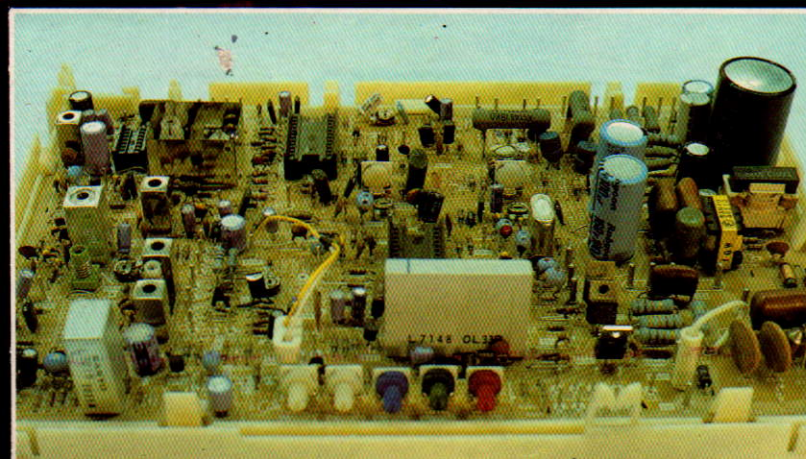
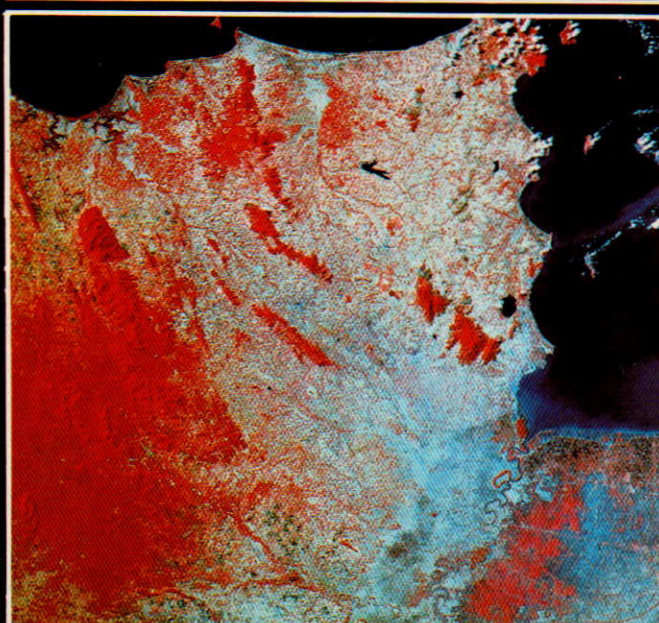
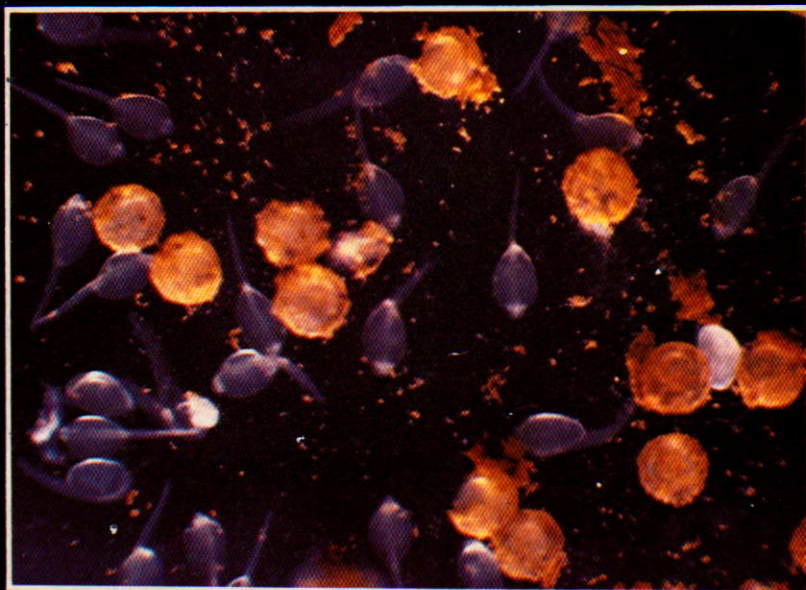


ThaiLife

SCIENCE AND TECHNOLOGY IN TRANSITION



SCIENCE AND TECHNOLOGY IN TRANSITION

ThaiLife

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1985*



FOREWORD

Thailand has long been actively involved in scientific and technological development. As with other societies, emphasis in the early stages was placed on the development of metalwares for practical use.

As Thailand is an agricultural country, it has been necessary to develop agricultural science and technology in order to strengthen the economic base of farmers who form the greater part of the population. Progress in this field has been so successful that the supply of agricultural products now exceeds the national demand. Few countries find themselves in such a position. The aim nowadays is to produce, by the use of modern technology, high protein foods for national consumption, either through tissue culture or artificial fish breeding.

Advances made in the field of education have helped to increase the usage of natural resources. Modern science and technology is presently being used in such areas as aerial photography, materials development, the development of natural gas, computer, electronics, the production of missiles, biology and medical science. The interest and support which such projects have received from the government and the private sector has helped to push Thailand into the position of being a semi-industrial country, in accordance with the set target. Development in all fields has greatly helped to improve the living conditions in the rural areas. Artificial rain making has been introduced to overcome the problems of drought, microhydropower has been developed and housing has been modernized with the aim of upgrading the standard of living for all Thai people.

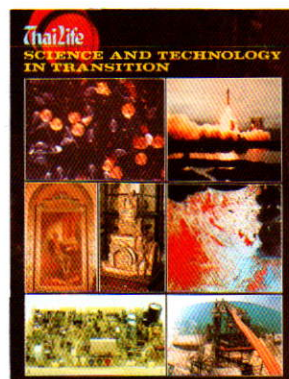
Scientific and Technological Development Programmes have also been initiated in co-operation with developed countries such as the United States of America and Canada.

This book, *Science and Technology in Transition*, has been produced with the co-operation of the Ministry of Science, Technology and Energy. The examples given show the degree of success which has been achieved in various development areas. Through these examples, the reader will be able to see the unique role which Thailand is playing in the development of science and technology.

*National Identity Board,
January 1985*



SCIENCE AND TECHNOLOGY IN TRANSITION



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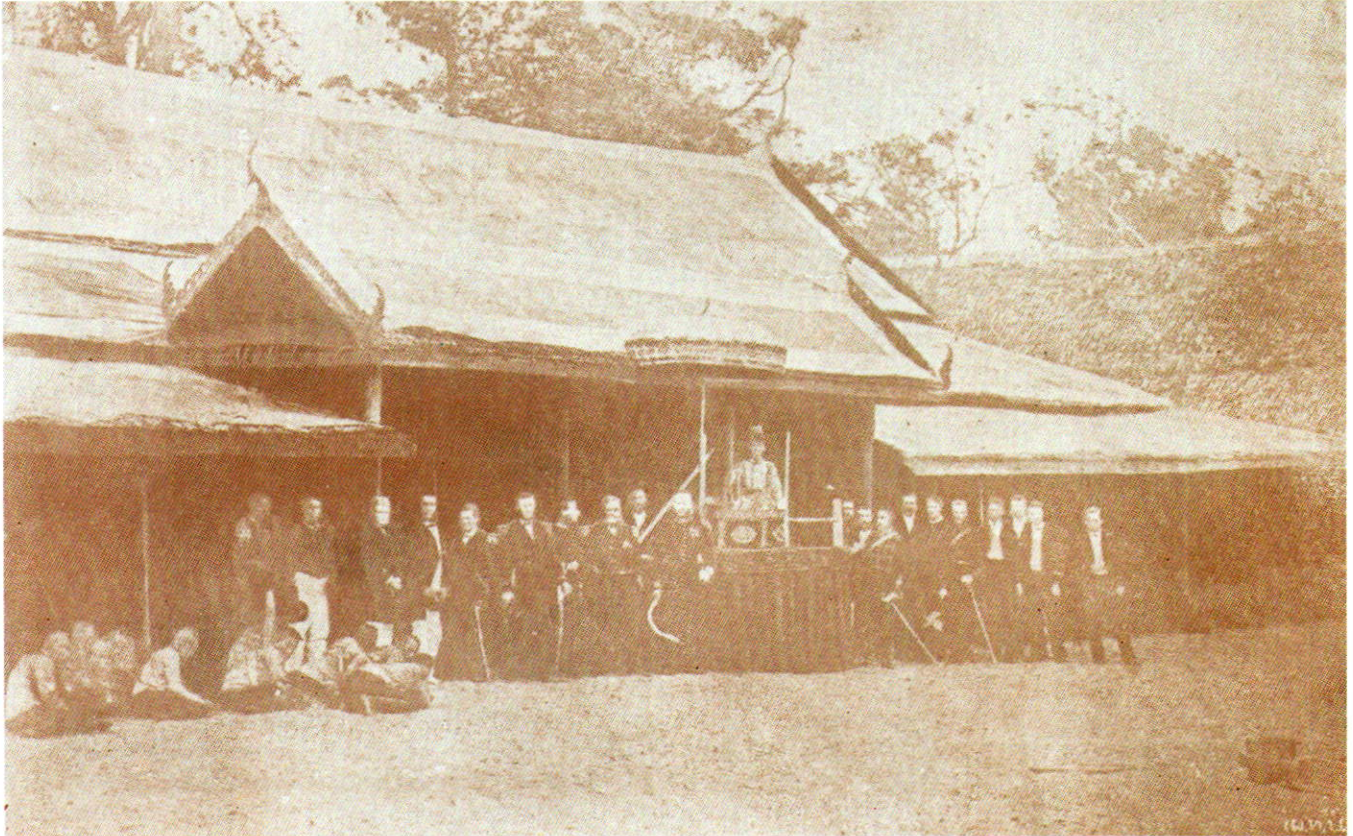
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KING MONGKUT

THE FATHER OF THAI SCIENCE

1.



1. King Mongkut waiting to receive Sir Harry Oat, Viceroy of Singapore, who came to witness the total solar eclipse at Tambol Wah Ko, Prachuab Khiri Khan Province, in August, 1868.

Throughout history events have occurred which future generations recognize as having had an important effect on political, economic and social changes, as well as national development. The extent of influence, be it direct or indirect, depends on circumstantial conditions and persons involved.

As the world entered the 19th century, unprecedented advances began to take place in the fields of science and technology. The industrial revolution had begun in the 18th century bringing with it an increase in economic power to western nations. This power enabled nations to improve the quality and production of manufactured goods in order to fulfil the

needs of the growing population. It also afforded them an opportunity to expand their power and influence. Many Asian countries became the target of western expansionists and imperialists who used developing science and technology as the basis of their power.

During that critical period a great man was born who would later lead Thailand through that period of change. His deep understanding of history and modern science helped him to establish policies which would help Thailand face the dangers which threatened her democracy and, at the same time, would pave the way for the country to develop along the lines of modern civilization.



2. Telescope belonging to King Mongkut.

That great man was Somdej Phra Chom Klao, the 4th King of the Chakri Dynasty, known more popularly as King Mongkut.

King Mongkut was born on the 18th October, 1804, during the reign of King Rama I. As a child he was trained in both civil and military affairs and was given an education befitting a young prince. At the age of 13 years he received ordination as a novice in the Buddhist tradition and spent 7 years studying in a monastery. Later, at the age of 20 years, he received full ordination as a Buddhist monk. Fifteen days after his ordination his father passed away.

Although he was in line of succession, as his father had not established an heir, the young prince, at that time, did not ascend to the throne. A meeting of the King's Councillors and Ministers decided it more fitting to offer the throne to his elder brother who

2.

was seventeen years his senior and already in an established position amongst the people of the Kingdom. The young prince thus decided to continue his life as a Buddhist monk and remained in the order for the next twenty-seven years.

The time he spent in monkhood was later, as it turned out, to be of great benefit to Thailand. During the reign of King Rama III, Prince Mongkut spent much time travelling throughout the Kingdom getting to know the country and the living conditions of the people through of foreign languages and modern sciences. It seemed to be a period of preparation for the young prince who was destined to become ruler of the nation at a time when the expansion of western powers was to reach Thailand. Upon the death of King Rama III, in the year 1861, the throne and crown were offered to Prince Mongkut. The young prince gave up his life as a monk and, accepting the crown, began to rule over the nation under the name Phra Bat Somdej Phra Chom Klao, or King Mongkut, King Rama IV.

One of the major problems confronting the country at that time was the expansion of western influence. The King saw that relations with western powers could not be avoided. The problem thus was not as to whether or not relations should be developed, but rather how they could be developed without threat to the monarchy and the country's independence. Two important policies were thus established namely, 1) to avoid disputes within the relationship and 2) to win respect of foreign nations by studying modern sciences and keeping abreast with progress taking place throughout the world. As for the first policy, Thailand signed a friendship and trade agreement which can be said to have opened Thailand to the outside world. As for the second policy, Thailand, under the guidance of King Mongkut, used every method to show the world that it was leaving behind the past and was ready to step forward into the modern world. These two policies played an extremely important role in preventing Thailand from becoming a colony of the western powers. It also brought recognition to Thailand as a member of the free world society.

The progress of the world was dependant on science as science was a tool used for economic and social development. It was therefore essential that a society have a deep understanding of science. King Mongkut showed quite clearly that he possessed such a quality. He had a deep insight into the principles of Buddhism, cause and effect, knew foreign languages and was able to apply scientific analysis in solving problems, an important factor of western civilization. He had also done a direct study in branches of applied sciences, such as mathematics and astrology. These things, combined with his deep understanding of the country and the people's needs, formed the framework of the administration of the country under his leadership.

The King's keen interest in mathematics and astronomy manifested in a very important event which occurred towards the end of his life. By way of astronomical calculation, the King was able to predict that a total solar eclipse would be visible over Thailand for the first time on the 18th August, 1868. He further predicted that it would be clearly visible in the village of Ban Wah Ko, Prachuab Khiri Khan Province, as it was in the centre of the sun's orbit, "His Majesty thus travelled to witness the event at that place. He also invited expert astrologers, both monks and laity, to accompany him on the journey. His Majesty was concerned that the predicted eclipse might not be total or might not occur at the predicted time. Should such a thing happen he would feel greatly shamed as he knew that nobody believed him. French and British philosophers accompanied the royal procession, as did Sir Harry Oat, Viceroy of Singapore, and his wife, who had come to witness the total eclipse at Tambol Wah Ko." On the 7th August, 1868, the King departed Bangkok on the boat Ankhraj Voradej and headed for the coast of Wah Ko. They landed at Ao Manao and went to the temporary royal residence at Wah Ko village on the evening of the 10th August, 1868.

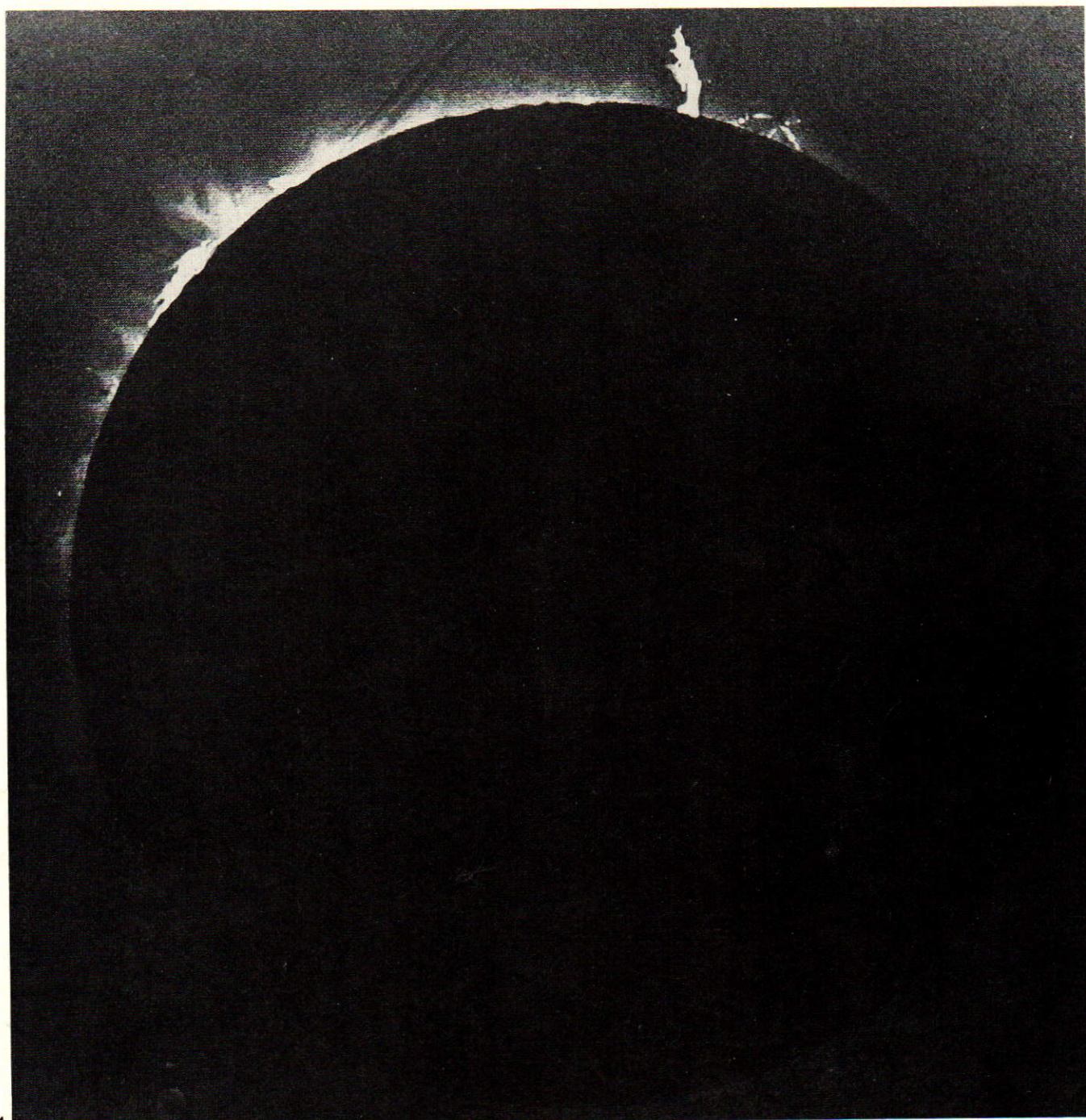
The royal prediction manifested itself in every way on the 18th August, 1868. At 10.16 in the morning, the sky over Wah Ko, which had been covered with rain

3.



3. His Majesty King Rama IV, King Mongkut, the Father of Thai Science.

clouds, suddenly became clear. The sun was visible in the distance and it was clear that the eclipse had begun. It lasted until 11.36.20 a.m. when it became total. The length of the total eclipse was 6 minutes and 45 seconds. People witnessing the event have said that "total darkness prevailed. People sitting nearby could not see each other. In the midst of the darkness of the total eclipse, the King's magnificence shone."



4.

4. Total solar eclipse photographed by Lt. Tennant Toey in India in 1868. This is the same eclipse that King Mongkut predicted would be visible over Prachuab Khiri Khan Province.

Some events in history appear to be destined. Upon his return to Bangkok on the 24th August, the King became sick with malaria. Then, on the 1st October in the same year, only 44 days after that historical occasion, the King passed away. Thailand lost not only a great King, but also a great scientist. At the end of his life, King Mongkut had lit the lantern to show the way for the country to develop.

One hundred and sixteen years have passed since that event and Thailand has maintained her independence to this day. To commemorate this great King, the Parliamentary Ministers, on the 14th April, 1982, gave permission for the 18th August to be declared National Science Day, in honor of the Father of Thai Science.

SOUTHEAST ASIAN BRONZE METALLURGY: A SUMMARY OF DATA AND THOUGHTS

Despite intensification of data and a few 'lonely voices' from those who have first-hand experience in the field of Southeast Asian Archaeology, the traditional view of the region as a cul-de-sac in the course of cultural development still lingers on. Only a close look at the real situation of Southeast Asian Archaeology and History will reveal the complexity and multiplicity of both problems and promises of remarkable rewards in the field. There still remains doubt as to the basic soundness of earlier theories about this region and the data which gave rise to them.

In the case of bronze metallurgy, it has been observed that many authors have attempted to solve exceptionally complex archaeological and historical problems by argument and theory of diffusionism, often without any logic and hardly a reference to the finds.

Until recently, the belief that bronze and iron occurred simultaneously still predominated. Dong Son Culture, named after a type-site in Vietnam, was thought to represent a 'Bronze Age' of Southeast Asia, despite the presence of iron in several, if not all, Dong Son sites. Data has proved that there was indeed a period when bronze became common in both Northern and Central Southeast Asia and was followed by a period when both bronze and iron were in use. Dong Son, thus, does not depict a 'Bronze Age' life either in a Western or Asian sense so far as the term is concerned. Sites in Vietnam and Thailand have already produced ample evidence of an advanced bronze technology, bronze casting, by about 2,000 B.C. which suggest a much earlier date for the first metals in this region. Contrasts can be drawn between Southeast Asian and Western context as to the application of bronze, and perhaps iron as well.

1. The use of bronze by prehistoric people in Southeast Asia was probably a

mere addendum to their agriculturally based societies. One would be guilty of oversimplification if he were to maintain that the period when bronze became common in this region is synonymous with the 'Bronze Age' of the West. Mining activities and the manufacture of both bronze and iron artifacts do not necessarily mean that a new level of social and political organization developed corresponding with the Bronze Age in the West.

2. The existence of bi-metallic implements at Ban Chiang in Thailand in transitional layers, between layers of bronze and iron, may not argue for its internal origin, but it does indeed demonstrate its internal development. Any theory on the origin of bronze technology in this region is, therefore, more confusing than revealing, when there is little evidence for the time being to support indigenous development or external influences of the techniques.

3. The contrast between these two worlds during the period in question expresses itself clearly in the production of the metal artifacts. Implements which may be classed as weapons, e.g. spearheads, etc., were least produced, while agricultural tools, as well as jewellery, predominated. Different forms of artifacts seem to indicate somewhat their functional differentiation.

Since different people have different cultures and histories, it is unwise, and even dangerous, to loosely compare various institutions with one another. There are a few more points based on recent works and observations which need to be made in regard to bronze metallurgy in general.

1. Colour variations on the surface of metal objects may indicate a difference in alloy. The Thai assemblage comprises both bronze and iron. Gold and silver was also evident at some sites.

