkorn University	1916	11	1,757	602	555
Chiang Main University	1964	6	1,084	60	336
Kasetsart University	1943	7	1,253	158	410
Khon Kaen University	1964	7	1,126	15	309
King Mongkut's Institute of Technology,Kadkrabang	1971	8	1,896	138	565
King Mongkut's Institute of Technology, North Bangkok	1971	4	1,461	80	510
King Mongkut's Institute of Technology, Thonburi	1971	5	1,131	64	280
Prince of Songkla University	1967	6	851	40	205
Total			11,715		2,867

Note *)

University	Department
Chulalongkorn University	computer engineering, mechanical engineering, electrical engineering, metallurgical engineering, industrial engineering,etc.
Chiang Mai University	mechanical engineering, electrical engineering, industrial engineering, etc.
Kasetsart University	mechanical engineering, electrical engineering, industrial engineering, etc.
Khon Kaen University	mechanical engineering, electrical engineering, industrial engineering, etc.
King Mongkut's Institute of Technology, Ladkradang	computer technology, control technology, electrical engineering, electronics, industrial science, mechanical engineering,etc.
King Mongkut's Institute of Technology, North Bangkok	mechanical engineering, electrical engineering, industrial engineering,etc.
King Mongkut's Institute of Technology, Thonburi	mechanical engineering, electrical engineering, industrial engineering, etc.
Prince of Songkla University	mechanical engineering, electrical engineering, agro-industrial technology, etc.

d) TISI (Thai Industrial Standard Institute)

- In conjunction with the establishment of the Bill for Industrial Product Standards this Institute was formed under the jurisdiction of the Ministry of Industry in 1979. In 1989 Japan provided a grant aid for a Center of Industrial Standards and Calibration which is currently being constructed.

e) MIDI (Metalworking and Machinery Industries Development Institute)

- This is a training institute for the metal working and mechanical engineering fields which was set up under the Ministry of Industry with a grant aid from Japan. It provides training and education relating to forging and casting equipment, heat treatment facilities, materials testing, inspection equipment, metal working equipment,etc. At present, it is engaged in project type technical cooperation.

In addition to the above mentioned public institutes there is an annually growing number of private educational institutions. However, in recent years the demands of the industrial sector for high level engineers cannot be fully met and an expansion of institutes for higher technical education needs to be carried out for national development.

The present situation of the educational institutes of engineers in similar institution to Faculty of Engineering, Chulalongkorn University is as follows:

1) King Mongkut's Institute of Technology, Ladkrabang (KMITL)

This was founded in 1960 as the Telecommunications Training Center, and was elevated to technical university status after the unification with two other colleges in 1971. In 1986 the Ladkrabang campus was made an independent university. This consists of five faculties; the engineering, architecture, agricultural technology, industrial education and science faculties.

The Engineering Faculty consists of nine departments; the communications, electrical, electronics, computer, control, machinery, construction, measurement and agricultural engineering departments. An annual student intake is about 500 students for the whole facul-

ty. Students tend to concentrated in communicating and electrical areas, and so the university is the main source of communications engineers and personnel in Thailand. Japanese grant aid and technical cooperation has been forthcoming since the foundation and equipment and facilities are well organized and provided for. Currently, there are 5 specialists on site dispatched from Japan. The computer system of the Engineering Faculty is up to date and was recently installed under a project type technical cooperation scheme with Japan. The mainstay of the system is a batch of 30 personal computers, a CAD work station together with printers, magnetic disk and tape devices, file servers, etc. The entire system is connected with LAN. As installation has only just been completed the actual operational performance of the system remains to be seen. In addition to the above computer equipment there is also a complete set of semiconductor manufacturing equipment (for the manufacture of transistor IC), optical electronics devices (transducers, laser production, solar cells,etc.), communications devices (telephone switchboard simulators, light transmission, infrared transducers,etc). There is provision for electronics and communications equipment.

The workshop and laboratory of the mechanical engineering department are undergoing restructuring and the provision of facilities will be carried out from now onwards. One vertical CNC milling machine has been delivered and programming instruction of the teaching staff is completed. In addition to an optical projector other basic equipment has been provided. There are a large number of things to be done in connection with the laboratory, staff, and departmental provisions to be carried out hereafter.

2) King Mongkut's Institute of Technology, Thonburi (KMITT)

This was founded in 1960 as a Technical College, and then amalgamated with the KMITL in 1971 to form an engineering university. In addition to the three faculties of the engineering, industrial education and industrial technology faculties, there are several centers such as the Research and Development Operation Center.

The Engineering Faculty consists of 5 departments including the chemical, civil, electrical, mechanical and industrial engineering departments. There are about 280 students per academic year. The computer center of the Engineering Faculty is given a governmental

budget and has provided for 20 engineering work station (EWS), plotter and a network station connected to LAN with this budget. It carries out research and development activities relating to CAD/CAM, FEMA (finite element method analysis), CNC programming, etc. For electric circuit design trial design is carried out for IC chips which are trial manufactured in Australia.

Facilities for the mechanical engineering and production engineering departments are at hand but tend to be out of date. The machine tools of the workshop are all outdated and NC machine tools are not installed.