2. Presence of moulds definitely indicate repetitive use of the moulds for

some time, more reproductions can be made, hence an advantage over the manufacture of stone industries in previous times. Moulds, especially of adze types, are found to be made almost exclusively of sandstone. Few clay moulds were used for making smaller adzes and jewellery.

3. Early bronze instruments and jewellery were made in forms similar to those made of stone, wood, shell and bone, the use of which continued for some time after bronze was introduced. Both bronze and iron continued to be used into historic times. Modern local villagers are still producing their own metallic artifacts, such as bells and spinning devices, as well as vessels. Many of these are similar in form to their prehistoric prototypes.

4. Technically, small cavities on the surface of the bronze have been observed from some sites, indicating some problems in smelting, for example, vesicles cannot be rid of effectively. It is an unfortunate fact that the poor state of preservation of many bronze artifacts, due to the environment in which they were buried, inevitably hinders identification of some kinds and prevents

examination of the metallic particles as well.

The appearance of cast bronze technology in Thailand dating from about 2000 B.C. has puzzled both archaeologists on the excavations and scholars in the field generally. Indeed, a few have challenged these findings. They have questioned a complete series of radiocarbon dates produced by the University of Pennsylvania laboratory and they have questioned the species of wood which produced the charcoal. Some asked to conduct validity tests on the material while at least one person tried to secure test samples surreptitiously. The point of this distressing tale is that the findings of technological development of this kind in Southeast Asian societies are often challenged as unlikely while those of, say China or India, are not.

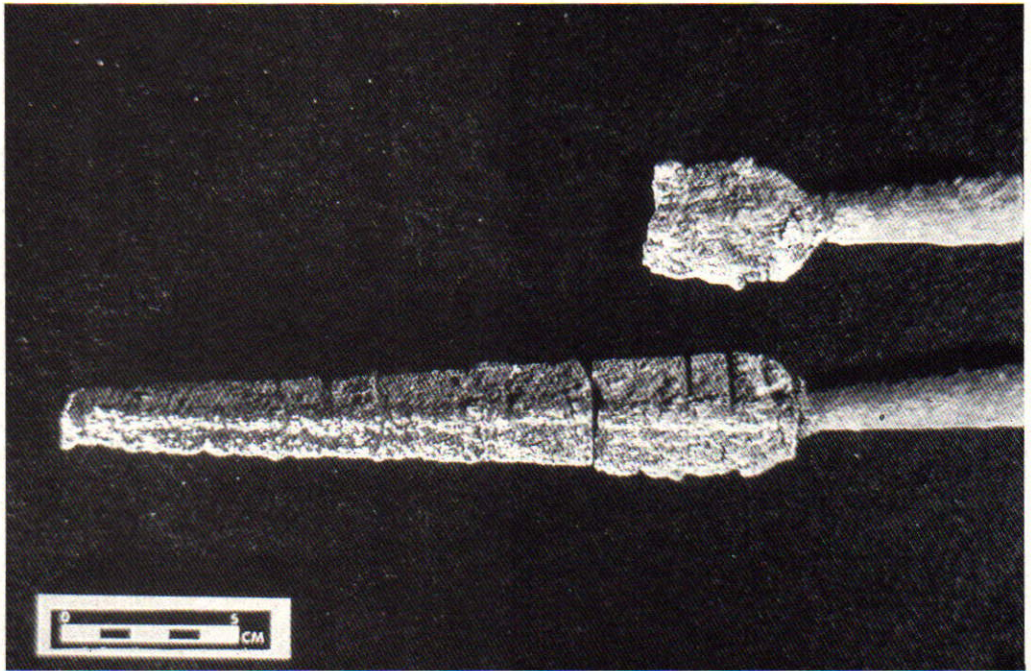
Hopefully, a new image of Southeast Asia will gradually change to a more logical one. Scientific and decent debates should be continued. A good text on world history cannot be too concise just for the sake of convenience.



1.

1. Cast bronze spear point associated with a flexed burial at Ban Chiang, ca. 2000 B.C.

2.

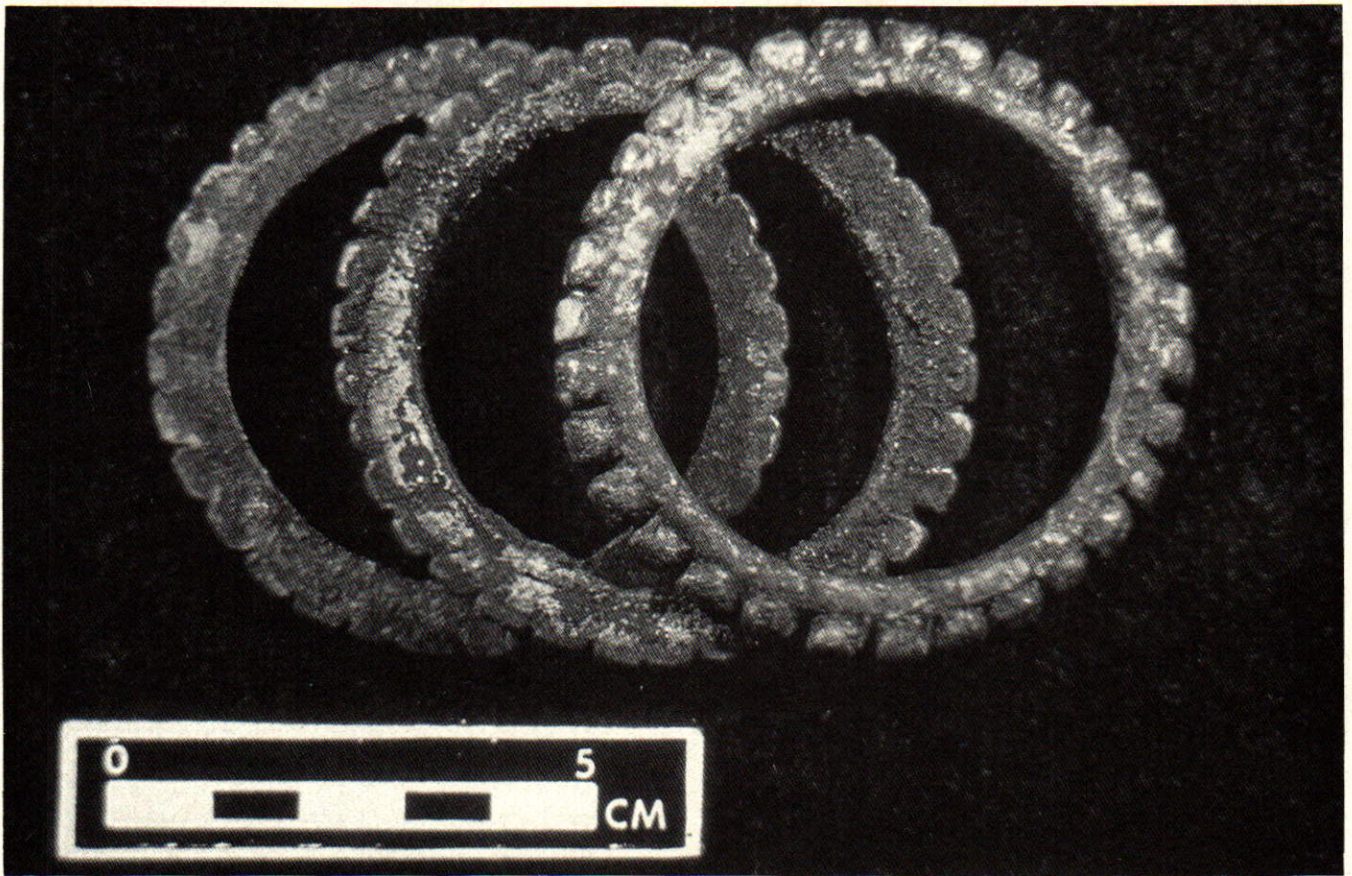


3.



2. Bi-metallic spear point. Iron blade with bronze bracelet, ca. 800-400 B.C.
3. Bi-metallic bracelet, ca. 800-400 B.C.

4.



5.



6.

4. A type of bronze bracelet, ca. 800-400 B.C.

5. The presence of clay crucibles (together with sandstone moulds, etc.) at sites are clear evidence of bronze casting process.

6. Iron implements commonly found at sites of later dates.

CHIANG SAEN

1.

Chiang Saen District is situated on the western side of the Mae Khong River in Chiang Rai Province. City moats and walls border three sides of the city while the river acts as a natural moat on the eastern side.

According to ancient records, Chiang Saen was founded in 1288 A.D. during the reign of King Mengrai who ruled at Chiang Rai. Saen Phu, by the command of his grandfather, King Mengrai, moved the people from Chiang Rai along the Mae Khok River in search of land to establish a community. After seven days he and his people arrived at the Mae Khong and found suitable land on the western bank. This land is located between the mouths of two rivers, the Mae Ruak to the north and the Mae Khok to the south. Saen Phu then founded the city and named it Chiang Saen. The word Chiang is the northern dialect for city. Chiang Saen, therefore, means the City of King Saen Phu.

Archaeological discoveries support ancient records which date some of the ruins and art objects discovered in the ancient city of Chiang Saen back to the reign of King Mengrai. Wat Pa Sak, which is located at the western gate of the city, is a fine example of architecture from that period. The main brick stupa with stucco decorations exhibits the classic Lanna style. It combines Sukhothai influences with the local Hariphunchai style to form a new style of architecture. Examples of this can be seen at the pedestal of the stupa. Niches containing stucco Buddha images are definitely of the Hariphunchai style. The flanked niches containing divinity figures, as well as the walking Buddha image on the northern side, are of the Sukhothai style. Moreover, the costumes of the



1. Wat Pa Sak

Founded in 1295 A.D. by King Saen Phu

Classic Lanna style demonstrating Hariphunchai and Sukhothai influences.

divinities are comparable to those of Sukhothai bronzes of Hindu deities. Records say that Wat Pa Sak was founded in 1295 A.D. by Saen Phu while he ruled at Chiang Saen. Sukhothai artistic influences may have come to the area by way of relationship between the kingdoms of Sukhothai and Lanna. The stone inscription at Wat Chiang Ram tells that King Ramkhamhaeng of Sukhothai, King Ngam Muang of Phayao and King Mengrai of Chiang Rai gathered at the area between the Mae Ping River and Suthep Hill in 1256 A.D. in search of land for establishing a new city, namely Chiang Mai. This undoubtedly suggests that Sukhothai and Lanna had a close relationship at that time. Stone Inscription I from the Sukhothai period, written by King Ramkhamhaeng, says that "In the middle of Sukhothai, the water in a reservoir called Tra Phang Phoi Si is as clear and drinkable as that of the Mae Khong in the summer". The date of the Sukhothai Inscription is about 1292, 4 years after the foundation of Chiang Saen and 8 years after the foundation of Chiang Mai. Where could King Ramkhamhaeng have tasted the water from the Mae Khong River if not at Chiang Saen?

Chiang Saen sculptures display their own individual characteristics, although some show Sukhothai influences. Each stucco Buddha image at Wat Pa Sak is topped with a lotus bud shape while the top of a Sukhothai image is a flame like shape. A Pa Sak image has a round face with a protruding chin. The torso gives a feeling of firmness. All of these particular characteristics are also evident in bronze Buddha images in the city of Chiang Saen. Sukhothai features are increasingly represented in images of the later period. However, the unique characteristic of the northern style still remains in the upper torso of the Buddha image which is slightly bent to the front or to form a verticle line.



2.



3.

2-3 North side of the main stupa at Wat Pa Sak, Lanna Style, A.D. 1295.



Bronze casting of Buddha images in Chiang Saen involved advanced techniques. Artisans had to know how to control the heat as well as running the molten metal without using a thermometer. A number of moulds were used for casting one image. The caster examined the heat of the metal by its colour. When it had been melted to the right colour, it was poured into the mould. The cast was done in cire-perdue or lost-wax technique which had been practised at Ban Chiang since pre-historic times. The thin wall of the images demonstrates the very high skill which the workman possessed. Images with a width of less than one metre were cast in one mould. Those with a width of between 1-1.5 metres had to be cast in separate parts, namely the top, the head, the torso and the left hand. These parts were then welded together. Those images with a width between 1.5-2 metres had to be cast in two parts with the torso divided at the waist. In some cases the heads were cast in two pieces, the face separate from the back. These techniques can be learned from a survey of the images in the Chiang Saen area. The image, Phra Chao Lan Thong (the Buddha of a million gold) is a fine example. It was cast in 1489 A.D. by Phra Chao Thong Ngua, grandson of King Trailokhanat of Chiang Mai, while he ruled at Chiang Saen. The width of this Buddha image, measuring from the left knee to the right knee, is 2.10 metres and, according to the name of the image, the one million gold in weight is approximately 1200 kilograms. Phra Chao Lan Thong is the largest bronze image in Chiang Saen and is still situated exactly as it was during the glorious age of Chiang Saen.

4.

4. *Buddha Subduing Mara*
Lanna Style
National Museum, Bangkok.

5.



6.



7.



5. *Buddha Subduing Mara*
Sukhothai Style
National Museum, Bangkok.
6. *Walking Buddha*
Sukhothai Style
National Museum, Bangkok.

7. *"Phra Chao Lan Thong" (Buddha of a million gold)*
Buddha Subduing Mara in the Viharn of Wat Phra Chao Lan Thong.
Bronze
Width 2.10 meters
Height 3 meters,

SUKHOTHAI

The name Sukhothai is well known amongst Thai people as the name of an ancient Thai city-state. Sukhothai is regarded historically with great importance as it was there that the first historical evidence, in the form of the Thai alphabet and the Thai language, was discovered.

The history of Sukhothai began approximately at the start of the 13th century. Si Satchanalai and Sukhothai, two cities located in the fertile plain on the meandering Yom river, are mentioned as early settlements of the Sukhothai region. In those days, the territory of Sukhothai stretched from Nakhon Sawan to Uttaradit. Tak marked the western border and Phetchabun the eastern border. By the early 15th century, however, these regions became parts of the Ayutthaya Kingdom.

Although two hundred years may be considered a short period historically, Sukhothai left many indigenous attractions to enhance her historic importance. Apart

from the historically invaluable stone inscriptions, there is the famous Sukhothai pottery. Not only is this pottery praised locally, but it is also acclaimed internationally for its high historic value. Sukhothai pottery is better known by the name Sanghkalok pottery, after the city of Sawankhalok which is another name for the city of Si Satchanalai. Sanghkalok pottery refers specifically to glazed ceramics. The process for making this pottery is highly complicated and requires the special skills of experienced potters. A source of suitable clay must first be found. This clay is then carefully prepared prior to being placed on a rotating potter's wheel for shaping. Once the required shape has been obtained, the pot is left to dry before glazing. Mineral oxides are specially mixed and prepared to make the colour glaze. This is a very important step and requires much experience. After the pots are glazed, they are placed in a kiln and baked at a temperature of 1200-1300°C for a pre-



1. The northern side of Sukhothai showing a mound where Sanghkalok ceramics were produced.

2.



4.



3.



5.

2. Earthen kiln for baking Sanghkalok ceramics. The roof and chimney have now been destroyed.
3. Various types of Sanghkalok ceramics.
4. Religious artifacts were also produced in this region.
5. Small objects, such as dolls, figures of people and animals used to dispel bad luck, were produced in this area.

determined length of time. The outcome of this long and complicated process is the beautiful refined Sanghkalok ceramics.

There are various technical details in the long process of pottery making which can only be recognized through experience. For example, the moisture in the clay must be completely eradicated before the pots are glazed, the kiln must be designed to a certain shape, the appropriate kind of firewood has to be selected, and it is necessary to know exactly how much to add in order to maintain an even temperature throughout the kiln. The temperature must be carefully controlled as it effects the colour of the pots being baked.

The art of making Sanghkalok ceramics is not easy to master and can only be learnt through experience. It is, therefore, not surprising to find Sanghkalok ceramics being produced and used locally and in neighbouring regions. The pottery production from each kiln ranges from bowls, dishes, pottery utensils to decorative objects, tiles, religious artifacts, pottery dolls used for dispelling bad luck and so on. After the Sukhothai region merged into the Kingdom of Ayutthaya, Sukhothai and Si Satchanalai became the trade centres for Sanghkalok ceramics. Sanghkalok ceramics are valued amongst Thai people not only as valuable antiques but also as important historical evidence of the flourishing Sukhothai civilization.

Sukhothai's successful growth was undoubtedly due to the fact that it was an important trade centre located on the trade route between the highlands of the North and the sea ports of the South, the Mae Khong river basin on the East and the Gulf of Bengal on the West.

The prosperity of this ancient kingdom can be accounted for by the fact that it was located in a vast fertile plain ideally suitable for agriculture. The actual sites of the two cities, Si Satchanalai and Sukhothai, were either too hilly or too marshy and provided only a small area of land for agricultural development, which was disadvantageous as the main agriculture was rice growing. Thus, when the small settlement expanded and developed into a large city-state, there arose

a need for agricultural development in order to cater for expanding communities. Extensive land was converted into agricultural land and a number of dikes were built to control the water. Some of these dikes were used as dams to prevent flooding. There were a large number of ponds in the city of Sukhothai which were used as reservoirs supplying fresh water for daily use. Mention of this is made in a stone inscription from the Sukhothai period which states: "The water in our ponds is cool and clear. Drinking water from our ponds is as refreshing as drinking the water of the Mae Khong during the drought..." The source of Sukhothai's water supply was the mountains to the west of the city and was brought to the city via an earthen aqueduct. Nevertheless, the ingenious system of irrigation failed to provide sufficient water supply for the rapid growing communities. It was not surprising, therefore, that the centre of administration was later shifted from Sukhothai to Phitsanulok on the Nan river where there were larger areas for agricultural development.

At the height of Sukhothai's prosperity, when there was a balance between the population and supply, the happiness much sought after by the people was that of the next life, in accordance with Buddhist beliefs. As a result, cities and towns in Sukhothai and its environs were adorned with Buddhist monasteries and temples. Local building materials, such as tiles and red porous bricks, were widely used in construction. The architectural styles were neither sophisticated nor grand, but simple and straight forward, keeping in harmony with the Buddhist philosophy and the contented way of life of the people of Sukhothai.

The search for greater happiness in the next life was reflected in the large number of bronze statues of the Buddha which have survived to this day and can be found in various temples and Buddhist households. It is impossible to estimate the exact number, but there must be thousands in varying sizes ranging from a small 10 centimetres in width to an enormous 3 metres in width. These Buddha statues have a thin, smooth

and even surfaced texture which reflects the great skill of metal casting and the accurate temperature control which allowed the even flow of the melting metal into the mould. A much greater skill was required for larger works. However, the people of Sukhothai had mastered the metal casting technique for more than 500-600 years and were able to mass produce Buddha statues as though it were a simple task.

It is evident that Sukhothai has left a trace of her ancient civilization and advanced technology, despite her being an autonomous city-state for 200 years. It is no wonder then that Sukhothai is regarded as one of the

most fascinating and idealized city-states of all time.

6. *A small reservoir on the western side of Sukhothai. This was built on the same site where traces of ancient dams were found.*
7. *As the Kingdom flourished, the people of Sukhothai concentrated on performing deeds which would ensure happiness in their next life.*
8. *Vertical columns were used in construction projects. Traces of natural materials are evident in religious structures. These have been found in vast quantities, however timber used in such structures has now completely disintegrated.*
9. *The people of Sukhothai were highly skilled in metal casting. The bronze image, Phra Sri Sakyamuni, is of the Sukhothai period. It measures approximately 6.50 metres across the lap. It has now been installed at Wat Suthat Thepwararam Ratchavoramaha vihar, Bangkok.*

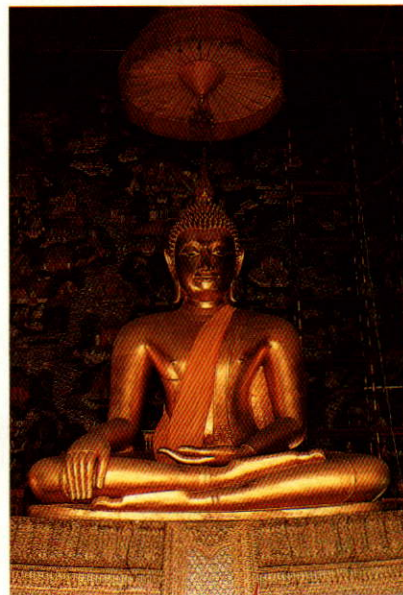
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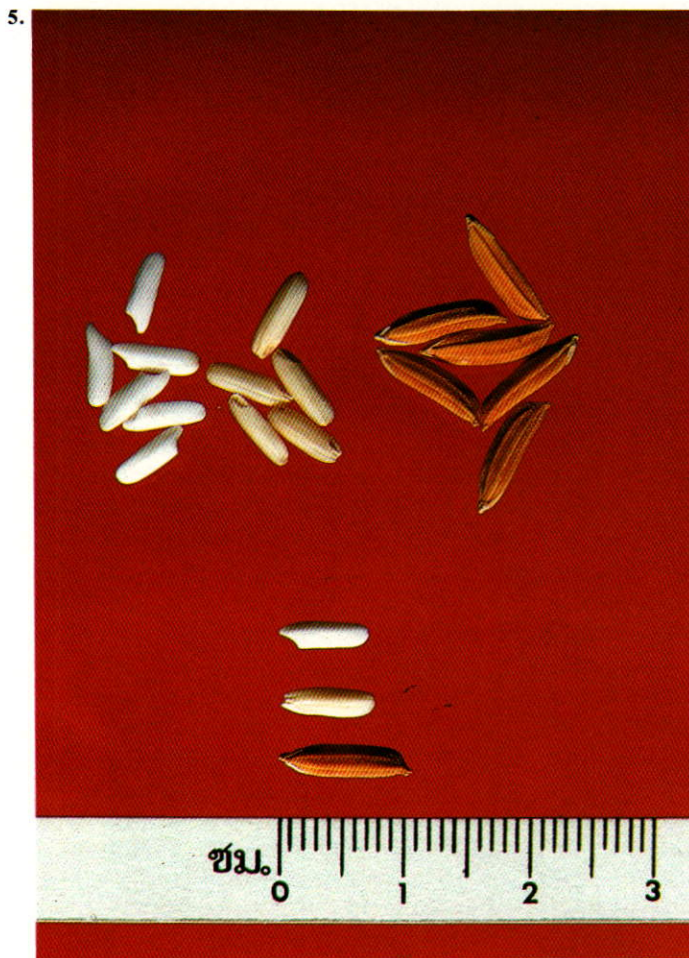
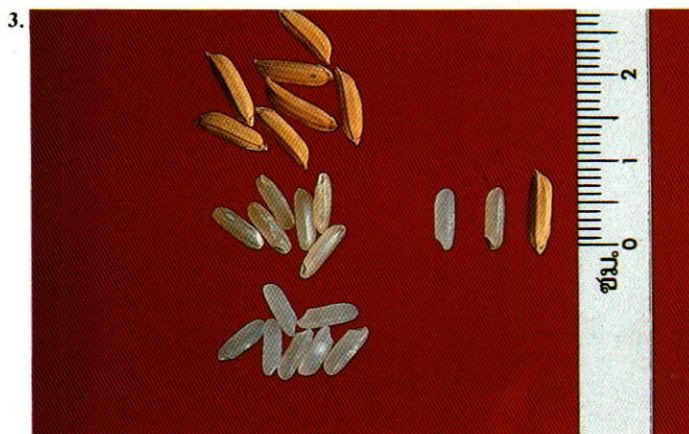
THAI RICE – A SPECIAL VARIETY

Thai rice farmers have long been regarded the back-bone of the country. Together with their buffaloes they live on rice farms which are generally located near water sources. In the rainy season they plough the wet paddy land with their buffaloes and, using their hands, plant rice for their own consumption and for the market. Only that rice which is surplus is sent to the market. At times of war, rice is the only commodity needed by soldiers. By nature, Thai people enjoy good food and have, for many years, been intent on selecting varieties of rice which are of a high quality. This careful selection of rice by Thai farmers has resulted in Thailand being known abroad, since 1933, as the land of quality rice.

During the reign of King Rama V, who was greatly interested in improving the quality of rice and rice production, two contests were organized to judge rice varieties. These were held at Thanyaburi in Pathum Thani Province in the year 1907 and at Suthat Thepwararam Temple in Bangkok in the year 1908. These contests were highly successful and were organised once again at a national level at the Agricultural and Commercial Fair held in Bangkok in the year 1910. Many varieties of high quality rice from all over the kingdom entered in the contests. As a result, at the Provincial Commissioners' Conference held in the year 1910, approval was given for the establishment of the first Rice Experimental Station in Thailand. This was set up at

Thanyaburi and, in the year 1916, was given the name The Rangsit Rice Experimental Station.

Phraya Pochakorn, who was the first head of the Rice Experimental Station, started a rice breeding programme in the year 1917 by selecting good local rice varieties with emphasis on grain quality, performance and agronomic characteristics. Later another 4000 varieties were collected from various locations. Phraya Pochakorn continued the cultivation programme until the year 1932 when M.L. Yingsak Isarasena became his assistant. In the year 1933, the Pin Kaew variety was discovered by Phraya Pochakorn and, in the same year, it was sent to the World Grain Exhibition conference in Regina, Canada. This variety was awarded the first prize at the exhibition. The Pin Kaew is native to the lowlands of the central plains of Thailand. It has a tall sheaf, very long, slender and clear endosperm and is good for cooking and consumption. It is also sensitive to photo-period. Since that time, Pin Kaew has been a well known variety of Thai rice and is being used as a basis in rice development programmes. Rice varieties from the current cultivation improvement, lead by Dr. Krui Punyasingh, Dr. Sala Dhasananda, Dr. Bhakdi Lusananda, Mr. Phairoth Sopanarath, which at present are widely accepted in terms of quality rice in the Thai rice market, are Khao Dok Mali, an aromatic rice, RD7 and RD23.



1. Typical dishes of the Thai rice farmer include cooked rice, curry, soup, fried vegetables hot appetizers, fruits and drinking water. Farmers usually eat rice three times a day.
2. Khao Dok Mali paddy and brown rice grains.
3. RD 7 paddy, brown rice and milled rice grains.
4. Rd 23 paddy, brown rice and milled rice grains.
5. Niew San Patong, brown rice and milled rice grains. This is a high quality glutinous rice grown in Thailand. People in the North and Northeast prefer glutinous rice or sticky rice as their staple food.
6. Hybridization is one of the techniques used for rice varietal improvement in Thailand. The picture shows the hand pollination technique.

TISSUE CULTURE OF TEAK : A CASE STUDY

Teak, one of the most well known timber of the world, occurs naturally only in India, Burma, Thailand, Laos and Indonesia, in which the climatic condition is of the seasonal tropical type. Among these sources the Thai as well as the Burmese-teak are considered as timber of highest qualities in the international market.

Owing to a rapid decline in timber production plus the excess demand for teak, large-scale planting programmes of the species have been set up in several countries both within and outside its natural region.

Teak plantation in Thailand was first established, on trial, in 1858 and the annual planting programme started since 1942. The rotation period of the teak plantation is generally expected to be between 60 and 80 years depending on site qualities. Given the lengthy rotation, the seedlings used for plantation establishment must be of high genetic qualities and the seed must be collected from the genetically improved seed sources such as seed production areas and seed orchards. Alternatively, clones derived from the genetically superior trees may be used for plantation to obtain better quality plantation with high growth rate.

1.



1. Seedlings in nursery.

A modern means of vegetative propagation of teak tree using tissue culture technique (micro-propagation) has been attempted by a research team from the Department of Forestry in conjunction with Chiang Mai University. After a few years of hard work, successful results revealed a new frontier for teak clonal propagation. The conventional propagation method of sowing seeds and budding may be replaced by culturing plant materials *in vitro*. When seeds from selected teak trees are sown onto an agar low-salt medium and cultured for 45 days, pieces of single-node buds can be dissected and transferred to an agar high-salt medium containing a proper balance of phytohormones suitable for inducing clusters of multiple shoots which grow rapidly providing 6 shootlets per single piece within 60 days. The individual shootlets can be dissected again into single-node buds at the rate of 3 pieces per shootlet, providing 60 pieces of explants within another 60 days capable of producing 300 shootlets or 900 explants within the next 2 months. The multiplication was highly increased from a single seed from selected trees. The rate of multiplication is so rapid that within one year approximately one million plantlets can be easily obtained. Using this prototype, a single bud from a mature elite tree can also be mass propagated to produce plantlets of the same genetic make-up.

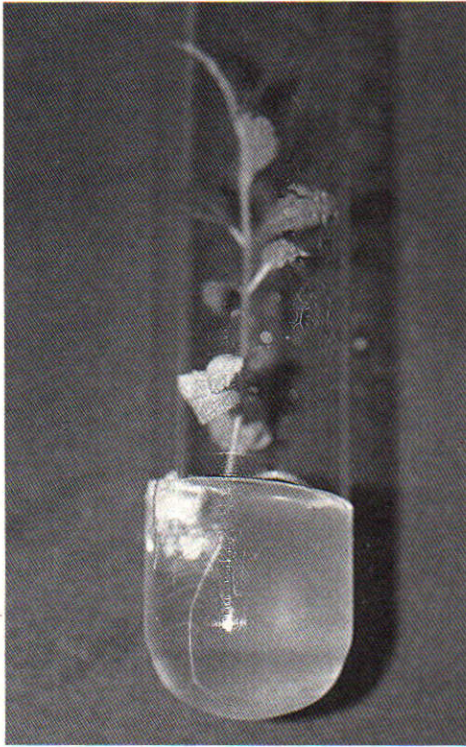
Apart from mass propagation for clonal plantation establishment this technique can also be employed in teak improvement programmes, especially through the callus obtained.



2.

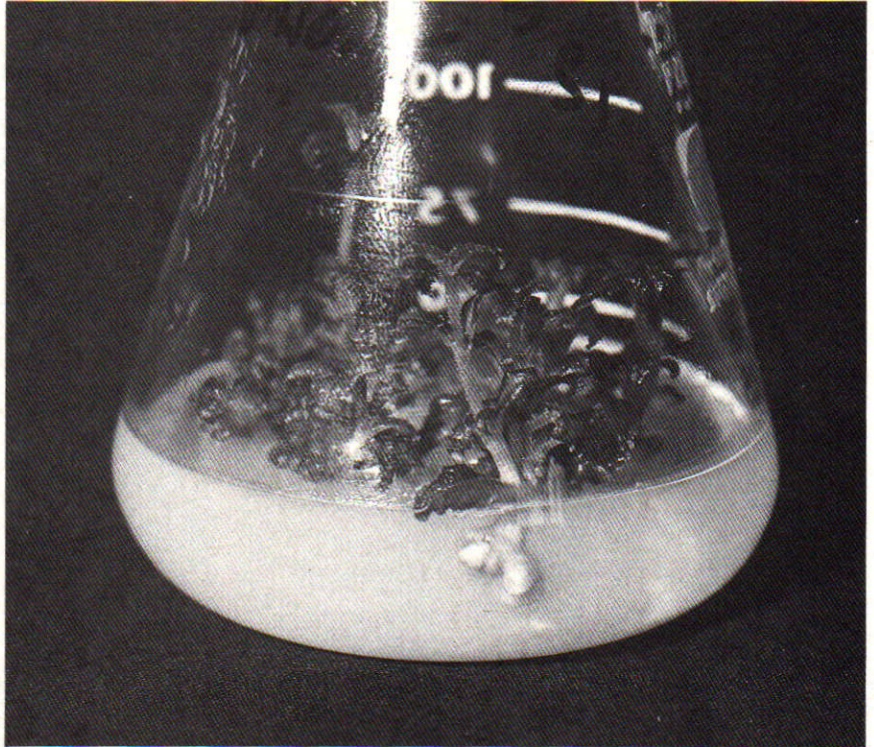
2. selected trees.

3.



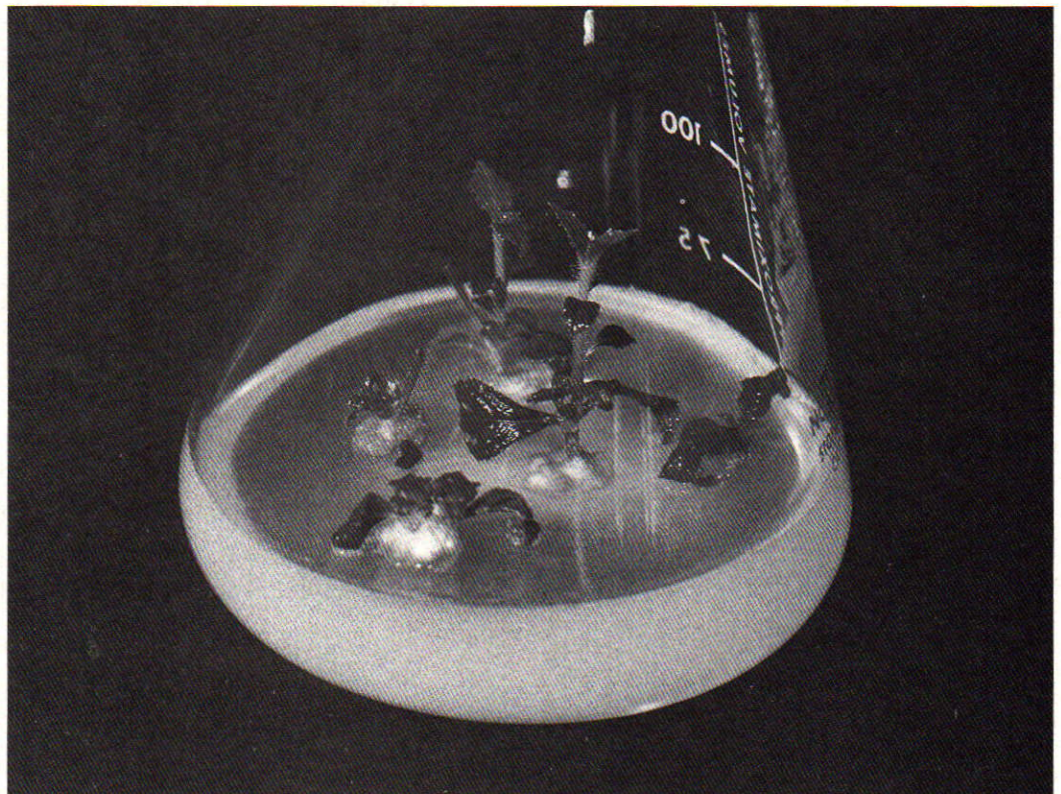
3. Seedling grown in vitro.

4.



4. Nodal segment cultured on artificial agar medium.

5.



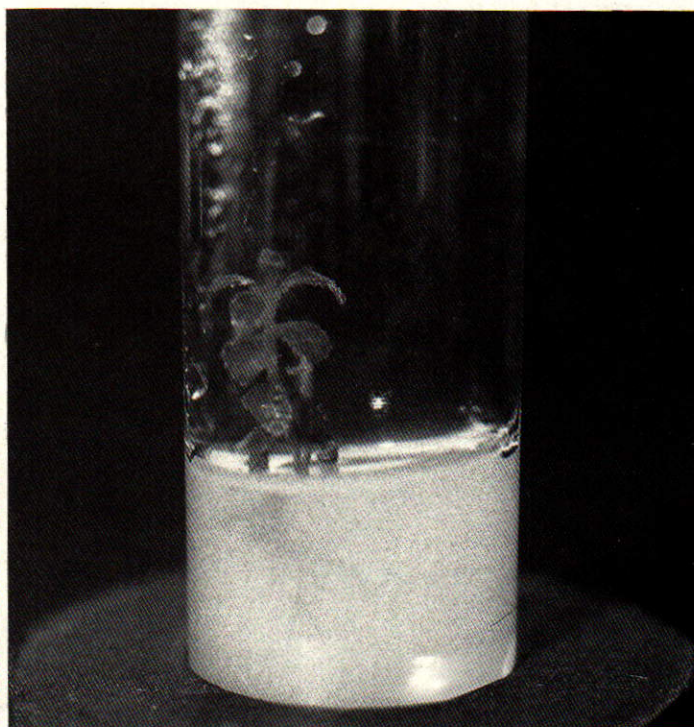
5. Clusters of regenerated shootlets from Figure 4.

6.



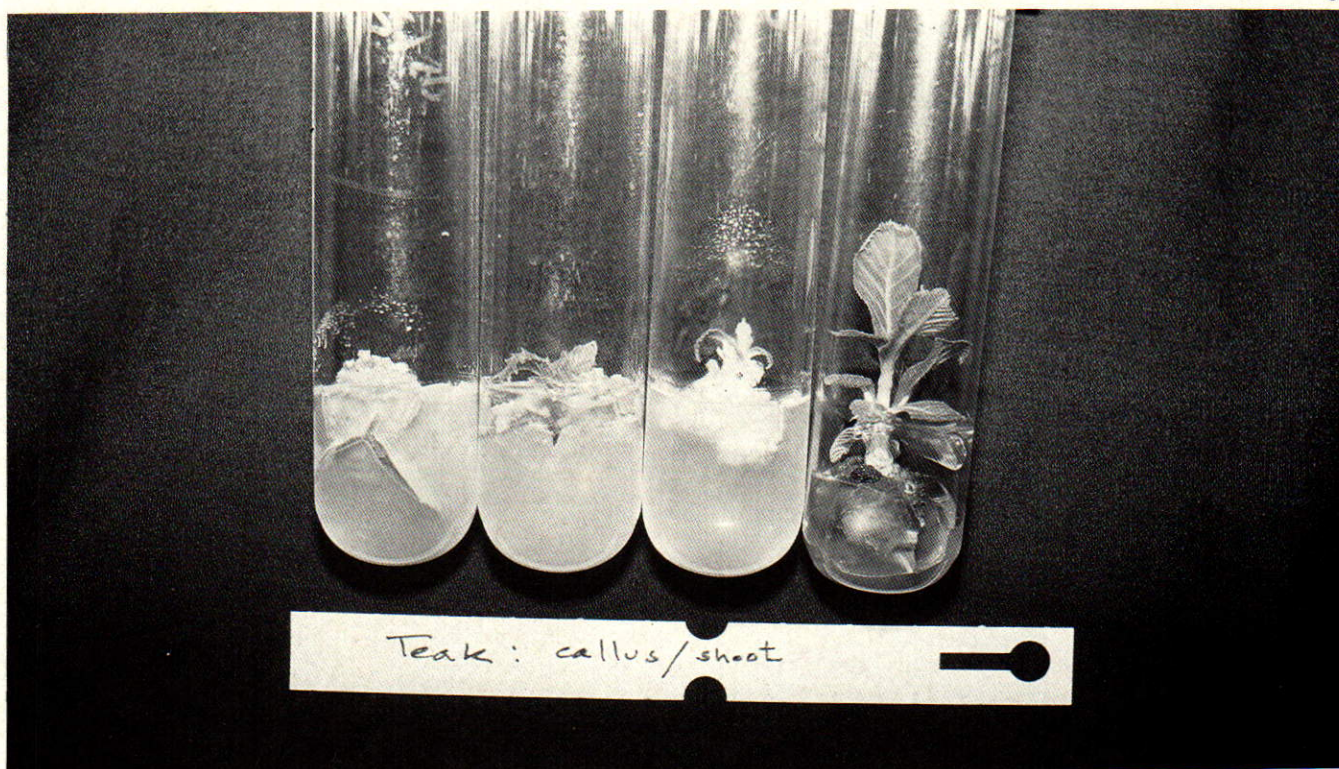
6. Shootlets ready to be dissected for sub-culturing.

7.



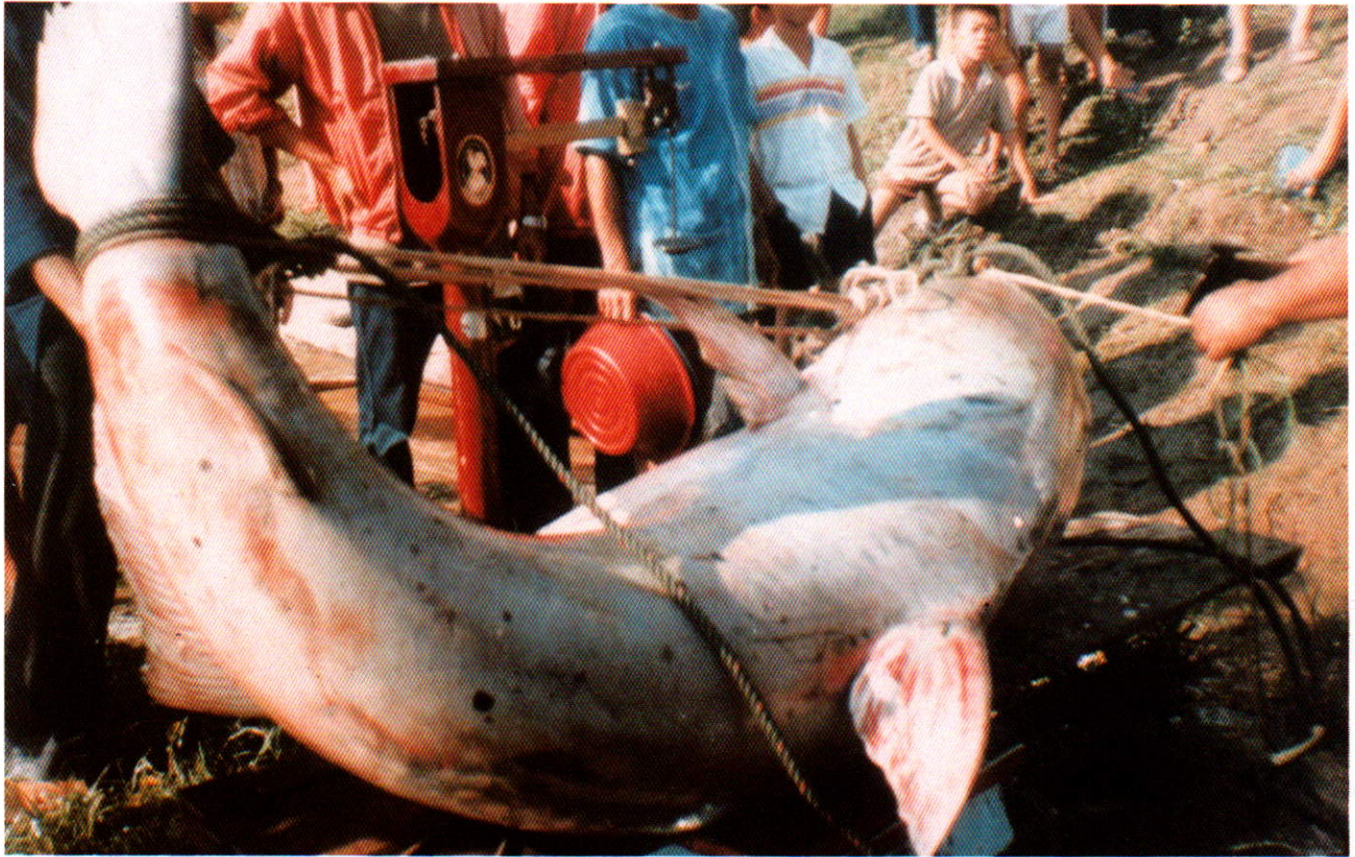
7. Individual plantlet derived from a root-induced shootlet.

8.



8. Bud from the selected tree (Fig.1) cultured on agar medium for multiplication of shootlets.

INDUCED FISH BREEDING IN THAILAND



1.

1. A 240 kg. Mae Khong River Giant Catfish.

As fish comprise a major part of the Thai diet, it is important that there is a sufficient supply to meet the never-ending demand. One way to ensure that the demand is met is by application of induced breeding techniques.

Experiments in induced fish breeding began in Thailand in the early 1960's and developed steadily over the years bringing much success in the breeding of various species of finfish and, particularly, the Mae Khong River Giant Catfish which was previously on the verge of extinction.

Work in this field is carried out by the various fisheries stations throughout the country as well as by the National Inland Fisheries Institute of the Department of Fisheries.

To induce spawning, fish are injected with a hormone solution derived from the pituitary gland of a fish of the same species as, or a species closely related to, the recipient fish. Dosage is determined by the size and weight of the fish being injected. Injection is generally intramuscular and spawning treatment is normally completed after only two

injections, given at an interval of about twelve hours. In the case of the Mae Khong River Giant Catfish, three injections are required over a period of sixteen hours.

Treated fish are usually ready to elicit eggs between five and ten hours after the second injection. Prior to stripping the eggs, the female is wiped with a towel to get rid of water. Eggs can be stripped into a dry plastic container by pressing the abdomen while milt is dripped onto the eggs by pressing the cloaca of the male. Eggs and sperm are mixed by stirring gently with a feather. Once this has been done, a little clean water is added and lightly mixed. After one to two minutes, clean water is added to wash the fertilized eggs. This process is repeated two or three times. The fertilized eggs are then transferred to hatching funnels, or hapa, where they hatch

after a period of 12-24 hours, depending on the species of fish.