Generally speaking, only the computer facilities are up to date and this stands out together with the quality of the teaching staff recruited in this area. The equipment and personnel resources needed to effectively employ the computer facilities are therefore available, but there is not a matching balance in the other experimental facilities to hand. For example, even though CAD can be carried out, the lack of NC machine tools means that actual training in its CAM applications can not be carried out.

3) MIDI: The Metalworking and Machinery Industries Development Institute

Under the jurisdiction of the Ministry of Industry, it is chiefly responsible for the training of mid level engineers in the field of metalworking and machinery industries, and for carrying out commissioned technical guidance, experimentation and inspection. This was founded with grant aid from Japan in 1987, followed up by project type technical cooperation with the dispatch of Japanese specialists. In addition to forging, casting, heat treatment, materials testing and inspection, welding, machining, precision measurement and inspection, plating, and metal mold testing it also carries out intensive instruction courses for upgrading the technical expertise and capabilities of mid level technicians and engineers using its educational audio visual facilities. It schedules the training of 1,200 technicians and engineers of technical school graduate in 1990. The breakdown of these trainees is to be on a 80% private manufacturing industries, 20% governmental bodies basis. The course curriculum is planned to cater for 50 courses, with one course taking two to three days.

This institute works most successfully for training of mid level engineers. However, managerial problems are (1) the difficulty of staff recruitment, (2) the difficulty of equipment maintenance with the institute staff resources alone and (3) the inability to respond to demands for CAD/CAM seminars. Nevertheless, considerable achievements have been realized with the guidance of the Japanese specialists dispatched under the technical cooperation program in progress.

4) STREC: Scientific and Technological Research Equipment Center

This is an analytical center under the direct control of Chulalongkorn University which covers the areas of metal materials, chemistry, biology, physics and electronics. The equipment was provided by a Japanese grant aid in 1981. The executive staff includes 3 of the teaching staff concurrently given executive duties here together with the full time director, and there are 30 full time analysts and a 5 member maintenance group attached to the Center.

The main analytical devices include a transmission electron microscope, scanning electron microscope, mass spectrometer, nuclear magnetic resonance spectrometer (NMR), atomic absorption spectrophotometer and other organic chemistry analyzing devices, together with 32 types of machinery including material testing equipment and hardness testers, etc.

There are a large number of analysis commissions received from within the University in particular from the Science. Engineering and Agricultural Faculties concerning materials, organisms, chemicals and electronic environment analysis. The center also handles orders external to the University from public corporations etc. connected with the government, from other universities and private industries. Moreover training in use of the devices was carried out.

All of the above institutes have an important role to play in the upgrading of technology in Thailand, though the nature of the role differs from one to the other. The KMITL and KMITT are both top level engineering universities acting as training institutes for the high level engineers of Thailand, like Chulalongkorn University also situated in Bangkok. In contrast the MIDI is a mid level training institute, whose function differs and which focuses on training of practi-

cal skills. Comparing the above two universities with Chulalongkorn University we find that the latter has a longer tradition and so a stronger staff and more departments. This makes for reinforcement of teaching and research activities, and for a balance in the activities of the engineering faculty generally. On the other hand, the former institutes are technical colleges elevated to university status, and their history is comparatively short but they retain their particular strengths and are able to give emphasis to a very practical applied training. In particular the KMITL is on an even level with Chulalongkorn University in the communications and electronics engineering fields. Both of these universities are supplied with engineering work stations (EWS) and development programs in the recently rapidly developing area of computer applications in engineering,particularly in CAD/CAM areas. The universities are actively engaged in development in these areas.

There is a certain lack in new equipment for mechanical and metallurgical fields of the KMITT. Compared to the two other universities Chulalongkorn University is well equipped, but in comparison with its activities in the electrical fields it shows a certain delay in meet the demands of the industrial sector relating to mechanical nd metallurgical fields. This is a result of (1) limited necessity to encourage mechanical and metallurgical engineers development program due to the dependence on the direct technology transfer from overseas, and (2) preference for the reinforcement of development capacities of electrical and electronics fields rather than of mechanical and metallurgical fields in Thailand because of rapid technological progress in the former fields in comparison with the latter in the worldwide.

2.3 Outline of the Faculty of Engineering of Chulalongkorn University

2.3.1 Chulalongkorn University

Chulalongkorn University was the first university in Thailand, and was founded in 1916 through the amalgamation of the Civil Servant Training Institute(founded 1902), the Royal Medical School (founded 1889) and the Engineering Institute (founded 1913). It consisted of the four faculties of medicine, law, engineering and humanities/sciences at the time of founding. In 1935 the Chulalongkorn University Act was promulgated and the first Bachelor degrees awarded, with the award of Master degrees following a few years later. Thereafter the University has

continued to expand the number of faculties. It has continued its work as the highest educational institution and has continued to send graduates of high quality to the various public and private institutions, contributing to the development of the human resources of the nation.

The University possesses an area of 500 acres in the center of Bangkok city. Besides serving for the location of university facilities, 32% of this area is leased out on a commercial basis and the income accruing from rents is allocated to meeting a part of the University running costs.