Fish so far successfully bred in captivity, by using this method, include various types of carp, such as the Silver Carp, Indian Carp, Bighead Carp, Thai Carp, and various types of catfish, such as the Walking Catfish and the River Catfish (Mae Khong River Giant Catfish).

The number of fry and fingerlings produced annually ensure a constant supply of fish for consumption and also supply researchers with sufficient brood fish for further spawning and breeding. Researchers are also provided with fundamental data which will help in managing the population of endangered species and prevent their extinction.



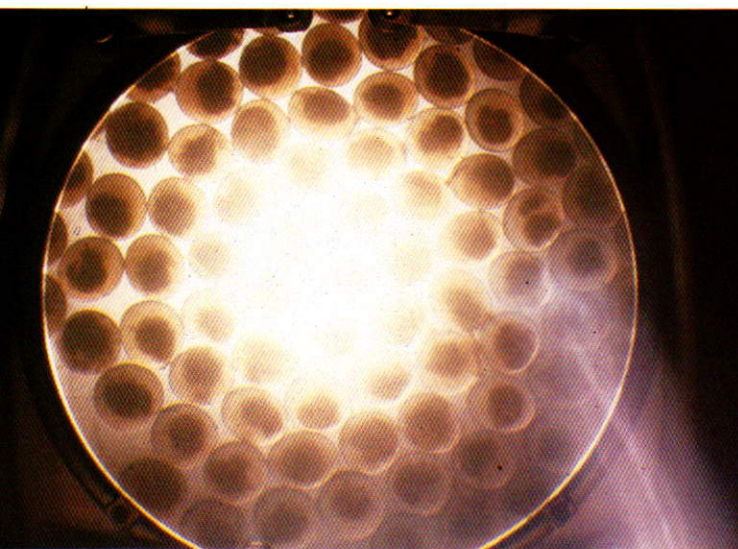
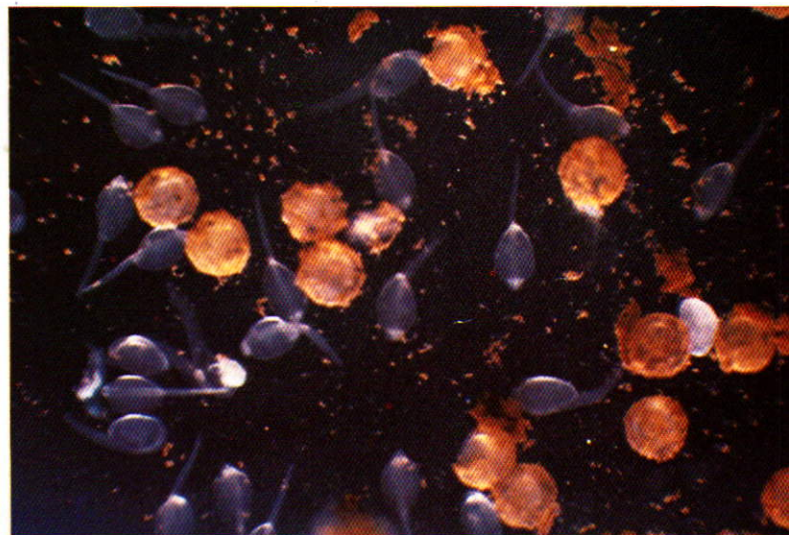
2.

2. Taking eggs from the female to determine stage of maturity.



3.

3. Hormone injection.



4. | 7.
5. | 8.
6. | 9.

4. Female fish hanging on a tripod for stripping.
5. Eggs being mixed with sperm from the male.
6. Fertilized Eggs.
7. Checking development of embryo.
8. The newly hatched fry.
9. A 10-day old fry.



REMOTE SENSING

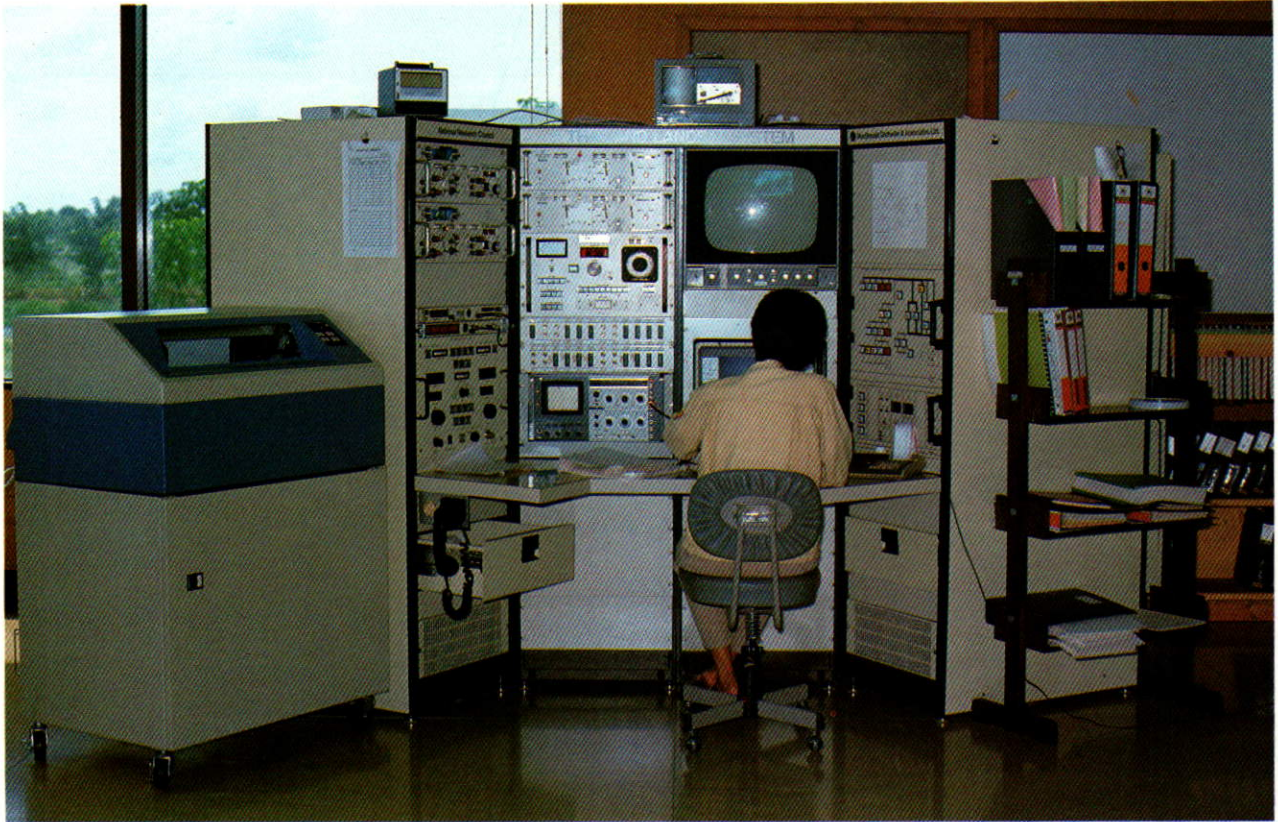
1. Thailand Landsat Station.

Historical background

Although the first satellites for observing the earth and space environments were launched more than twenty years ago, it was not until the last decade that satellite technology was developed and became an effective tool for use in surveying and monitoring natural resources. This is particularly true for Thailand. Prior to the launching of LANDSAT in 1972 — satellite series for land resources observation — the only form of remote sensing used for the surveying and mapping of natural resources was via the conventional aerial photography. Through participation in the NASA Earth Resources Technology Satellite Programme in 1972, Thai scientists in various disciplines have become familiar with satellite remote sensings. To focus on certain aspects of

satellite applications that would best suit the country as regards national planning and development, a national co-ordinating committee on remote sensing was then set up to include representatives from various concerned departments. In order to promote and increase awareness of satellite technology and its applications to studying natural resources, multi-disciplinary subcommittees were appointed by the national committee to initiate, supervise and co-ordinate activities in remote sensing and related subjects. Such activities have led to the development of ground facilities that are capable of satellite data reception and processing in order to serve the needs of users on a national, as well as regional, level.





2. Control Console of Thailand Landsat Station.

Thailand LANDSAT ground facilities

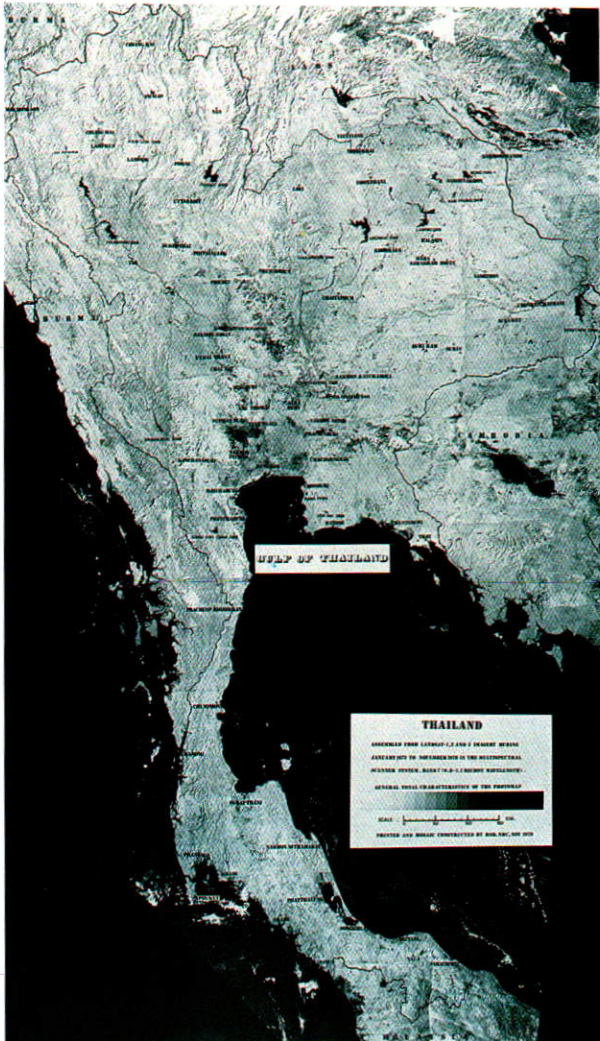
The LANDSAT ground receiving station of Thailand, under the responsibility of the National Research Council of the Ministry of Science Technology and Energy, was set up in November, 1981. After undergoing an experimental phase of data reception and processing, the station commenced normal operations in 1982. The station facilities include LANDSAT MSS receiving system, data pre-processing and processing equipment, and interactive image analysis system. These systems and related routines are run by Thai engineers and scientists who were trained by the satellite station contractor.

The LANDSAT ground coverage by the station covers as many as eighteen countries in Southeast Asia, namely Bangladesh, Bhutan, Brunei, Burma, Kampuchea,

China, Hong Kong, India, Indonesia, Laos, Malaysia, Nepal, Pakistan, the Philippines, Sri Lanka, Taiwan, Vietnam and Thailand. In addition to the acquisition of LANDSAT MSS data, the reception capability has been extended so that it can receive other meteorological satellite data such as the NOAA/TIROS-N series and the Japanese GMS satellite.

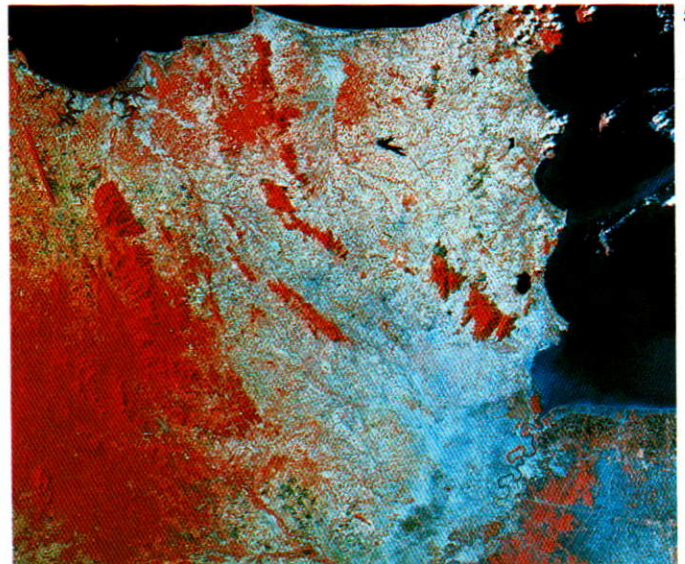
The pre-processing and processing systems allow for satellite signals to be converted into usable and interpretive forms. The processed data, either in the form of photographic images or computer tapes can then be achieved in a central file. Such data can be reproduced and distributed upon users' requests.

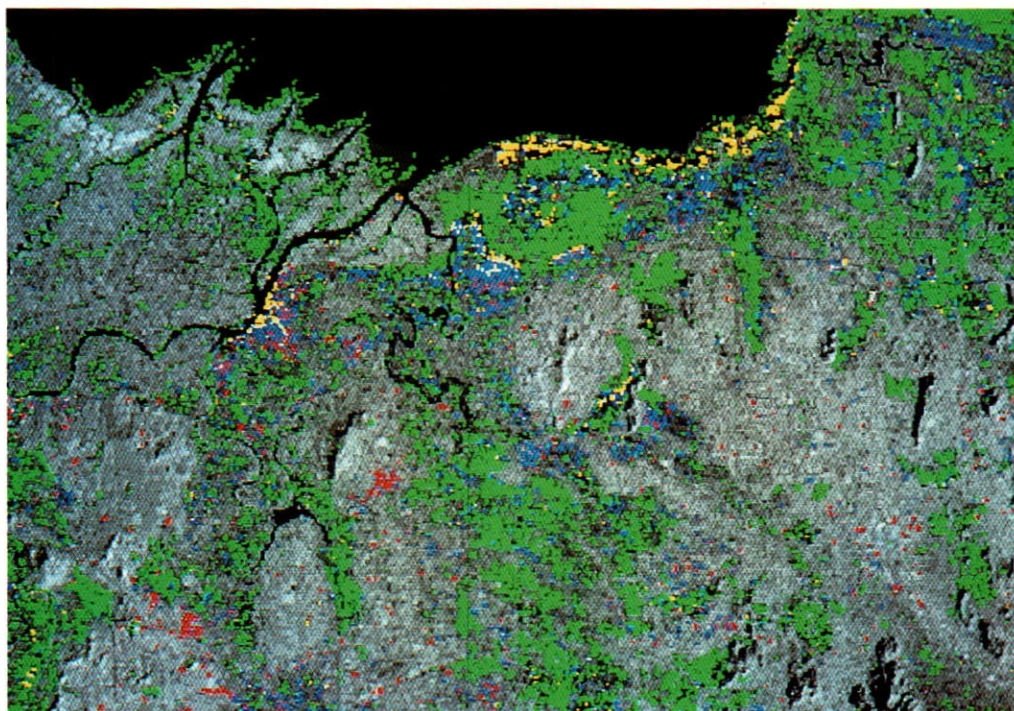
3.



3. Mosaic of Landsat Infra-red image of Thailand.

4. Her Royal Highness Princess Maha Chakri Sirindhorn graciously visits User Service of Thailand Remote Sensing.
5. False Color Composite of Landsat Multispectral Scanner Data of Eastern Seaboard.





6. Land Use classification of Landsat data by Digital Analysis of Suratthani Province, South Thailand : yellows depicts urban area; green shows paddy fields and agricultural land; blue is orchard and red is mining or open land whereas dark area is water or sea.

Satellite applications

Since the launching of the first LANDSAT satellite, the space-borne data have been widely used for surveying and mapping natural resources, particularly in areas which are of socio-economic importance to the country. For instance, by using LANDSAT images it has been possible to map the forested area of the entire country, thus allowing the extent of deforestation to be monitored very closely. The fact that the forested area is rapidly decreasing is alarming. Landsat data play an important role in planning and management to prevent desertification problems. Another example of regional mapping is land use classification for different parts of the country. Thematic maps showing patterns of important crops, such as rice paddy, orchards, sugar cane, and rubber plantations, have also been produced. Such information is valuable for rural and urban planning as well as for the land development scheme. Landsat proved

its importance to the field of geology by doing the first mapping of the geological structures of the entire country in a manner quicker and more accurate than any other conventional method could offer. Furthermore, several large scale faults and fractures were able to be detected. These geologic features were found to correlate well with certain mineral deposits. The up-to-date data from the satellites have also permitted some studies to be made on dynamic phenomena or natural disasters such as in the case of monitoring floods in the Northeast and the Central Plains.

In conclusion, satellite data have proven useful through various applications and have become a valuable tool for natural resources observation. Quite extensive work on different aspects of application has been carried out at various institutes. National resource maps have been produced and existing maps updated.

MATERIALS

Thailand has a relatively high potential in mineral resources and some agricultural commodities, such as rubber, that could constitute a sound basis for the production of industrial materials. The mining industry contributes substantially to the national economy by supplying materials to local industry and for exportation.

The total mineral production in 1983 amounted to over 8,200 million baht, over 72% of which came from tin concentrate. Other important minerals (and their production values in million baht) are lignite (395), gypsum (297), fluorite (333), lead

(217), barite (164), tungsten (150), feldspar (63), antimony (42), and kaolin (25). Minerals that could be processed into high value added metals and materials, such as columbite, tantalite, monazite, ilmenite and zircon, have been found in the tailings of tin ore dressing. Exports of minerals and certain metals bring in much needed foreign exchange earnings. For example, the 1983 total export value was 6,666 million baht (5,225 million or 75% from tin). As regards non-mineral based materials, Thailand is the world's third largest natural rubber producer. Natural rubber exports in 1983 totalled 11,637 million baht.

1. Oxide-coated float glass used in high-rise building.

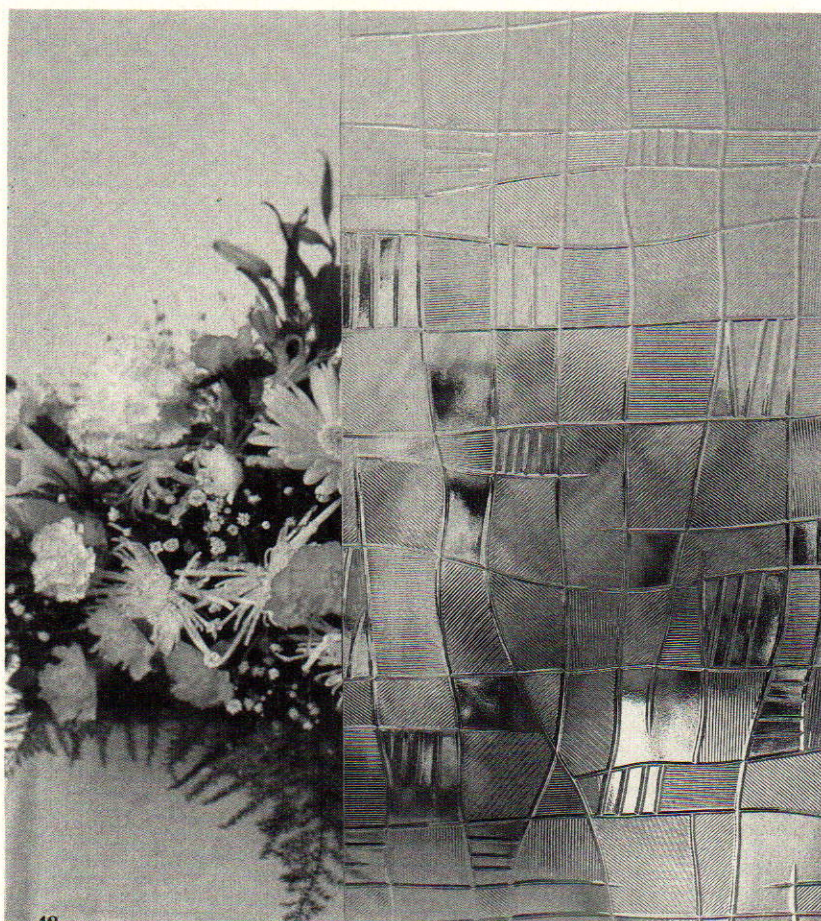


Indigenous materials have been found to be of a quality comparable to imported materials. Notable are the extensive activities in the ceramic industry producing items such as table-ware, sanitary-ware, tiles and bricks. A variety of products manufactured from local materials, such as cement, gypsum-board, paint, glass and glass-ware, is available for the domestic market as well as for exportation. With regard to natural rubber, about 10% of locally-produced natural rubber (sheets, crepe and blocks) is absorbed by Thailand's industrial sector, the remainder is exported. The only industries which utilize a significant amount of domestic rubber are the tyre and rubber band industries, which in recent years have become increasingly export-oriented.

However, certain minerals and mineral-based intermediate materials from which raw materials can be locally obtained are imported for industrial production. Examples of these are coating grade kaolin and titanium-based pigments. In addition, local utilization of minerals such as tungsten, tantalum, antimony and fluorite has not materialized due to lack of local processing of these indigenous materials. Moreover, it is well recognized that for metal-based materials technology transfer and selective R & D activities are required in the fields of extraction, purification of metals, alloys production and manufacturing technology of metal products. To rectify the situation and to establish a firm foundation for the development and utilization of materials,



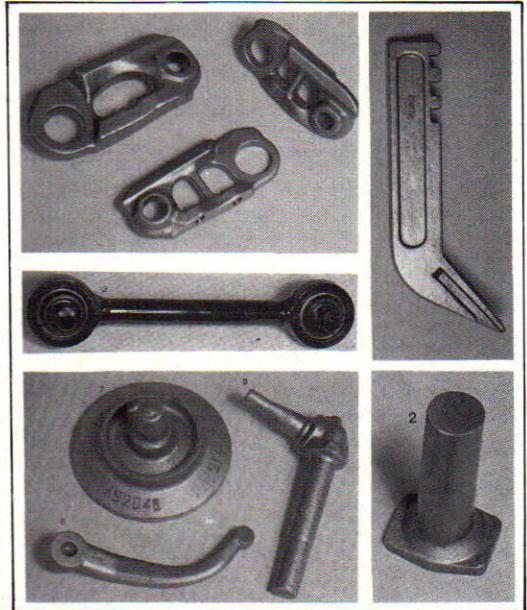
2. Glass fibre products used as insulating materials are now produced in Thailand.



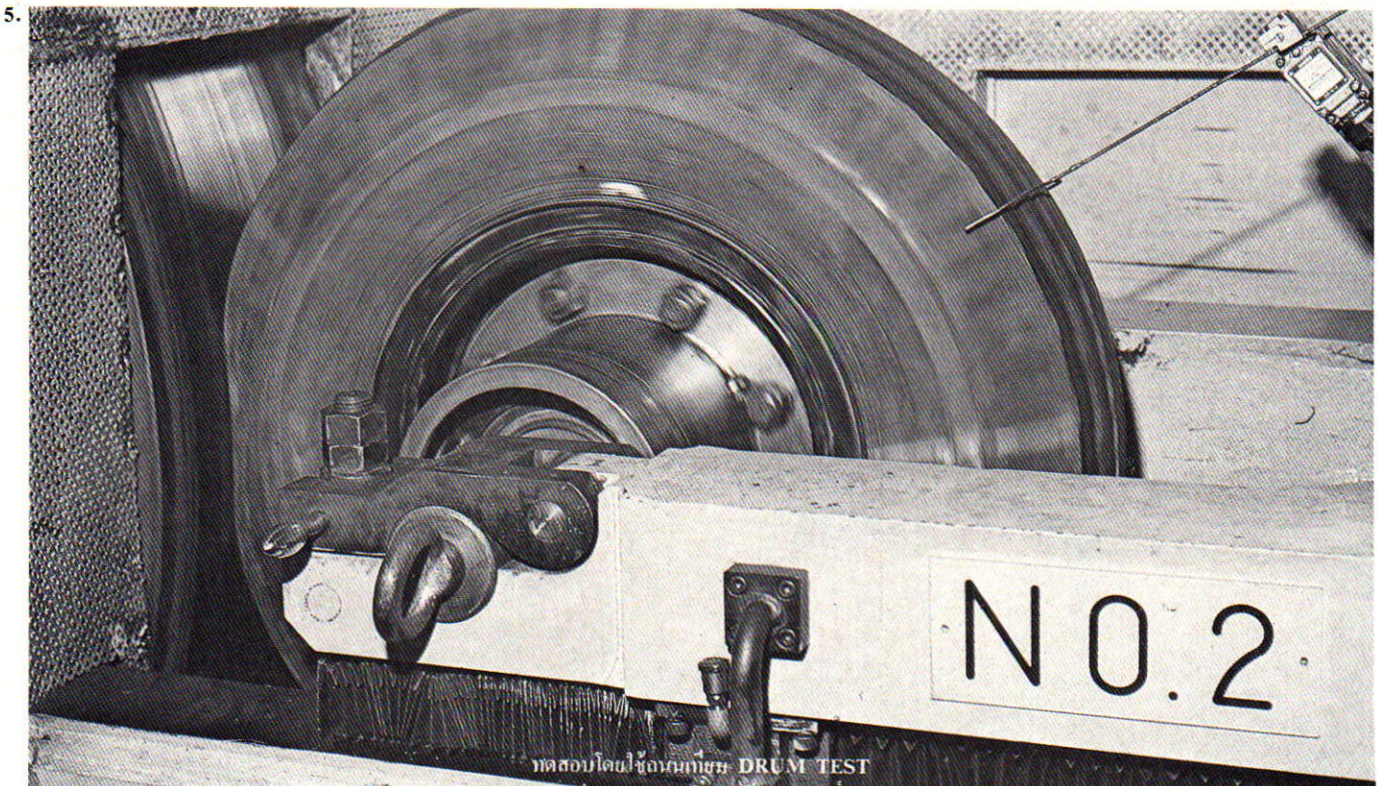
3. Locally produced figured glass.

the Ministry of Science, Technology and Energy is setting up a National Centre for Metallurgy and Industrial Materials for co-ordinating, performing R & D works and promoting technology transfer from abroad. The activities will range from minerals processing to physical metallurgy, and will include non-metallic materials such as ceramics and textiles.

The upcoming development that will herald a new avenue on the local materials scene is the Eastern Seaboard Development Programme, which includes a gas separation plant complex and a string of petrochemical industries. Authorization has been made to set up plants to produce 110,000 metric tons of high-density polyethylene, 80,000 tons of vinyl chloride monomer, 70,000 tons of polypropylene and 100,000 tons of low-density polyethylene per year, respectively. Its impact on polymer materials technology in Thailand is yet to be felt.



4. Automotive and agricultural machinery parts hot-forged from imported iron.



5. A tyre undergoing "Drum Test" to ensure its efficiency and reliability. Locally produced rubber constitutes its major raw material input.



6. Locally produced ceramic tiles with traditional geometrical patterns adorning temples.
7. Pewter coffee-set hand-crafted from pewter alloy containing lead free Thai refined tin.

NATURAL GAS DEVELOPMENT IN THAILAND

In 1981 Thailand consumed the equivalent of 300,000 barrels of crude oil per day of which 73% had to be imported. The dependence on imported oil, of course, has therefore put a large burden on Thailand's foreign exchange reserve. The only way to reduce this dependency is to effectively develop and utilize indigenous energy resources.

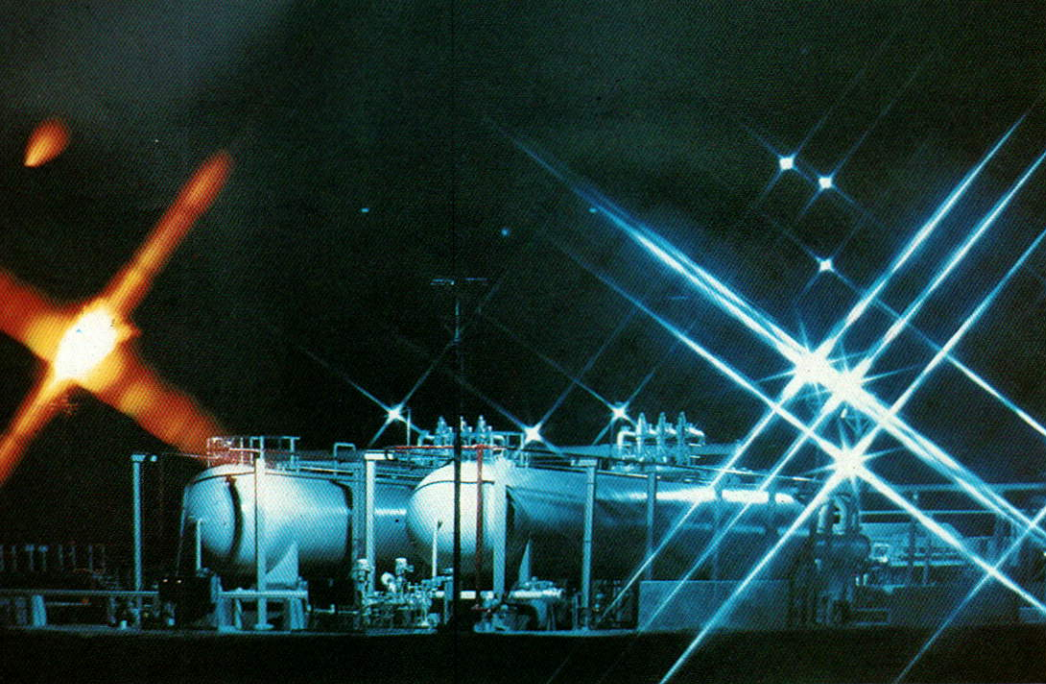
Natural gas, discovered in the Gulf of Thailand, can be utilized as fuel and feedstock. Initially used as fuel, natural gas from the Erawan field is piped through a 425 km. pipeline, the longest submarine pipeline in the world, shored near Rayong province, with a current rate of product of

230 million standard cubic feet per day (MMSCFD). It is then transported through the onshore pipeline to supply fuel to the Bang Prakong and South Bangkok power plants as well as to two cement industries at Tha Luang and Kaeng Khoi in Saraburi province.

Besides the gas supply from the Erawan field, an additional supply of approximately 300-400 MMSCFD from Union Oil's concession Block 10/13 is planned to be sent through an under-construction tie-in offshore pipeline. This is expected to be on stream in 1986. In addition to the gas supply from Union Oil, negotiations between PTT and other con-

1. Product pipeline from gas separation plant to marine terminal storage tank.





2.



3.



4.

2. Construction of port for transfer of products.

3. Control station for liquification of gas at Rayong.

4. Oil terminal, Bang Chak storage plant is visible in the background.



5.

5. LPG Storage tank at marine terminal, Khao Boya, Chon Buri Province.

cessionaires are being made to strengthen the stability of the gas supply.

To gain full benefit from the gaseous hydrocarbon in natural gas, PTT together with the Eastern Seaboard Development Programme, views the necessity of natural utilization as feedstock for major industries. Therefore, construction of a 350 MMSCFD gas separation plant began in November, 1983 and is expected to be completed in December, 1984, at an investment of US\$ 310 million. Products from the gas plant, namely 74,000 million cubic feet of methane per year, ethane 350,000 t/y, LPG (propane + butane) 450,000 t/y and natural gasoline 64,000 t/y will be used as fuel and chemical feedstock for fertilizer and petro-chemical industries.

Methane, the major natural gas component, will be used as fuel and feedstock from chemical fertilizer production. The construction of a fertilizer plant will

begin in late 1985 and will continue for three years at an investment of US\$ 400 million. The chemical products comprise liquid ammonia 15,800 t/y, urea 142,000 t/y, MAP/DAP 62,800 t/y each, NP/NPK 670,000 t/y, MAP 60,000 t/y and phosphoric acid 250,000 t/y. Subsequently, ethane and propane will be consumed as feedstock for petro-chemicals and LPG. The production of low density polyethylene 100,000 t/y, high density polyethylene 110,000 t/y, vinyl chloride monomer 80,000 t/y and 70,000 t/y of polypropylene will commence in 1988 upon completion of a US\$ 350 million plant.

More than any other development in Thailand's history, the natural gas development improves the economy significantly by reducing the foreign exchange for imported petroleum and provides the foundations for a whole new phase in industrialization.

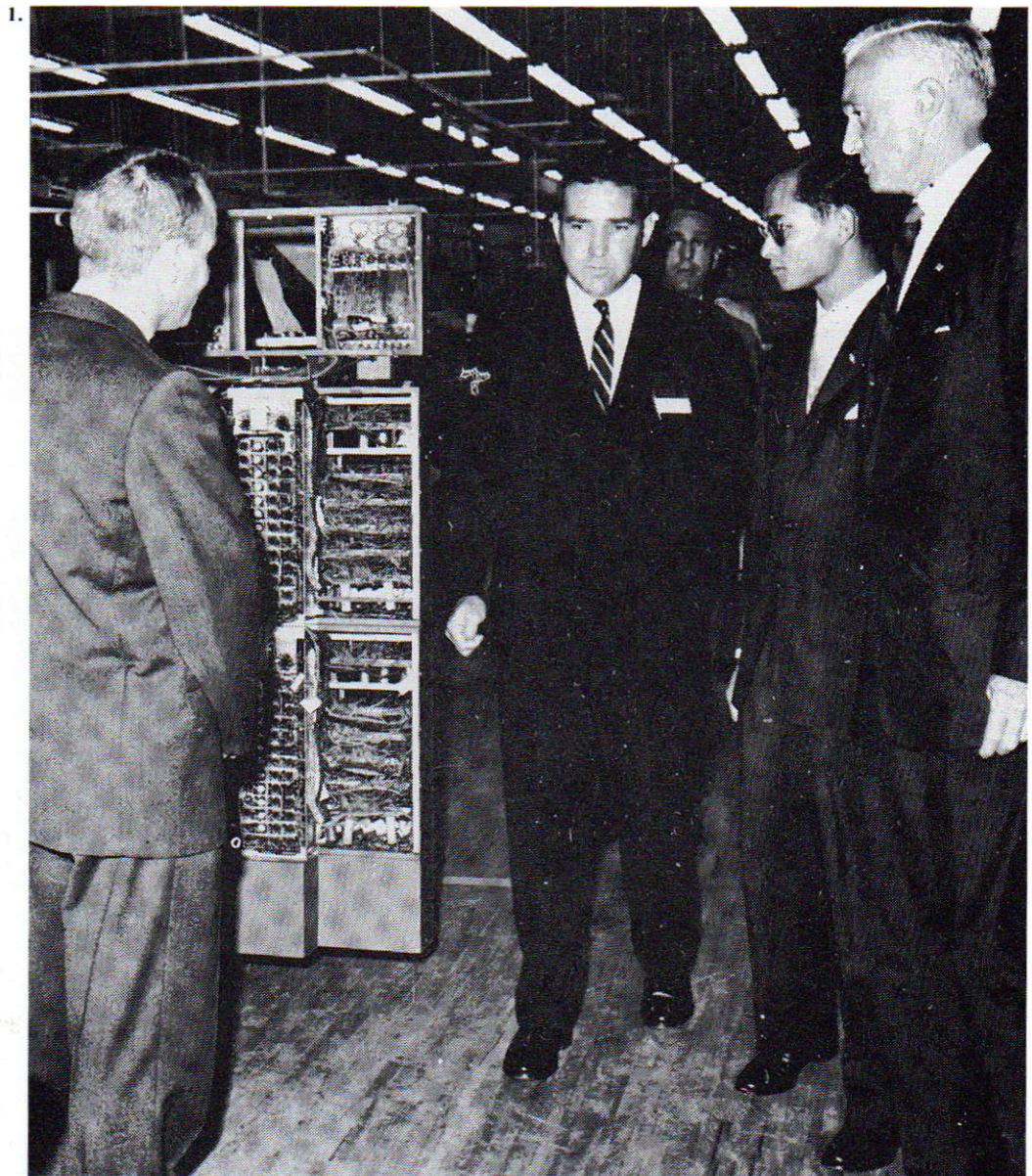


6. Gas Separation plant at Rayong Province designed for a total capacity of 350 MMSCFD of feed gas.

COMPUTERIZATION IN THAILAND

Computerization in Thailand may be said to have been seeded in 1984 when the Royal Thai Government decided to order IBM unit record equipments for detailed agricultural and population census.

In July 1960, His Majesty the King expressed his interest in computerization by visiting the IBM computer plant in San Jose, California.



1. H.M. the King visiting the IBM computer plant in the United States in 1960.

In 1961 the SEATO Graduate School of Engineering, which was a part of Chulalongkorn University, confirmed the realization of the important of computer technology by presenting a scholarship for a Ph.D. level studies in computations in the United States, to the M.S. graduate with the highest grade.

The first computer to be installed in Thailand was the IBM 1620. This was installed at Chulalongkorn University and was followed by the installation of an IBM 1401 at the National Statistics Office.

As the Thai language is completely different from English, the computer printer and visual display units (VDU) had to be modified to handle Thai. The first Thai printer for computer was introduced in 1966 and the Thai VDU in 1976.

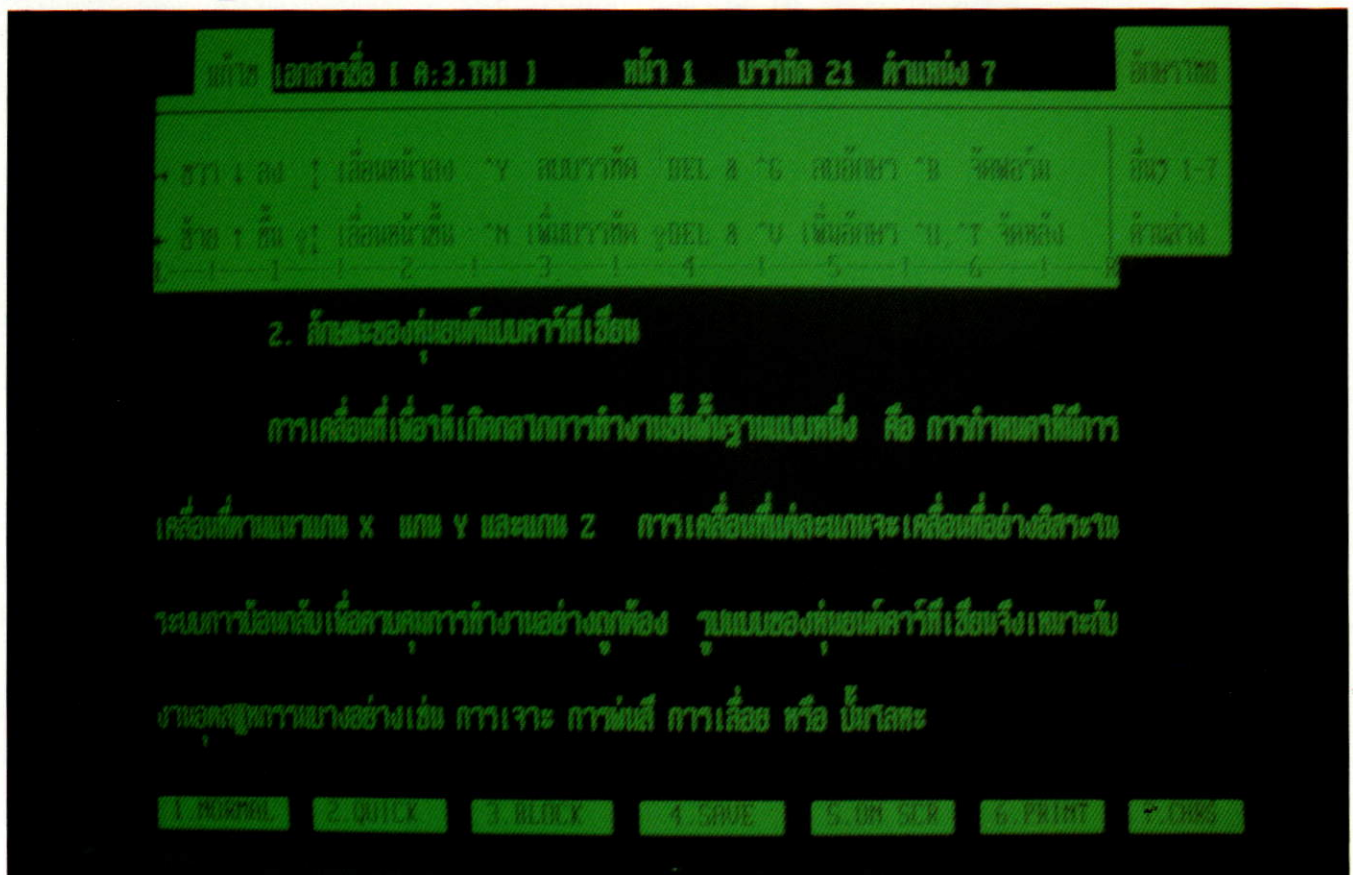
Minicomputers were introduced in Thailand in 1972 and microcomputer started around 1978.

More and more Thai executives are using computers to enhance their capabilities by providing more information and alternatives for management decision.

Thailand has the most complete formal education programs in computer-related fields amongst all Asean countries. Ph.D. level is offered at the Asian Institute of Technology and King Mongkut's Institute of Technology; M.S. level at Chulalongkorn University, King Mongkut's Institute of Technology, AIT and NIDA; and B.S. level at several colleges and universities. Several Junior colleges and high-schools have been computerized, some with over 100 microcomputers each.

2.

2. Typical Thai characters on a computer screen.





At the 1979 National Computer Conference and Exhibition held at the Dusit Thani Hotel, a locally designed and built microcomputer, called Siam Computer, was exhibited. It has a 64K main memory and can be connected to a visual display unit, a teletypewriter, a passbook printer, and as 8-inch disc drive. A modified version of the computer is now available commercially in Thailand.

Electronic banking in Thailand was introduced in 1970. By 1984 most major banks and finance companies had been computerized. Office banking, telephone banking and automated teller machines are also available.

The number of computers has increased steadily from two in 1963-64 to 60 in 1974 and over 10,000 in 1984.

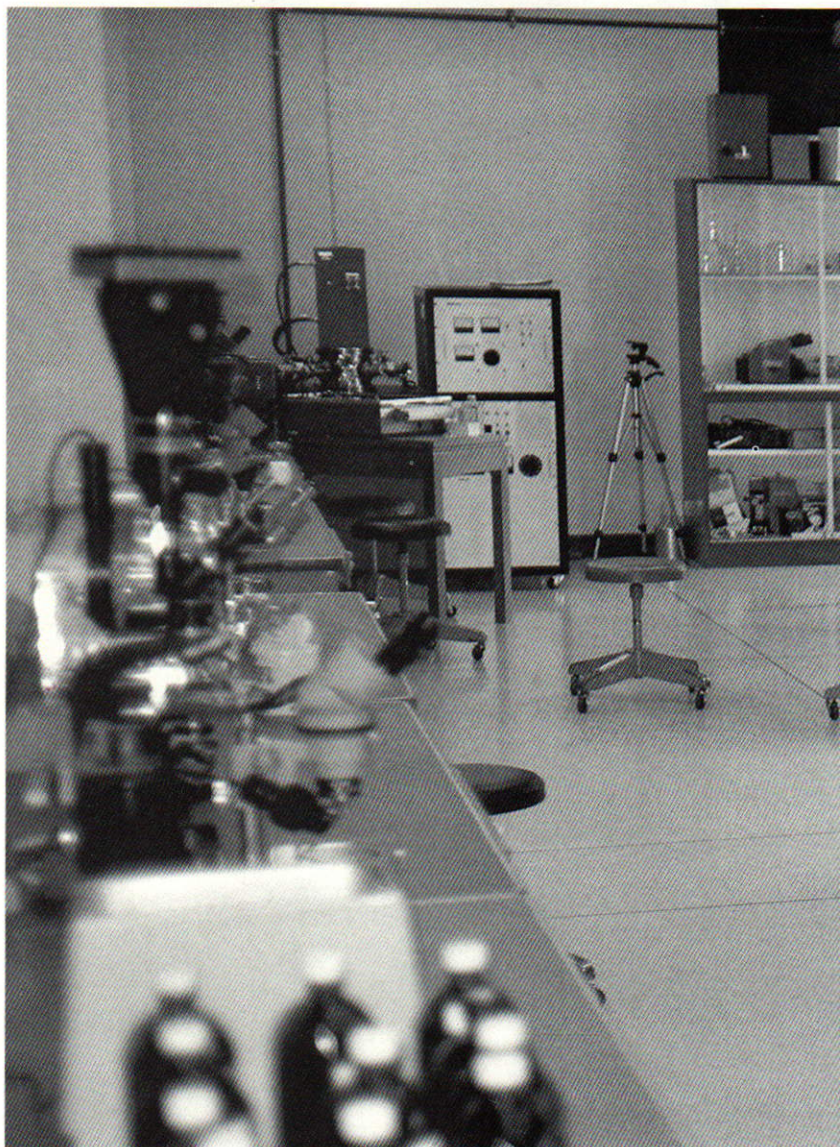
Of the more than 10,000 computers in Thailand in 1984, approximately 80-90 are main frame computer, 800-900 minicomputers and 8,000-9,000 microcomputers.