The University is placed under the control of the Ministry of University Affairs, however it is on an equal position and importance with the various department of the Ministry. There are 15 faculties (13 faculties having postgraduate courses), 11 Research Institutes under the University control, and 7 Centers. Staff and student numbers for 1987 were as follows:

full time teaching staff	approx. 2,400
part time teaching staff	approx. 500
administrative personnel	approx. 2,200

	male students	female students	TOTAL
Undergraduates	7,506	6,996	14,502
Higher Certificate	123	78	201
Master Course Students	2,649	2,536	5,185
Doctor Course Students	54	32	86
Total	10,332	9,642	19,974

The government annually appropriates budgets for Chulalongkorn University as a public institution covering about 75% of the University's annual expenses. The government allocation for Chulalongkorn University over the last 5 years has been one billion Bahts annually, which represents just below 20% of the total budget allocated to all of the 16 national universities.

Table 2.3.1 lists the University budget in the last 5 years. The budget for personnel expenses (salaries and wages) and public utilities are provided by the University as a whole, and so are the budgets for equipment purchased by the University and construction. Each faculty receives allocation accounting for about 40 percent of the total for education, research and development and other expenses. Table 2.3.2 shows the budget of the Faculty of Engineering which increased from 60 million Bahts to 80 million Bahts in the last few years.

Table 2.3.1 *Chulalongkorn University's Budget*

(in million Bahts)

Item	Year				
	1986	1987	1988	1989	1990
Salaries and Wages	465.8	483.2	510.5	537.3	624.8
Public Utilities	34.0	34.0	37.0	42.0	60.0
Equipment and Construction	64.6	73.1	96.9	94.4	189.0
Subsidies *	417.9	415.7	420.0	433.8	542.4
Total	982.3	1,006.0	1,064.4	1,107.5	1,416.2

* Budget to allocate to each department

Table 2.3.2 Faculty of Engineering Budget

(in million Bahts)

Item	Year				
	1985	1986	1987	1988	1989
Government Budget	55.6	53.4	55.3	57.9	64.1
Faculty Foundation Budget	5.8	7.6	12.3	14.1	14.6
Total	64.1	61.0	67.6	72.0	78.7

2.3.2 Faculty of Engineering

The forerunner of the Faculty of Engineering was the Engineering Institute (Yantara Suksa) founded in June,1913 by King Vajiravudh. This became the present Faculty of Engineering when Chulalongkorn University was founded in 1916.

The following represents the major dates in the Faculty's history thereafter:

1935 Bachelor degrees were first awarded for the three departments of civil, mechanical and electrical engineering.

1941 Master courses were set up for the three departments of civil, mechanical and electrical engineering.

1950 The SEATO Engineering University was founded within the Faculty of Engineering (this moved to a new site at Rangsit where it was an independent campus and renamed AIT University in 1971).

1955 Between 1942 and 1955 the new departments of production engineering, mining, sanitary engineering and surveying engineering were established.

1983-4 Doctor courses for civil engineering, electrical engineering and mechanical engineering were set up in the respective departments

In this way the following 11 departments were gradually established;

Department	Undergraduate Course	Master Course	Doctor Course
Civil Engineering	0	0	0
Electrical Engineering	0	0	0
Mechanical Engineering	0	0	0
Industrial Engineering	0	0	
Chemical Engineering	0	0	
Mining Engg. & Min. Geology	0	0	
Survey Engineering	0	0	
Environmental Engineering	0	0	
Metallurgical Engineering	0	0	
Computer Engineering	0	0	
Nuclear Technology		0	

The number of teaching staff of the Faculty of Engineering are 225 (19 Professors, 85 Associate Professors,etc. please refer to Table 2.3.3). The student body numbers are 2,500 (2,000 Undergraduates, 500 Postgraduates).

Table 2.3.4 lists the number of graduates in the recent years by departments which demonstrate over 20 percent rise in the last 4 years, particularly sharp increased in electrical, mechanical and metallurgical engineering department which have a bearing on the Project. About 90 percent of recent alumni work for private firms and the remaining 10 percent for the government and public entities. About 30 percent of bachelers attend master courses, and 5 percent doctor courses. About 30 grauduates each year go abroad to study.

Table 2.3.3 Academic Staff Members in Faculty of Engineering

Department	Position				Degree			Total
	A	B	C	D	E	F	G	
Civil Engineering	10	15	9	3	20	16	1	37
Electrical Engineering	4	19	8	7	27	9	2	38
Mechanical Engineering	1	11	16	8	11	17	8	36
Industrial Engineering	1	10	7	3	7	11	3	21
Chemical Engineering	-	1	3	5	5	4	-	9
Mining Engg. & Min. Geology	2	9	2	1	6	6	2	14
Survey Engineering	-	3	3	7	1	6	6	13
Environmental Engineering	-	1	3	4	2	3	3	8
Metallurgical Engineering	-	8	4	3	11	4	-	15
Computer Engineering	1	6	11	7	3	19	3	25
Nuclear Technology	-	2	4	3	2	7	-	9
Total	19	85	70	51	95	102	28	225

Note: A: Professor
B: Associate Professor
C: Assistant Professor
D: Lecturer
E: Doctor
F: Master
G: Bachelor

Table 2.3.4 The Graduate Students in Faculty of Engineering (Bachelor degree)

Department	Year			
	1986	1987	1988	1989
Civil Engineering	70	80	60	66
Electrical Engineering	75	83	87	101
Mechanical Engineering	54	66	75	62
Industrial Engineering	33	55	55	68
Chemical Engineering	26	34	37	36
Mining Engg. & Min. Geology	16	20	15	13
Survey Engineering	17	9	20	19
Environmental Engineering	12	10	17	16
Metallurgical Engineering	5	17	13	14
Computer Engineering	36	31	34	30
Total	344	405	413	425

Figure 2.3.1 shows the organizational structure of the Faculty of Engineering. Activities of the Faculty of Engineering pertain to the following three areas:

(1) Educational

Education is two-pronged : one is undertaken in the form of lecturer, experiment and training in accordance with the predetermined curriculum ; and the other is more sophisticated education including lectures and training for postgraduate students.

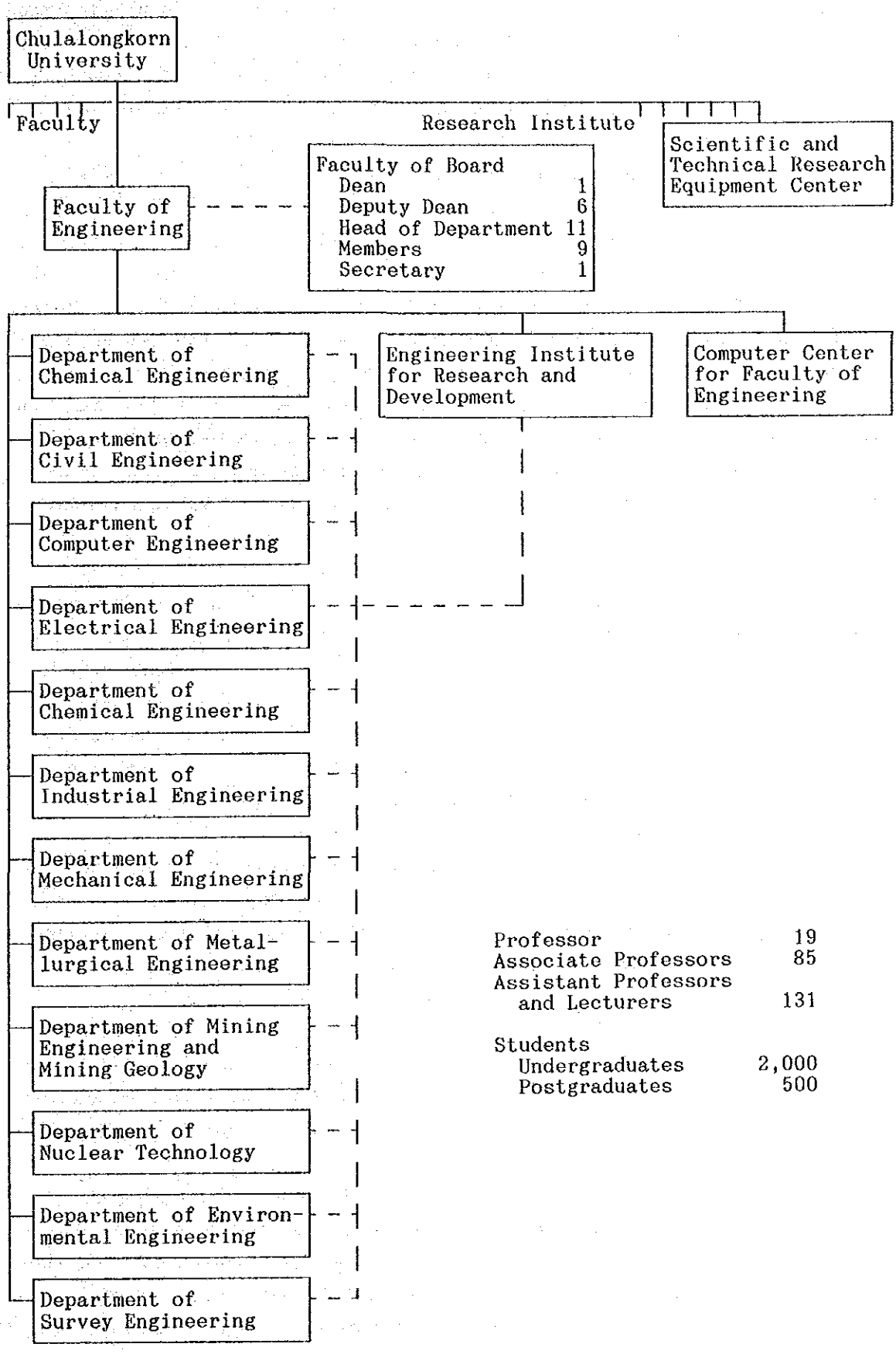
(2) Research

The main objectives of a university includes to spearhead progress of industrial technologies of the country. In Thailand where research institutes, both private and public, are scarce, universities are expected to perform an extensive range of research and development. University education can be made more effective by asking undergraduate and postgraduate student to participate in professor's research.

(3) Services

A university is able to train engineers belonging to public organizations or private companies or provide technical counseling to them by utilizing its research and development outcome and research equipment. This is university's direct contribution to industry. In Thailand where the technological standards of the private sector are low, university's technical services are highly valued.

Figure 2.3.1 Organization Chart of Faculty of Engineering



Departmental heads are responsible for educational activities carried out under the direct supervision of the Dean of the Faculty. Actually research and development activities are done by the faculty members and staff in each department, and EIRD coordinates the research and service activities under the control of the Dean of the Faculty.