3. Microcomputers are finding their way to executive desks in Thailand.

4. A typical computer room for education.

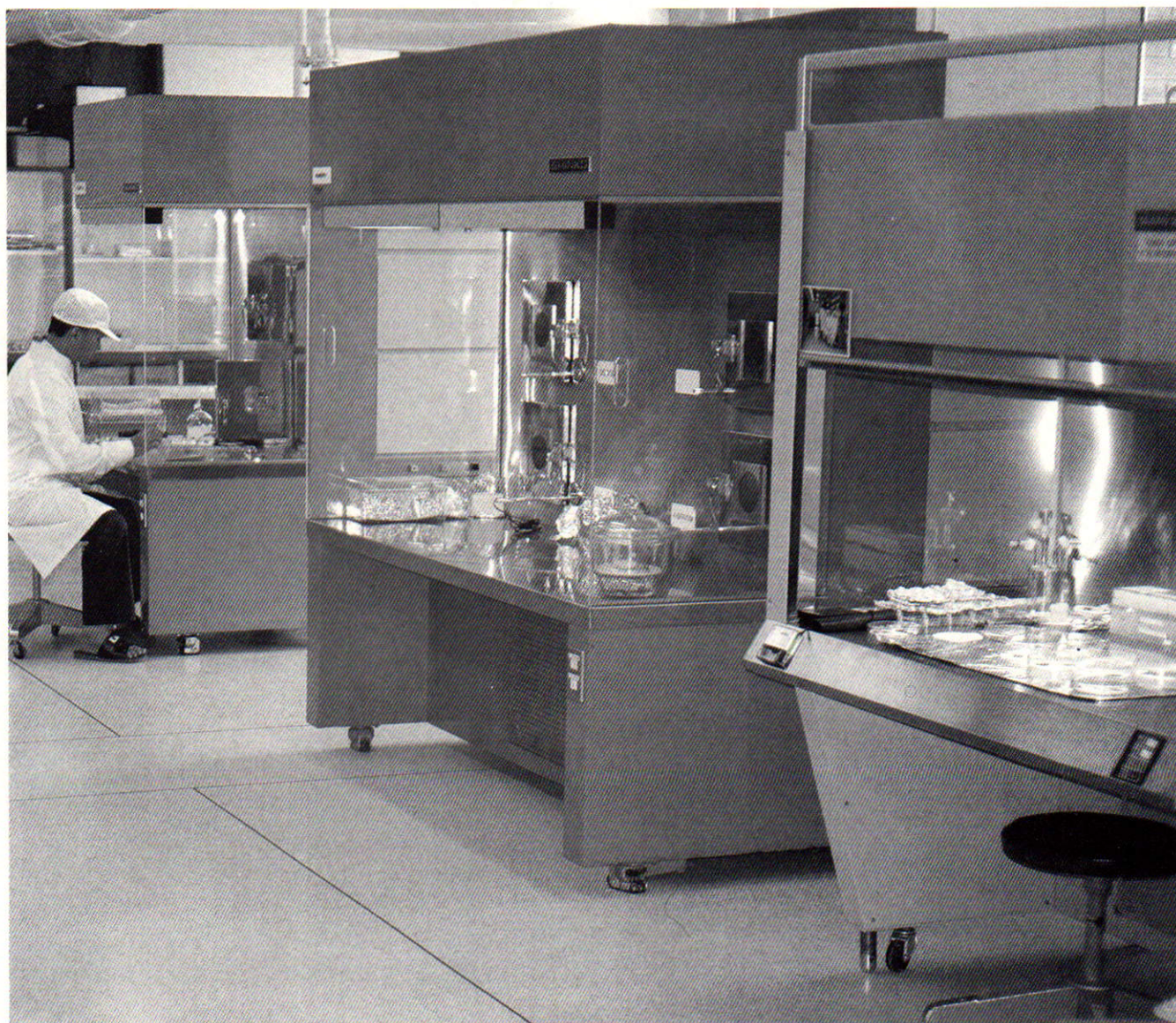
1. An intergrated circuit research laboratory at a local university.

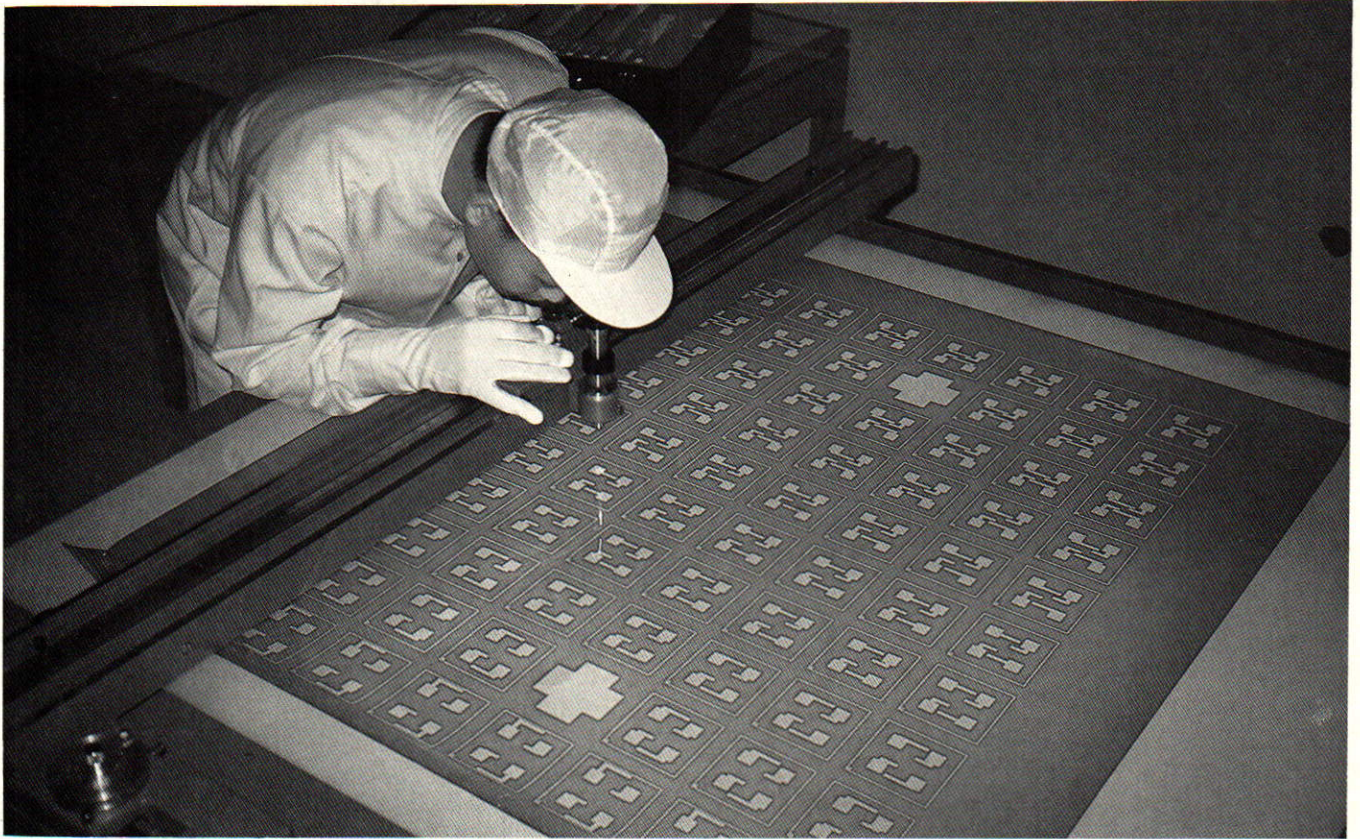


THAI LIFE IN ELECTRONICS

Electronic activities in Thailand spread from the academy to the factory life. Thai university researchers know the fabrication techniques of solar cells for domestic uses. They have also demonstrated their innovative skills by inventing new negative-impedance solid state devices and microwave components. Large-scale integrated circuits (LSI), assembled in factories by Thai workers, earn their country a large export income. Audio

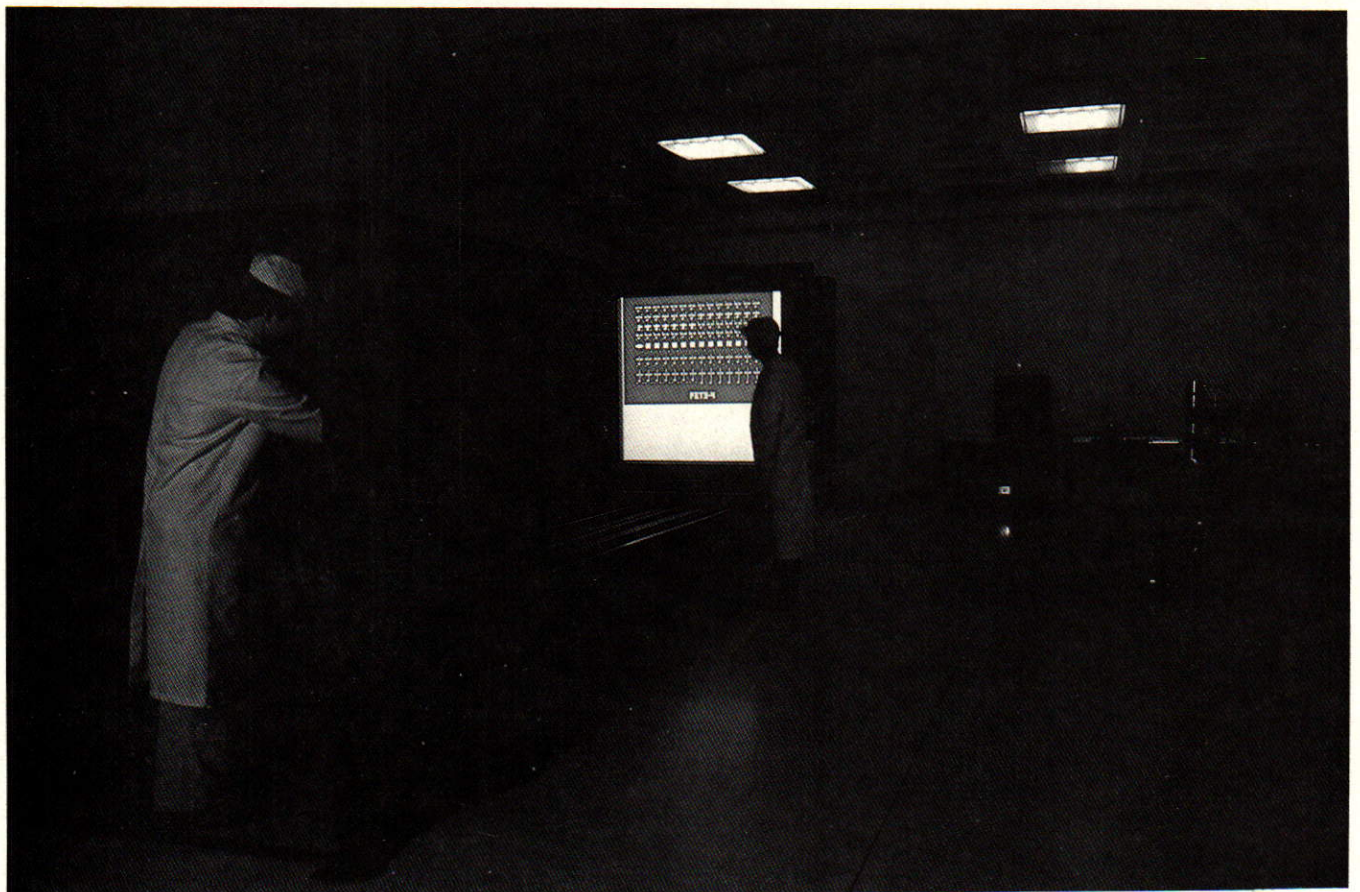
equipment, television sets, electric rice cookers and refrigerators are examples of locally-manufactured appliances that can be found in most Thai homes. The production of electrical transformers also indicates that Thai skills can be extended into the electrical transmission area. Now, with the new government policy for science and technology, electronics in Thailand will play a more important role in Thai life.





2. Mask preparation for a integrated circuit.

2.



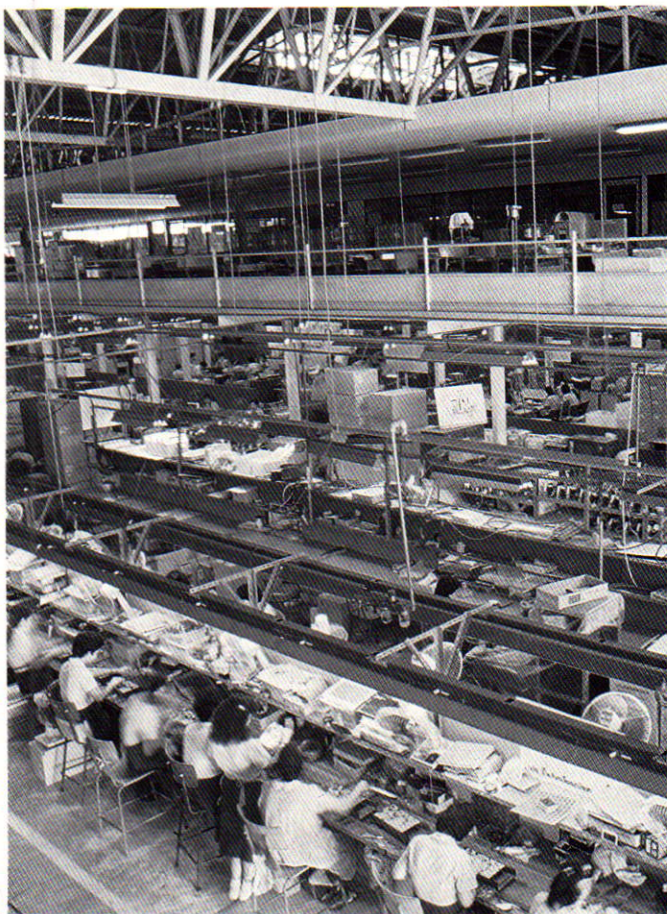
3. Mask reduction by a high resolution camera.

3.



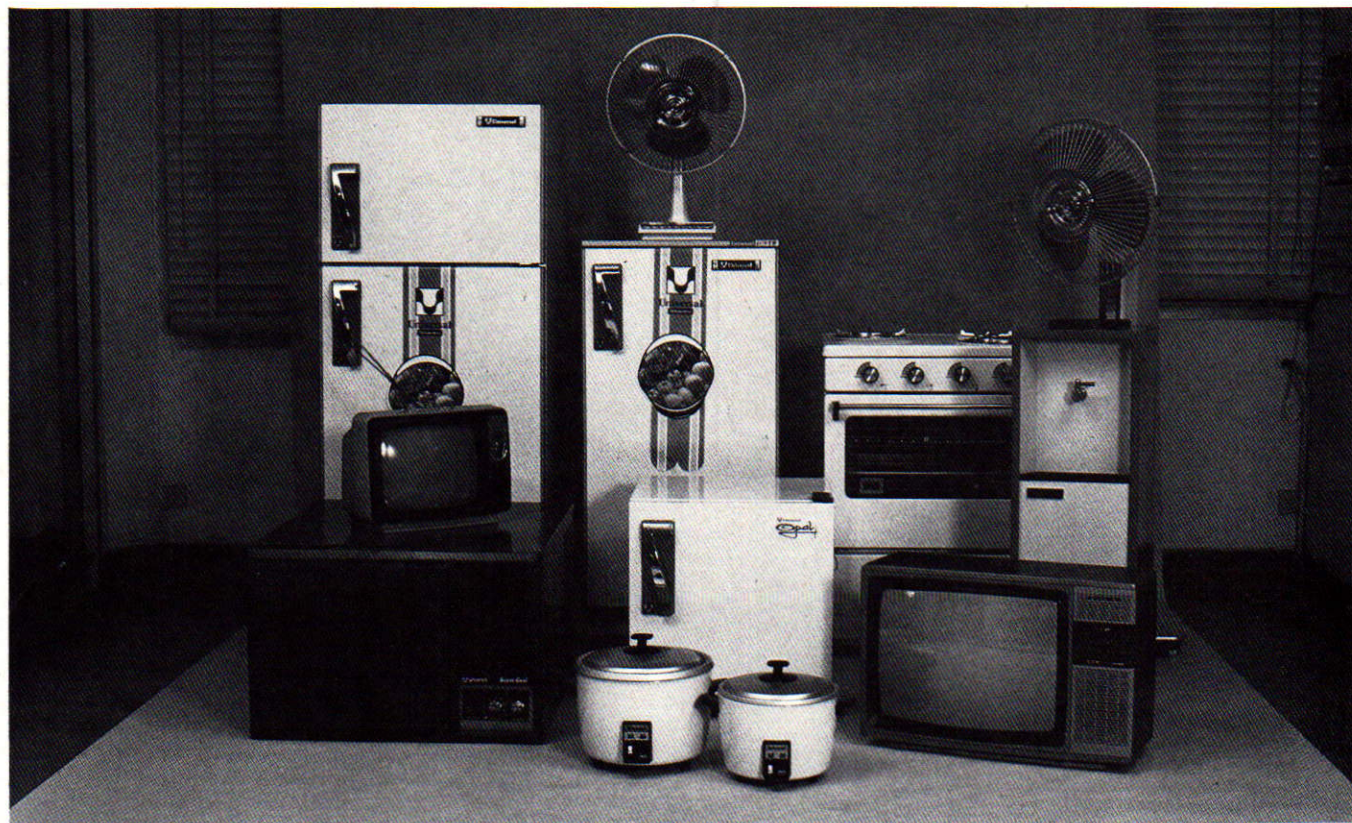
4.

4. An electronic production line.



5.

5. Inside an electrical factory.



6.

6. A collection of locally-manufactured electrical appliances.

MICROWAVE FERRITE ISOLATORS & CIRCULATORS



MICROTEK

THAILAND IN THE SPACE AGE

In this space-age world, many countries, particularly the super powers, are focusing their attention on carrying out research and producing a seemingly endless amount of products which will help in the advancement of technology. Thailand is also now becoming greatly aware of high technology (Hi-Tech). Products are being produced and adapted to suit local needs, irrespective of whether it be in the field of agriculture or industry, both of which have the same objective which is to carry Thailand into the space age so that she does not lag behind developed countries.

Those who follow with interest the changes taking place in Thailand can see that much scientific progress has been made. Some results are visibly evident while others are promised in the near future from work which is still in the research and experimental stage. Inventions already produced have received recognition and fame throughout the world and bring a great deal of pride to the people of Thailand. The high standard of workmanship draws praise from foreign nations thus demonstrating that Thailand possesses a special talent. The quality of the product is its guarantee.

It is the policy of the Thai government to encourage and support research work and the Hi-Tech Industry presently taking place has received the government's approval and promotion. In the year 1984, an award for the most outstanding scientist was given to Dr. Art-ong Jumsai, inventor of the Microwave Ferrite Isolators and Circulators as used in microwave equipment such as Microwave Communications, Radar, Satellites, Spacecraft, Navigation and Guidance Controls. Equipment such as that mentioned requires high technical

efficiency in order to be of the greatest use and to bring the best results.

The inventor of these products was educated abroad in the field of Microwave Technology. On his return to Thailand he set about to find a way of modifying equipment so that it could compete with that of developed countries. During personal travels and study tours abroad, he saw that there was a need for certain components used in the microwave industry so designed microwave equipment which he called Microwave Ferrite Isolators and Circulators. Research was carried out over a period of two years and over two hundred designs were produced. Experiment and research is still being carried on so that the quality and efficiency of the equipment may be improved to a standard higher than that of other countries. Each piece of equipment is produced in limited numbers as each piece must be carefully examine and designed to meet the needs of the buyer and suitability of the job for which it is to be used. This practice is followed in order to increase production quality.

One example of equipment produced is the transmitter and receiver which can be used in the same antenna. When a signal is transmitted, it will pass through a circulator which separates the waves, making it possible for them to pass through only one antenna, preventing them from passing through the receiver. At the same time the receiver will be cut off. When a signal is received, it passes through a circulator which separates the waves, allowing them to pass through the receiver only, thus preventing them from passing through and interfering with the transmitter.

Benefits to be gained from these inventions can be summarized as follows:

1. They bring in foreign currency.

2. They bring recognition and fame for Thailand.

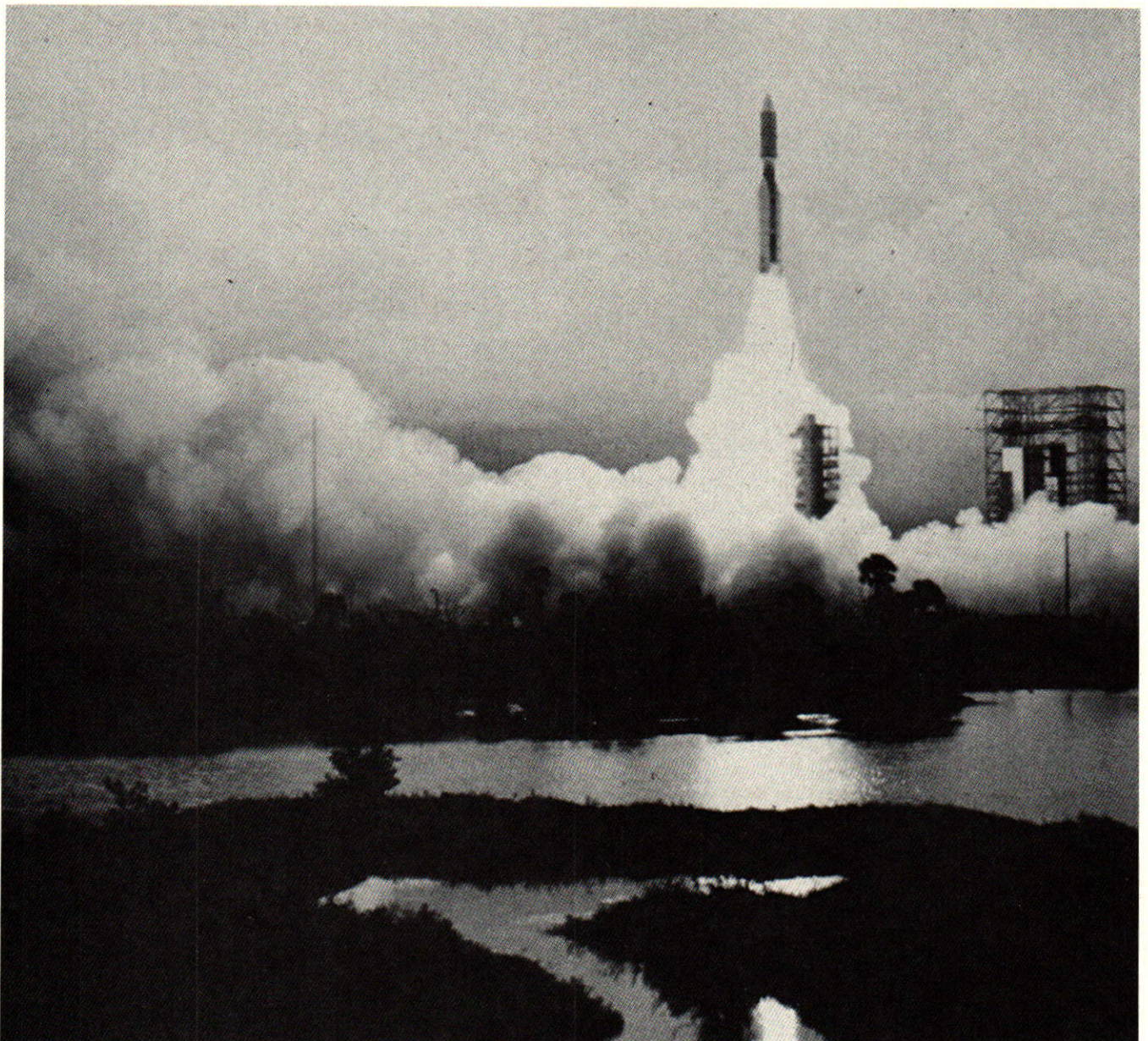
As the equipment mentioned incorporates high technology, was invented by a Thai scientist and produced in Thailand, much recognition is received from abroad, particularly the U.S.A., Canada, Europe and Japan.