2.3.3 Founding Aims and Functions of EIRD

A research committee was established in 1972 in order to ensure that funds for research activities of the Faculty are effectively spent and that research activities are in accordance with national economic planning. In 1987, in order to upgrade and expand the research activities of the Faculty of Engineering, the research committee set up the EIRD in the Faculty after discussion and agreement with the Faculty management. The aims of EIRD included an active response to the research and development needs of the nation in the engineering sector. EIRD has continued to follow these aims during its 10 years operations to date and its present role includes;

(1) coordination of the research activities of the Faculty of Engineering
(2) contact with external private and public organizations in its capacity as representative of the Faculty of Engineering
(3) the management of governmental budget allocations and other funds for research projects
(4) activities focused on the long term research groups

The policies of EIRD for research emphasizes sectors considered to be of future national importance, and research funds are controlled with this principle. The focus is on the application research that supports upgrade of industrial technology with the following three central aims:

1) to develop and spread technology necessary to the industrial sector
2) to promote technology necessary to the development of the nation
3) to train engineers who support the industrial sector

As indicated above, EIRD is an organization which ensures that research activities are actively carried out in accordance with the set aims as well as administering the actual education of the various departments of the Faculty of Engineering. Actual research of the

individual departments is the responsibility of the teaching staff concerned in the departments with the assistance of technicians and students. The EIRD is not an organization which is concerned with the individual research plans of each department, but is responsible for coordinating the overall research of the entire faculty. Therefore the research teams of the Faculty of Engineering form the basis of the EIRD.

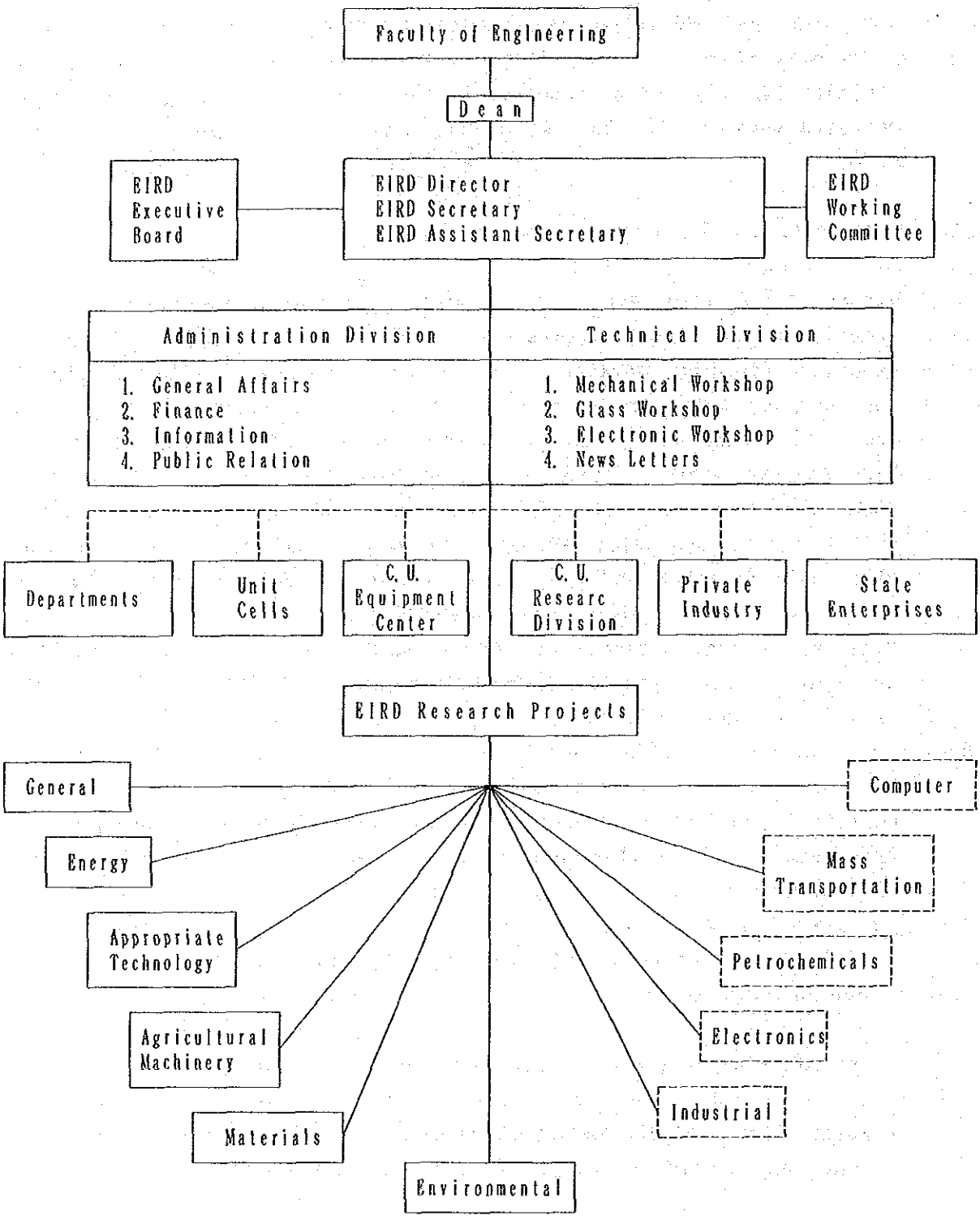
2.3.4 Organization and Administration of EIRD

Figure 2.3.2 illustrates the administrative organization of EIRD. Actual management and administration of EIRD is carried out by the Executive Board and Working Committee under the Dean of the Faculty of Engineering, while the EIRD director carries out actual management. The deputy dean is appointed to the position of the EIRD director. EIRD has an administration division consisting of general affairs, finance, information and public relations sections and also a technical division consisting of a mechanical workshop, glass workshop, electronic workshop and newsletter section. The workshops under the direct control of EIRD are common facilities offering support to the various research projects as needed. However, the present workshops are lacking in equipment and facilities and do no function sufficiently.

EIRD has the function of seeing that team work research is implemented so that there is a coordination of the research projects commissioned from outside. The following are examples of such projects carried out under EIRD control:

- Technological development relating to agricultural development of Thailand
- Introduction of new technology to energy peak demand load controller
- Establishment of the industrial know how of the petroleum and petrochemical sectors
- Study of the impact of the installation of a natural gas pipeline

Figure 2.3.2 EIRD Organization Chart



Engineering Institute of Research and Development (EIRD)

- Study of the environmental impact of the gas separation plant

In addition to the above EIRD has carried out projects for such private firms as the Siam Cement and South East Asia Construction Co.

The research funds of EIRD include those contributed from the private sector and public corporations as well as the governmental budget allocations. The funds of the EIRD continue to increase annually. Table 2.3.5 shows the recent annual funds of EIRD. Funding from the government, the Faculty of Engineering and the University is expected to remain in the region of 2 million Bahts. Other funds, including the portion from private and public industry, is expected to increase, and will eventually come to account fro up to 70% of funding.

Table 2.3.5 EIRD Research Funds

Funding source	1984	1986	1987	1988	1989
Engineering faculty	306	329	293	243	255
Thailand government	423	400	350	400	303
Chulalongkorn University	1,167	1,823	1,522	775	1,620
Sub-Total	1,896	2,552	2,175	1,418	1,620
NRCT, etc.	35	261	1,147	562	71
Others	2,937	6,377	9,138	14,411	3,562
%	60	69	74	88	68
TOTAL	4,868	9,190	12,450	16,391	5,253

NRCT : National Research Council of Thailand

2.3.5 Present Situation of the Departments relating to the Project in the Faculty of Engineering

Departments relating to the Project are the computer center electrical, metallurgical and mechanical engineering departments. The following is an outline of their present situation.

(1) Computer center

The Chulalongkorn University has a central computer center serving the

entire university. This is used largely for administration purposes but there is a plan for placing computer centers in each of the University faculties. In addition to the Faculty of Engineering the Medical and Commercial Faculties possess computer centers. The main use of the computer center of the Faculty of Engineering is for technical calculations of each department.

The main framework of the system is a PRIME 9750, installed in 1986. This is already outdated and its capacity is insufficient for carrying out CAD/CAM for electric circuit or machining work, or CAD for metal mold designing. A new system with a larger capacity is required.

In addition to the above, there are also two Sun's engineering work station which is equipped with LAN (Model 60). There are also 60 personal computers installed which are available for student use.

(2) Electrical engineering department

The electrical engineering department is the largest department in the Faculty of Engineering with a student population of 120 students annually and 38 teaching staff. Third and fourth year students specialize in electric power, communications, electronics or control studies. There are also masters and doctor courses in addition to these undergraduate courses. There are nine laboratories related to the electrical engineering department. The electronics designing laboratory to study CAD design of electronic circuit and the semiconductor devices laboratory investigating materials engineering (electronics materials) are involved in the Project.

Electronics design laboratory

This was set up in 1987 with support from the Indian government which provided the main equipment and technical support. Circuit design is carried out using IBM Personalized computer hardware and software (ORCAD). Furthermore, exposure equipment, etching equipment and soldering equipment for printed circuit board production is installed. The design and trial production of electronic devices is investigated using this equipment. A telephone switchboard circuit is one example of a research object which has already been commercialized by industry in Thailand.

Semiconductor device laboratory

Set up in 1975 with aid from the French government which provided

equipment and technical support. This laboratory functions as the pioneering research center for semiconductor research in Thailand. Provision of equipment from Japan took place in 1985 with a Japanese grant. The laboratory carries out the most dynamic research program of the EIRD. Starting from basic research into the principles of semiconductor materials and devices, it has moved on to applications of photovoltaic systems for the production of solar cells. With liquid phase epitaxy (LPE), electron beam evaporators, electronic device production systems and scanning electron microscope, etc. which are equipped by grant aid from Japan, the production of semiconductors devices and their evaluation were carried out. Research into applications in optoelectronics sectors such as light emitting diodes, gallium arsenic transistors, lasers and holography, etc. was carried out as well. Using the laboratory equipment provided experimental devices are trial manufactured including solar cells, CO2 lasers and holographic devices. Not only have these research projects given positive results they have also achieved concrete results in cooperation with national projects for installations and applications of actual equipment for solar cells in rural and marine locations of Thailand.As the country's leading semiconductor research unit international exchanges are frequent and active. Invitations have been extended to academics of French, Japanese and West German research institutes while staff have also been sent abroad for training. Efforts to introduce new technology are pursued and the laboratories has established itself as a key factor in the rapidly developing semiconductor industries of Thailand.