3. They form a foundation for

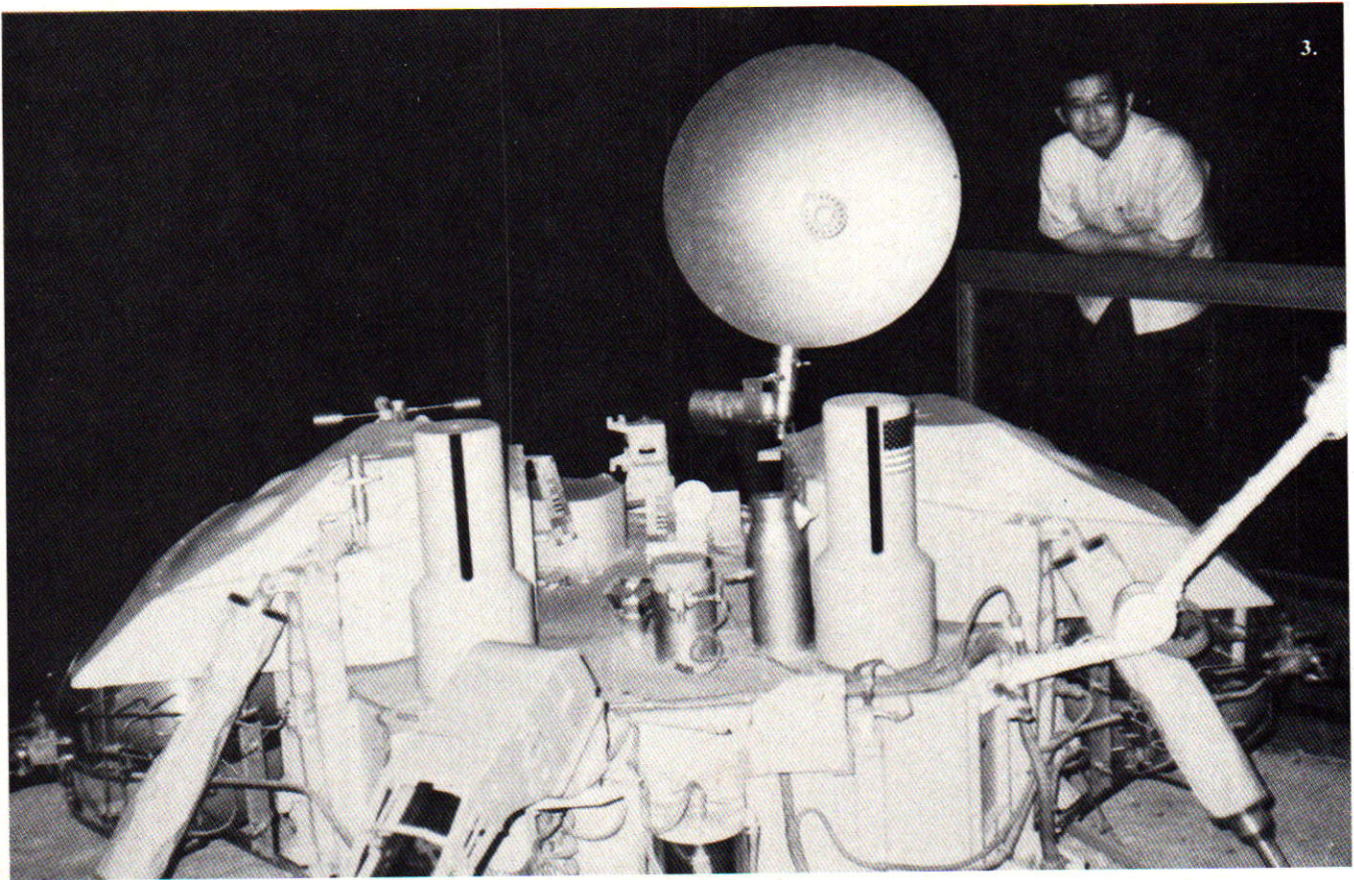
Thailand's future in expanding work in the field of microwave industry and communication.

4. They help to create work and train engineers and technicians in the field of high technology.

5. They stimulate an interest in the government and the people in general in the field of high technology for industrial development.



2. *The Viking Space Craft Lift-off.*



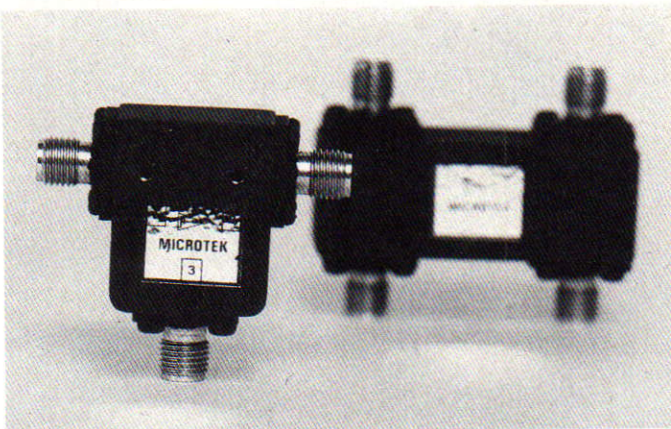
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6.

- 3. The Founder of Microtek and a Model of the Viking Lander.
- 4. Research and Development.
- 5. Isolator.
- 6. Circulators.

1. 4000 year old cave drawings found in Udon Thani in north-eastern Thailand showing man's control over cattle.



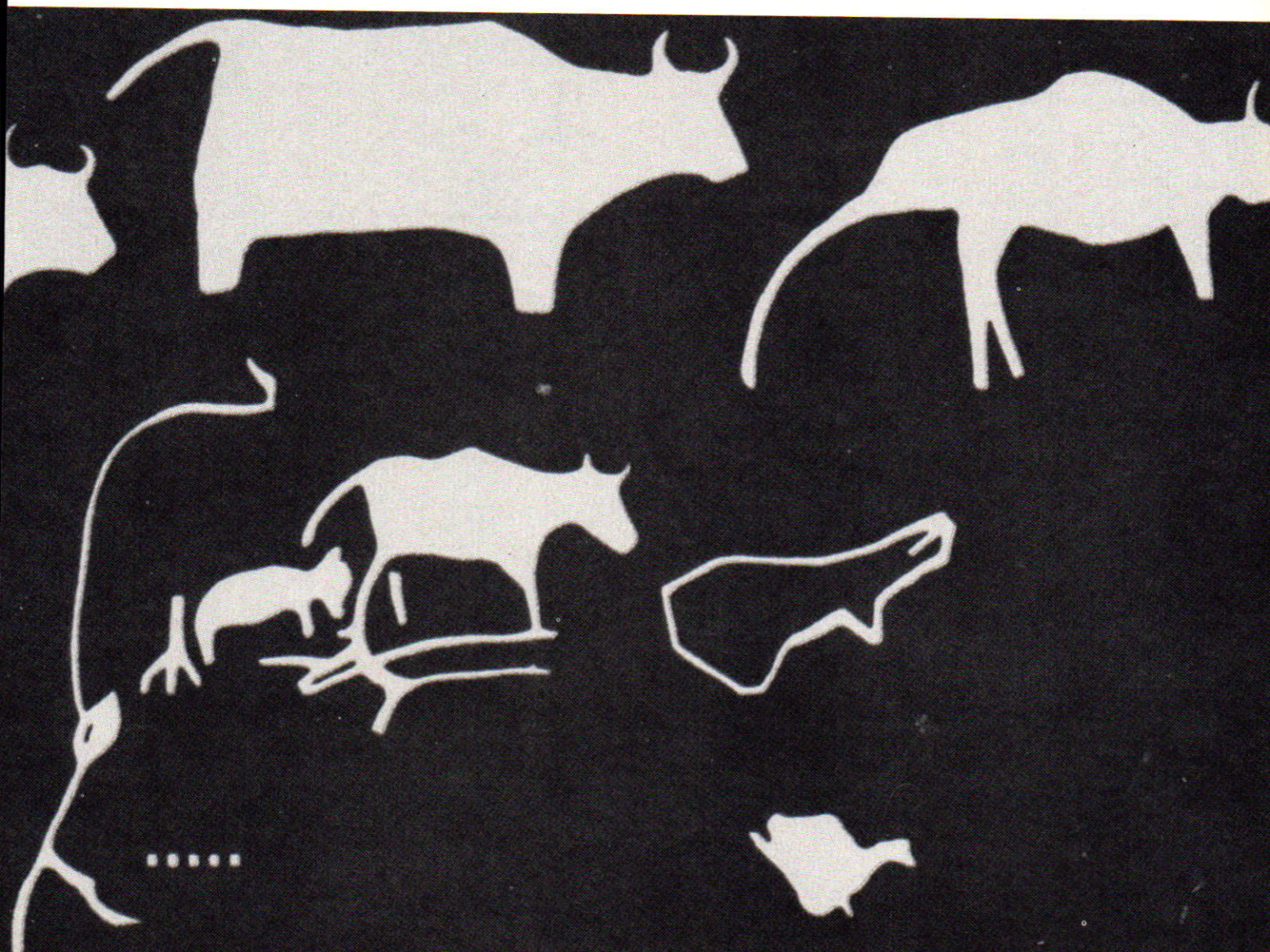
BIOTECHNOLOGY IN THAILAND

Biotechnology is the application of knowledge of living things for human benefit. It concerns itself with the production of materials ranging from new high-yielding rice varieties to drugs for common cold.

Since prehistoric times, Thai people have known how to handle living things. Evidence of this is shown in cave drawings in Udon Thani dating back some four thousand years showing that man was able to control cattle, seeds found with human skeletons buried about ten thousand years ago at Mae Hong Son and utensils made

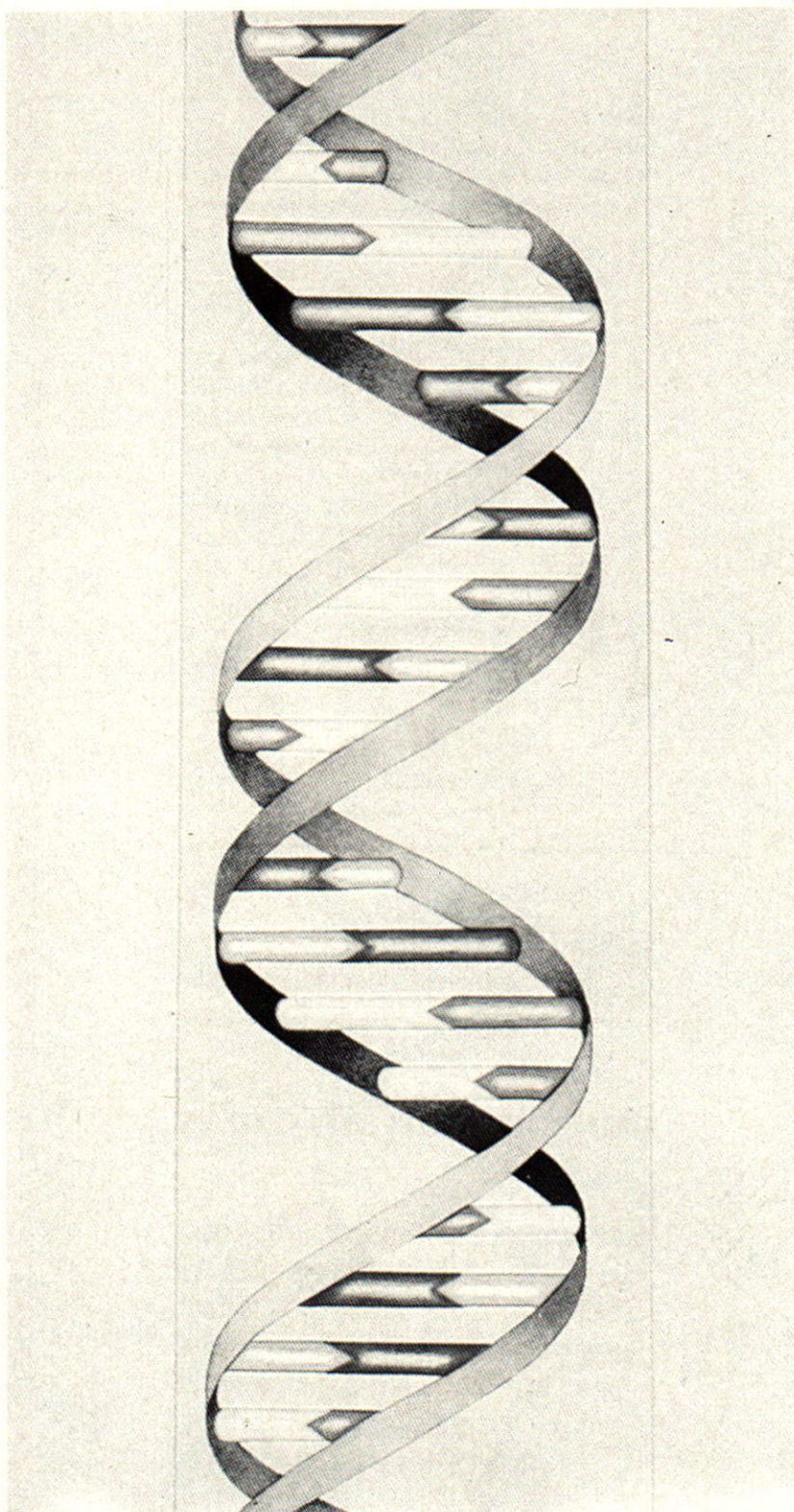
from animal parts found in various prehistoric archeological sites.

Man later developed a knowledge of fermentation, a major part of biotechnology involving the controlled use of microbes as is used in making alcoholic drinks from rice and fruits. Through fermentation man has also been able to obtain various foods and food ingredients such as "plara" from ferment fish, "taochiao" from fermented soya beans, fish sauce and soy sauce for example. Some techniques have been imported from outside the country while others are indigenous.



Traditional techniques used in biotechnology have been handed down from generation to generation. Other countries also have their own traditional biotechnology such as is used in making beer and the making of wine and cheese. During the past few decades, however, new discoveries of living things down to the cellular and molecular level has transformed the face of biotechnology. Most of the new knowledge obtained comes from scientific research of the nature of life and is so powerful that it invites a comparison with the Agricultural Revolution at the dawn of human history.

Thailand stands to benefit greatly from modern biotechnology as the country is richly fertile in agricultural products and possesses a variety of natural resources which can be developed through the aid of this technology. For example, the large fertilizer demand can be met, at least partially, through the use of mass-produced bacteria which can fix nitrogen efficiently in legumes. Better still, crop productivity can be increased by developing techniques for the introduction of genes involved into plant cells. Other bacteria can be mass-produced and used efficiently as a nontoxic agent for the destruction of mosquito larvae. Vaccines can be developed against malaria and other existing infectious diseases. Materials used for the diagnosis of diseases can be produced reliably and at little cost. At present most of these materials have to be imported. Industry will benefit from new technology through the total or partial manufacture of drugs, especially where local plant and microbial resources are used. The technique of growing cells from plants in "test tubes", or plant tissue culture, should open new and much more efficient ways of deriving drugs and other materials from plants. The rich variety of wild flora available in Thailand offers excellent raw materials for such development. Not only are plants not destroyed, but such preservation also contributes to the conservation of the environment. This can be done through the establishment of gene "banks", which employ tissue culture and other techniques.



2. DNA, the genetic element, is the basis of modern biotechnology being harnessed in Thailand and all over the world.



MAHIDOL UNIVERSITY, THAILAND
UNDP/WORLD BANK/WHO SPECIAL PROGRAMME
FOR RESEARCH AND TRAINING IN TROPICAL DISEASES

INTERNATIONAL LABORATORY WORKSHOP
GENETIC ENGINEERING TECHNIQUES
IN TROPICAL DISEASES RESEARCH

13-30 November 1984

Faculty of Science, Mahidol University, Bangkok 10400, Thailand
and Centre for Molecular Genetics and Genetic Engineering,
Mahidol University, Bangkok 10400, Thailand

Organizers : Natth Bhamarapravati Sakol Panyim Yongyuth Yuthavong

GENERAL INFORMATION

The specific objectives of this highly practical workshop are :

1. To instruct participants in selected techniques of genetic engineering especially in gene manipulation applicable to research in tropical diseases
2. To demonstrate current and potential use of genetic engineering in the identification and characterization of parasites, host-parasite interaction and related problems.

Plasmodium strains will be used as model system and participants will be encouraged to provide material and sera from their own region for characterization.

Laboratory work will focus on analysis and cloning of genes from *Plasmodium falciparum* into *Escherichia coli* using both phage and plasmid vectors, strain identification using cloned DNA and isolation of genes for clinically important antigens. Techniques will include DNA analysis, cloning and screening with DNA and antibody probes.

Lectures and demonstrations will also cover restriction endonucleases, cDNA synthesis, DNA sequencing and oligonucleotide synthesis, radiolabelling of parasites, drug resistance and mono- and polyclonal antibodies.

The official language of the workshop will be English.

APPLICATIONS

Applicants should come principally from tropical endemic countries, and have Ph. D., M.D., M.Sc. or equivalent qualification. Participants will be selected on the basis of their experience in molecular biology, biochemistry, microbiology and research background related to tropical diseases.

Applicants should provide :

- Curriculum vitae, and evidence of their skills in microbiology, biochemistry and molecular biology.
- A short description of the applicant's research activities, an indication of future involvement in research related to the workshop's content.
- A supporting letter from the applicant's institution, indicating research interests and facilities available.
- Two letters of recommendation.
- Source of financial support (subsistence will be provided ; limited travel assistance may be made available on request).

Closing date for applications : 15 May 1984

Eighteen places are available and successful candidates will be informed of their acceptance by letter. Applications and requests for further information should be sent to : Dr. Y. Yuthavong, Department of Biochemistry, Faculty of Science, Mahidol University, Rama 6 Rd., Bangkok 10400, Thailand, Tel. Bangkok 281 0572.

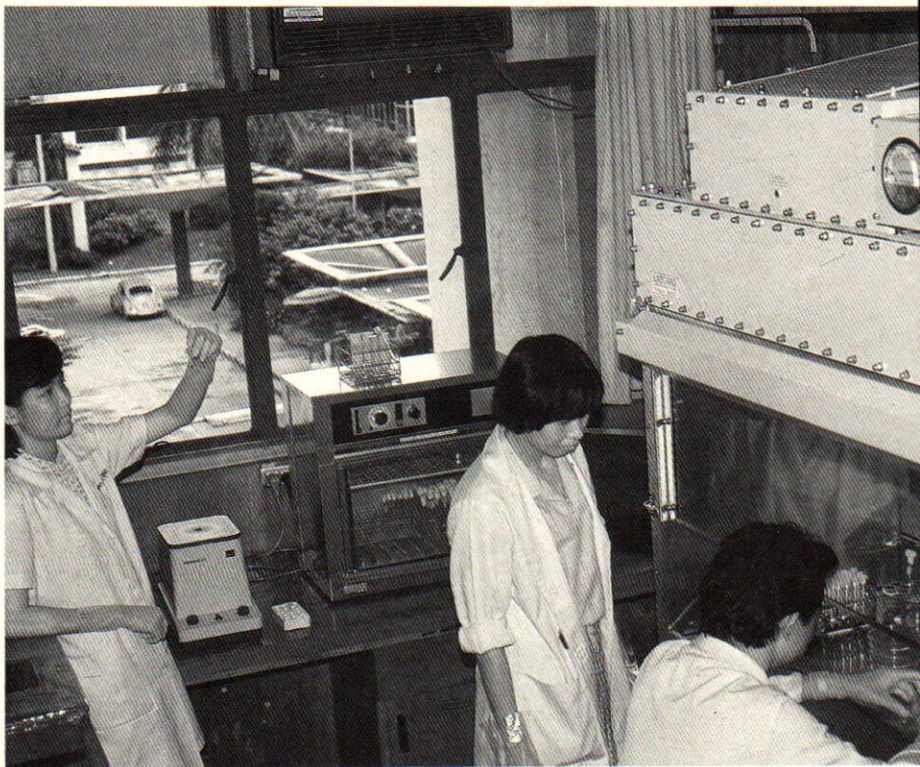
Teaching staff

- | | |
|---|--|
| ★ N. Bhamarapravati (Mahidol University) | ★ J. G. Scalf (University of Edinburgh, Edinburgh) |
| ★ A. Bhuniratana (Mahidol University) | ★ R. Sersirivanich (Mahidol University) |
| ★ P. Billings (Mahidol University) | ★ S. Thaitrong (Chulalongkorn University) |
| ★ V. Boonsaeng (Mahidol University) | ★ S. Tharavanij (Mahidol University) |
| ★ C. R. Brockelman (Mahidol University) | ★ S. Tungpradabkul (Mahidol University) |
| ★ R. L. Coppel (Walter and Eliza Hall Institute, Melbourne) | ★ H. K. Webster (Armed Forces Research Institute of Medical Sciences, Bangkok) |
| ★ M. Goman (University of Edinburgh, Edinburgh) | ★ P. Wilairat (Mahidol University) |
| ★ B. Panijpan (Mahidol University) | ★ Y. Yuthavong (Mahidol University) |
| ★ S. Panyim (Mahidol University) | |

In order to help Thailand reap the benefits of modern biotechnology, the National Centre for Genetic Engineering and Biotechnology (NCGEB) was established in September, 1983, following Cabinet approval of the proposal from the Ministry of Science, Technology and Energy, and endorsed by the National Economic and Social Development Board. In establishing the Centre, the Thai Government is taking active measures not only to follow directives given in the Fifth National Economic and Social Development Plan concerning science and technology, but also to promote strongly this rapidly emerging field. The potential of Thailand to excel in biotechnology and related fields has been witnessed by the recent recommendation of the Selected Committee of the UN Industrial Development Organization, composed of outstanding international scientists and technologists. The committee named Thailand as the only developing country among various candidates suitable for the location of the International Centre for Genetic Engineering and Biotechnology. A similarly high rating of the biotechnology potential in Thailand was given by a visiting team from the US National Academy of Science in June, and by the official team of biotechnologists from the UK in July, 1984. Hence, not only is Thailand rich in bioresources, but she also has a good scientific infrastructure relevant to such development.