Although the history of the two laboratories outlined above differs in length, they would both contribute by encouraging the participation of students and postgraduates in order to nurture and train the human resources in demand in the electronics industries of Thailand. The laboratories in this way furnish graduates who are active in the Energy Generation Authority Thailand, private industry and as teaching staff in other universities.

(3) Metallurgical engineering department

It is thirteen years since the metallurgical department was split off from the mining and geology department to become Thailand's sole independent metallurgical department. It is a small department with only 20 students annually and 8 staff members but it is planned to increase these numbers to 40 and 18 respectively. At present there is

only undergraduates course available, but there is an ambitious plan for the creation of a master and doctor courses in the future.

In addition to the research currently conducted in the fields of casting, metal physics and metal chemistry it is planned to expand into the areas of metal shaping, welding, surface treatment, and metal mold research. To date the two areas of metal purification and metal properties have been the backbone of activities. However installation of a experimental furnace for heat treatment use, equipment for observation of metal structures and for chemical analysis as well as casting equipment for shaping and trial plating equipment has been carried out. The department is poorly equipped with basic evaluation equipment such as tensile or hardness testers.

Services to the industrial sector include technical services such as materials testing and analysis, advice on solving troubles as well as training courses and seminars. Teaching staff of the metallurgical department have also participated in the MIDI program.

(4) Mechanical engineering department

This department together with the electrical and civil engineering departments has a history dating from the founding of the Faculty of Engineering. Graduates of the department are active throughout the industrial sector in Thailand. The annual student intake is 75 students and there are 36 teaching staff. The undergraduates choose among courses in energy engineering, marine engineering, agricultural engineering and applied mechanical engineering. There are also courses for the master and doctor.

Laboratories relating to the department are the energy technology lab and the agricultural machinery laboratory. There is also a robotics laboratory which has relation to the Project. In the robotics laboratory trial manufacture and function tests are carried out on the gas pipe cutting model, cylindrical coordinate type robot model and X-Y table model. Further, a scara type robot is undergoing trial manufacture, largely with participation of master course students guided by the teaching staff. For design, the CAD system is employed with the mini-computers of the computer center. Finite element method (FEM) systems are used for a part of response calculations used in analysis but the slow speed of the computers in the Computer Center for arithmetic calculations is a drawback. Machine tool in the workshop are

old fashioned and include a lathe, vertical milling machine as well as a sawing machine, tool grinder, shearing machine, 40 ton hydraulic press, etc. An NC milling machine was installed 3 years ago but since this was no introduced with the interface with the computer systems envisaged for the near future in mind, it will not be very applicable. Other experimental and testing equipment as well as the boiler, compressor, engine tester, turbine pump etc. are well provided for though these tend to be older models.

It is compulsory for first year undergraduates to take mechanical drawing instruction, and in the mechanical engineering department there are courses in design and mechanical drawing for second and third year students. However, CAD instruction is not yet provided to the departmental students.

In general research activity in the mechanical engineering department tends to fall behind that of the more dynamic electrical engineering department. Experimental and training equipment is relatively well provided for teaching purposes, but equipment for research purposes, including graduation research, is rather limited. Moreover, there is a certain lack of ingenuity in the educational framework. Against this general background the robotics laboratory is comparatively well directed largely because of the enthusiastic and ambitious vision of the related teaching staff. A number of academic papers have been published abroad in relation to robotics. It is anticipated that this laboratory will prove the leading force in CAD/CAM in coordination with system automation using computer technology in Thailand in the future, and will further expand its activities in the area of CNC machine tools.

(5) Existing equipment of the Faculty of Engineering

The mainstay of the computer center in the Faculty of Engineering consists of mini-computer systems which were installed in 1986. These are equivalent in capacity to the present capabilities of personalized computer systems and are not able to meet the demands of CAD technology in demand from the industrial sector. It is therefore necessary to install a system which can meet the requirements for CAD research and development and for actual training.

Equipment in the metallurgical engineering department is already outdated and is insufficient for evaluating the physical and chemical

properties of metals. There is also a lack of necessary equipment for metal processing with the exception of equipment for foundry and plating processes. There is almost no equipment for producing metal molds. A minimum of processing and evaluation equipment is needed urgently.

For a certain amount of electronics materials has been provided largely focusing on semiconductor devices in the semiconductor device laboratory of the electrical engineering department. These were provided with support from French and Japanese government and thanks to commissions from various governmental bodies. It is necessary to introduce new equipment to keep a pace of international developments, to maintain a leading stance in the field of national technology and to diffuse the new technology domestically.

The equipment of the mechanical engineering department is all out of date and in particular almost no NC machinery is installed for machine working. There is research into the in house production of robots in the field of system automation, but the equipment is quite simple in comparison with that of industries actually beginning automation changeover in the industrial sector. Without provision of a minimum of equipment, it will be impossible to carry out actual training.

Appendix-5 shows the lists of related existing equipment.

2.4 Outline of the Request

2.4.1 EIRD Expansion Project

(1) Background of the Expansion Project

The Thailand economy has already entered the industrialization phase. Against this background the government will continue to take appropriate measures to further local content production and export industries. The industrial sector in this context needs to (1) reinforce the quantity and quality of education for engineers and (2) influence the universities to give guidance and support to strengthen their research capabilities for production technology.

In terms of organized research activities undertaken, the level of Chulalongkorn University is higher than that of the other universi-

ties. The long tradition of supplying engineers to the industrial sector of Thailand and the excellence of its research can be said to constitute an important contributory factor to the industrial foundations of the nation.

Also, with the increase in student numbers it will be necessary to increase not just the amount of equipment available but also the number of the teaching staff. The graduates of Chulalongkorn University study abroad in the U.S.A., Europe or Japan and as university staff are accorded social status and respect they tend to realize a high level of contribution to the Thailand nation. It is important to ensure that there is a favorable research environment for the teaching staff who return from study abroad.

The necessity of improvements in production technology in the industrial sector is a theme which is emphasized in the Sixth National Development Plan. It is firmly believed that the production of high quality Thai industrial products having greater cost competitiveness can be achieved through such improvements of production technology and management. This will reinforce the competitive position of Thai products on international markets and in the long run contribute to an amelioration in the international balance of payments.

Vital sectors involved in such industrial technology improvement schemes include such areas of precision engineering as material engineering, automation systems,etc. Therefore human resources trained in automation technology and possessing technical expertise are needed. It is the function of the universities to develop such resources and supply trained engineers. Further, as human resources engaged in research are limited elsewhere in tertiary and higher education in Thailand the universities are required to assume leadership of research and development for industrial development.

Bearing in mind the above background, emphasis is to be put on the field of precision engineering since this will form the backbone of the industrial development of the country. To this end the EIRD Expansion Project for the educational and research program of the Faculty of Engineering of Chulalongkorn University was established. The leading role played by Chulalongkorn University in higher technical education in Thailand and the need to ensure preparedness of facilities to respond to the new phase of industrialization were the guiding principles behind the national project.

(2) Objectives of the Expansion Project

The aims of the EIRD Expansion Project are as follows:

1) To strengthen and upgrade research and development in the areas of CAD (Computer Aided Design) technology which employ computers, materials engineering and systems automation.

2) To train engineers with research and development abilities in the fields of precision engineering through the actual research and development activities undertaken by EIRD.

3) To strengthen EIRD's functions so that it can offer technical support to the industrial sector.

(3) Outline of the Expansion Project

1) Areas concerned

The EIRD Expansion Project is composed of the three areas of CAD/CAM technology, materials engineering and system automation.

2) Plan of activity

EIRD of the Faculty of Engineering plans to undertake the following activities as part of the Expansion Project. Engineering equipment necessary to the undertaking of these activities is to be installed.

A. Research and development activities in the fields of CAD/CAM technology, materials engineering and system automation.

It is an essential function of the university to undertake research in addition to education. The education and research of the Faculty of Engineering serves industry through the training of engineers and it is to act as a pioneer leading industry through its research activities.The focus of the EIRD's activities is on research of application technology.

B. Educational activities for the undergraduates (graduation research) and postgraduates of the mechanical engineering, electrical engineering and metallurgical departments.

Educational activities are to be carried out through practical training and through the participation of undergraduate and postgraduate students in research activities.

C. Education and training of engineers from industry

There is a shortage of engineers capable of basic knowledge and application technology relating to development capabilities. Engineers are to be accepted from industries in response to their demands and technical services in the form of practical training and seminars,etc. will be carried out.

3) Buildings

The building space set aside for the installation and location of the equipment are the main EIRD building and the 4th story extension of Building 3. The Thai party is undertaken with duties relating to the extension, preparation and related works.

The government of Thailand requested a grant aid from the Japanese government in 1989 for the provision of the engineering equipment needed for the above Expansion Project.

2.4.2 Outline of the Request

The following is an outline of the final request made by the government of Thailand.

(1) Objectives

The Project, in conjunction with the aims of the EIRD Expansion Project, is for the provision of equipment relating to research and development functions in the three areas concerned. The above equipment will be employed for the practical training of students via student experimentation and graduation research as well as for the practical training of engineers from industry in production technology.

(2) Executing agency

The executing agency for the Project is to be the Faculty of Engineering of Chulalongkorn University.

(3) Implementation works

The Project concerns the three areas of CAD/CAM technology, materials engineering and system automation. Contents of the following activities are involved.

CAD/CAM Technology : training of engineers capable of efficiently and accurate design of electrical circuits using computer technology for this purpose.

Materials engineering : the training of engineers who are able to carry out efficiently the design and manufacture processing of metal materials (particularly of metal mold processing) and of electronics materials.

System automation : the training of engineers with expertise and experience in control systems using computers, in systems engineering, interface technology and computer applications for manufacturing automation.

(4) Outline of the requested equipment

CAD/CAM technology

Hardware

- Microcomputer system
- LAN adaptor card
- High speed hard disk
- Plotter
- Dot matrix printer, Laser printer
- UPS (Uninterrupted power supply system)

Software

- Software for printed circuit design
- Software for electronic circuit design and analysis
- Software for logic design
- Software for gate array design etc.

Materials engineering

- CAD mold design system
- CNC wirecut EDM
- 100 ton hydraulic press
- Precision surface and profile grinder
- YAG laser
- CO_2 laser
- Optical power meter
- Laser displacement meter
- Surface analyzer (ESCA/AUGER)

System automation

- Portable robot
- Robot vision system
- Precision cartesian coordinates positioning unit
- Scara type robot
- Cylindrical coordinate type robot
- CNC milling machine
- CNC lathe
- Grinding machine
- CNC machine center