In order to realize the potential of biotechnology in Thailand, international collaboration will be sought to strengthen the NCGEB and its programmes. The fast changing nature of modern technology, and its application to the development of unique bioresources in Thailand, make international and bilateral co-operative programmes essential components which should mutually benefit both Thailand and the co-operating countries.

4.



5.

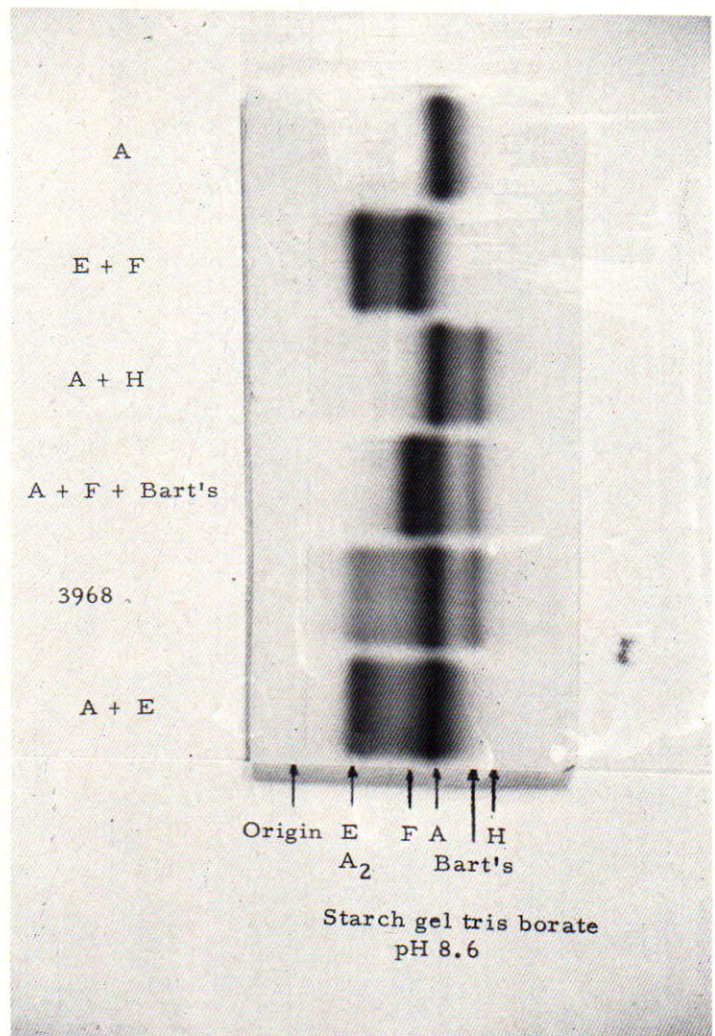
4. The rich bioresources in Thailand can be developed and conserved with the aid of modern technology.

5. Laminar Flow Hood - an instrument for biotechnological experiment under aseptic conditions.

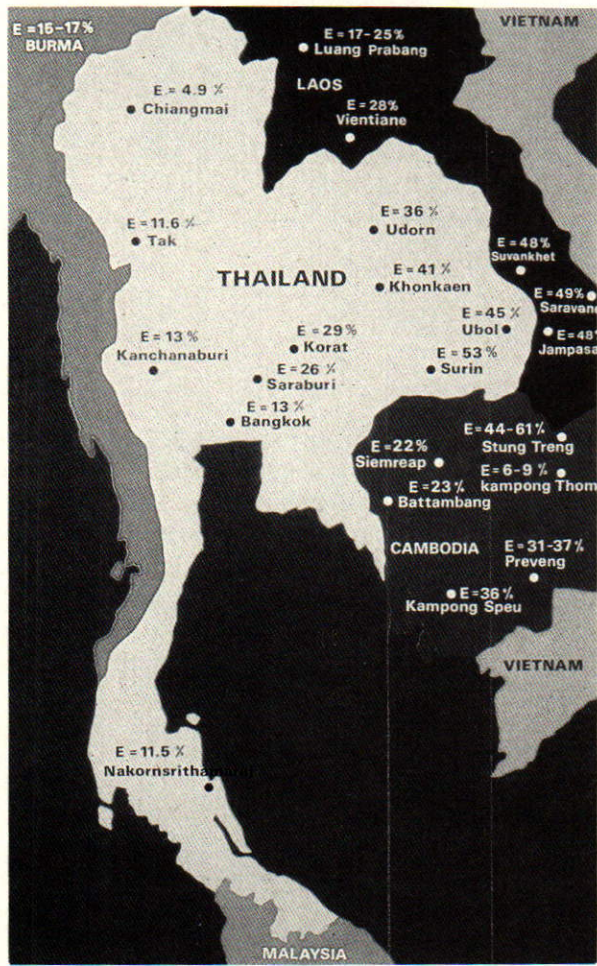
THALASSEMIA RESEARCH IN THAILAND

In one cubic millimetre of blood there are 5 million red blood cells. In each red blood cell there are 300 million molecules of the oxygen-carrying pigment haemoglobin. It is haemoglobin that is responsible for the red colour of the blood. The haemoglobin molecule consists of haeme and globin. Globin is a protein and its structure and amount are precisely

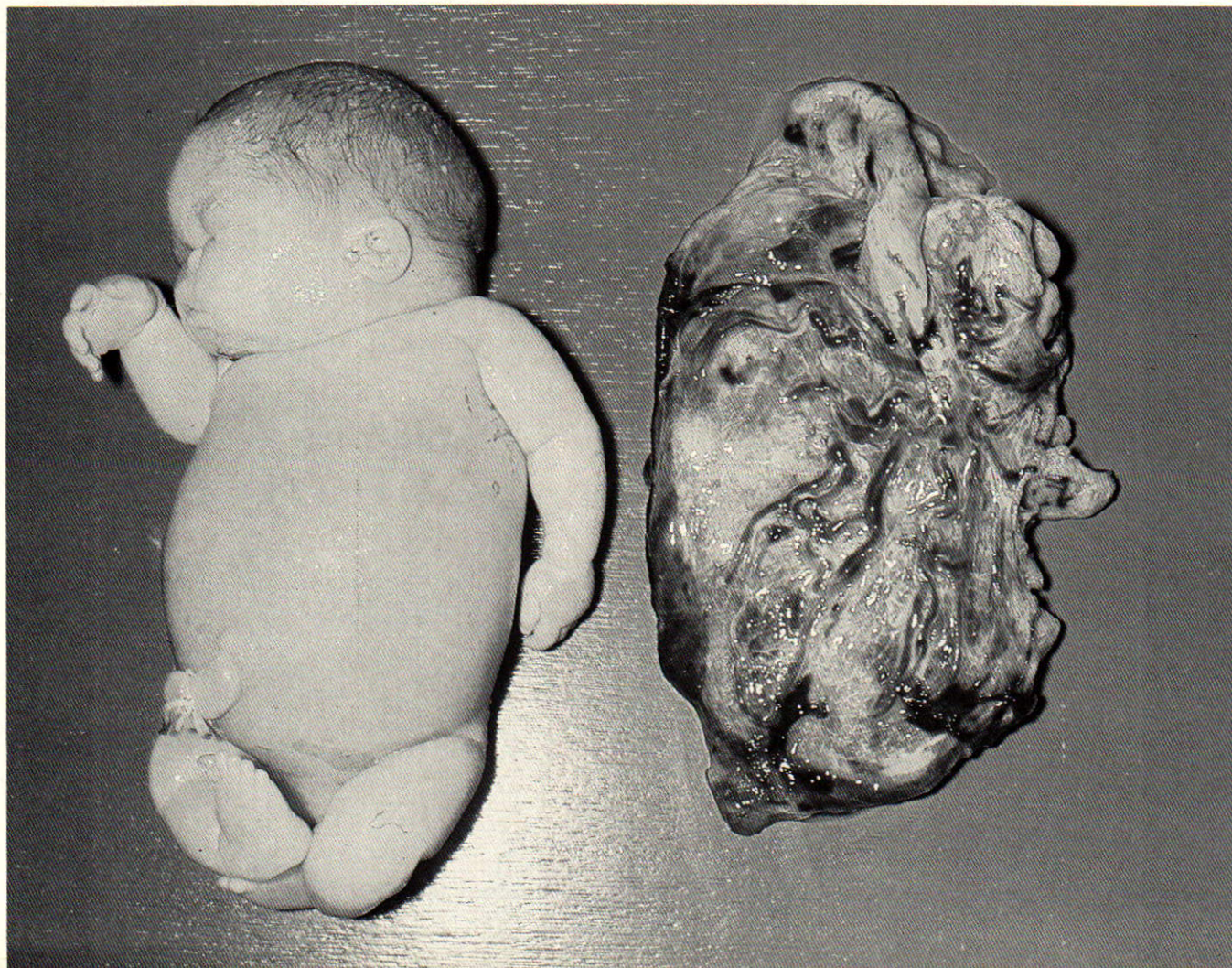
controlled by specific genes. Some genetic defects cause abnormal structures leading to the occurrence of abnormal haemoglobins of which several hundred types have already been discovered. Other genetic defects lead to decreased globin production resulting in a condition called thalassemia, of which there are different types.

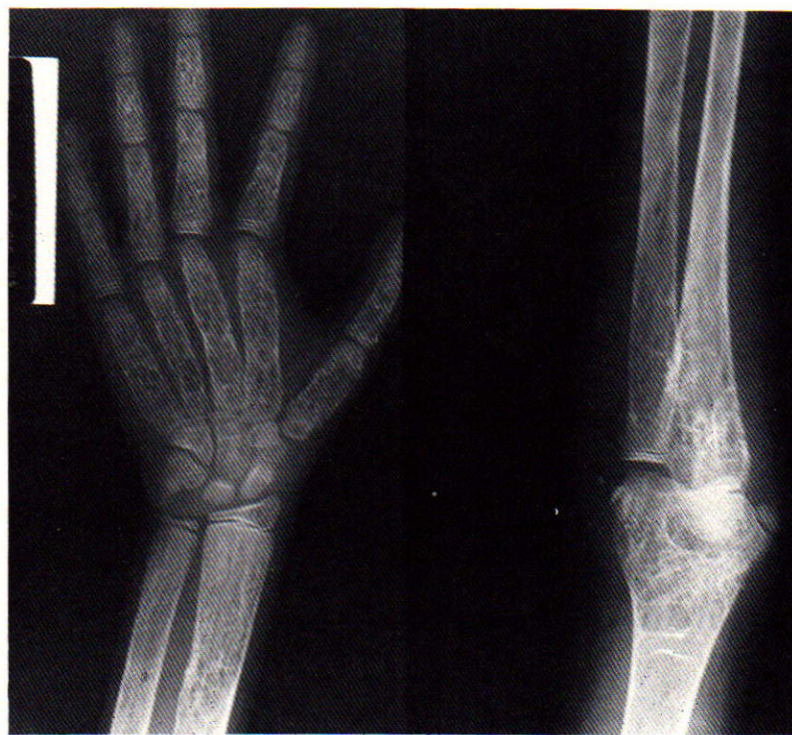


1. Separation of haemoglobin types by electrophoresis.



2. Map showing high frequencies of Haemoglobin E at the junction of Laos, Thailand and Kampuchea.
3. A foetus which died from the effects of severe α -thalassaemia.
4. Another foetus which died from the effects of severe α -thalassaemia.





5. A patient with β -thalassemia and haemoglobin E disease which is very common in Southeast Asia.

6. Skull of a thalassemia patient. The skull is thick causing abnormal facial configuration.

7. Bones are thin and soft due to depletion of calcium and protein.



Abnormal haemoglobins and thalassemias have been one of the fields that have been intensively studied in Thailand over the last 30 years. Several abnormal haemoglobins have been identified such as Haemoglobin Thailand, Haemoglobin Siam, Haemoglobin J-Bangkok and Haemoglobin Mahidol (the name of a leading health science university). Several types of thalassemia have been characterized and studied from various perspectives.

An abnormal haemoglobin called Haemoglobin E is very prevalent in Thailand and throughout Southeast Asia. It is typical to the region in the same way that the sickle cell haemoglobin is typical in Africa. It can be found in as many as 50-60% of the population around the junction of Thailand, Laos and Kampuchea — the so-called haemoglobin E triangle.

The two major types of thalassemia are known as α -thalassemia and β -thalassemia, and both are prevalent in Thailand. About 20% of the people in Bangkok, and about 30% in Northern Thailand, carry α -thalassemia genes. Thai scientists have played an important role in investigating the genetic mechanisms of α -thalassemia. The names α -thalassemia 1 and α -thalassemia 2, given by Thai scientists, have been used throughout the world.

Abnormal gene interactions amongst Thai people lead to the occurrence of over 60 thalassemia syndromes. The most severe form of thalassemia, the Haemoglobin Bart's hydrops fetalis, which causes death either in utero or a few minutes after birth, is prevalent in this region. Other thalassemia diseases of differing severity are common. The more severe diseases cause defective development, enlarged liver and spleen, abnormal configuration of faces and bones, increased iron deposition in the liver, increased susceptibility to infections, etc.

This group of diseases causes not only medical but also socio-economic problems to the country. Thai scientists are engaged in studying thalassemia at every level, from molecular biology to community control.

It may be added that similar problems also exist in Indochina and successive wars in that region have relocated a great number of Indochinese around the world, carrying with them thalassemia and abnormal haemoglobin genes. This has posed problems to physicians unfamiliar with the Southeast Asian Hb E and thalassemias.

Thai scientists have been asked by the WHO to organize a global workshop on thalassemia control, to be held in Thailand in July, 1985. An International Conference on Thalassemia will also be organized in conjunction with the WHO workshop on July 1-3, 1985. Interested persons wishing to attend or participate are invited to contact:

Dr. Prawase Wasi, M.D.
Division of Haematology,
Department of Medicine,
Faculty of Medicine Siriraj Hospital,
Mahidol University,
Bangkok, 10700, Thailand.



8. A patient with fractured arm and legs due to bone defects.

DEVELOPMENT OF MINILAPAROTOMY FOR FEMALE STERILIZATION

In recognition of implications of the rapid and unplanned population growth, the Government of Thailand declared the Population Policy in 1970. At that time the population growth rate in Thailand was about 3 per cent per year and the population fertility was very high. About 65 per cent of the fertile families already had 3 to 20 children whereas the family size they desired was 3. This indicated a great demand for a permanent contraception or sterilization service.

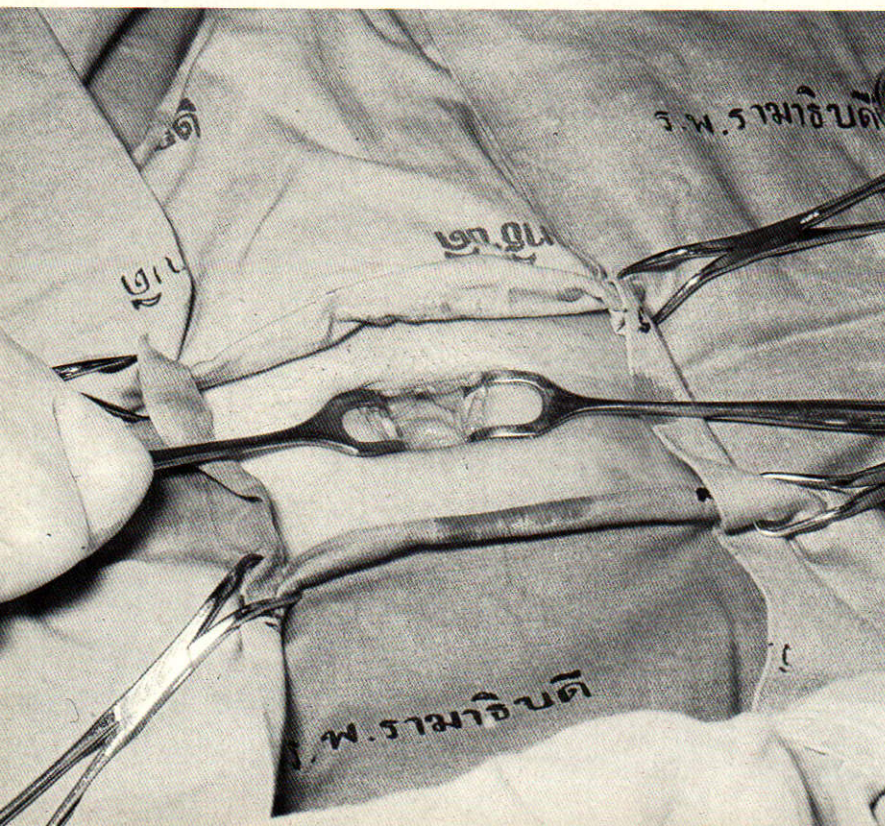
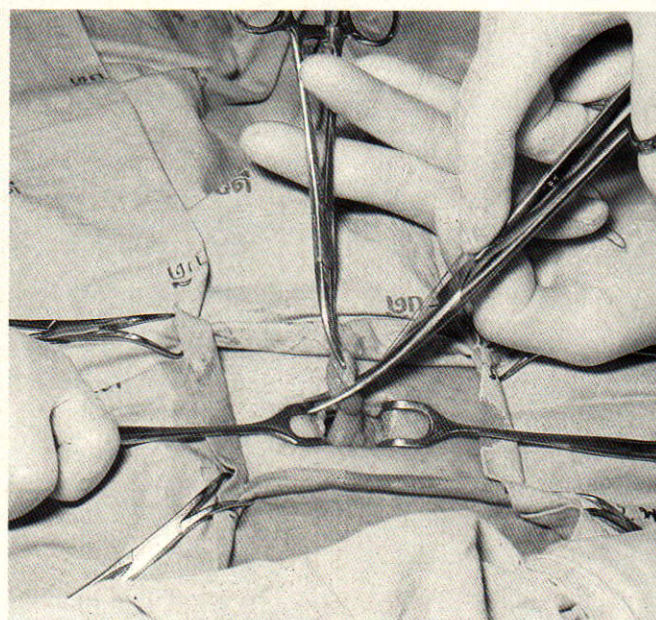
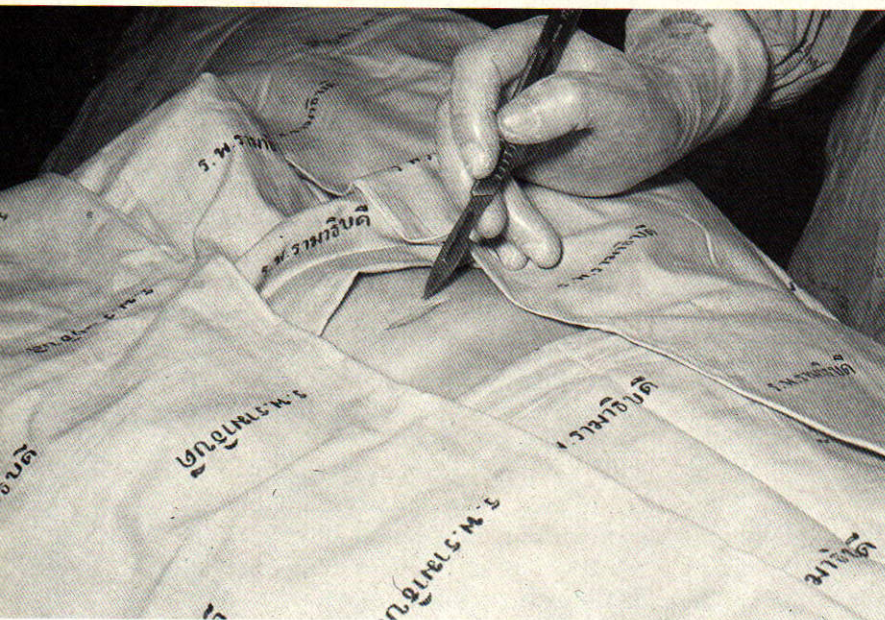
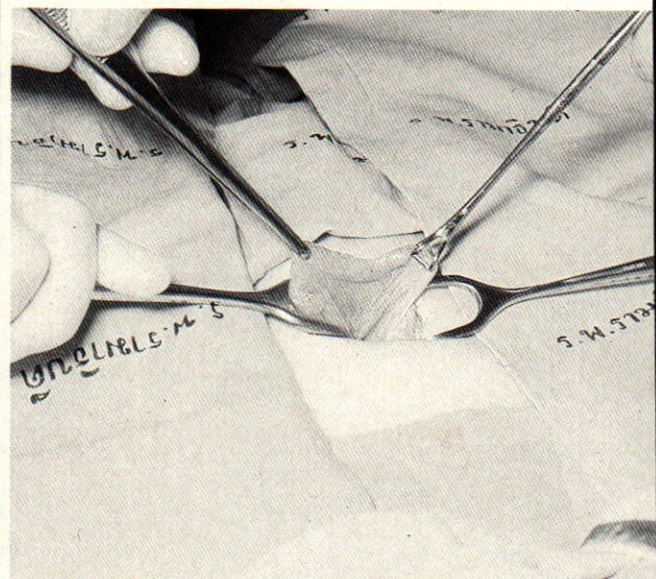
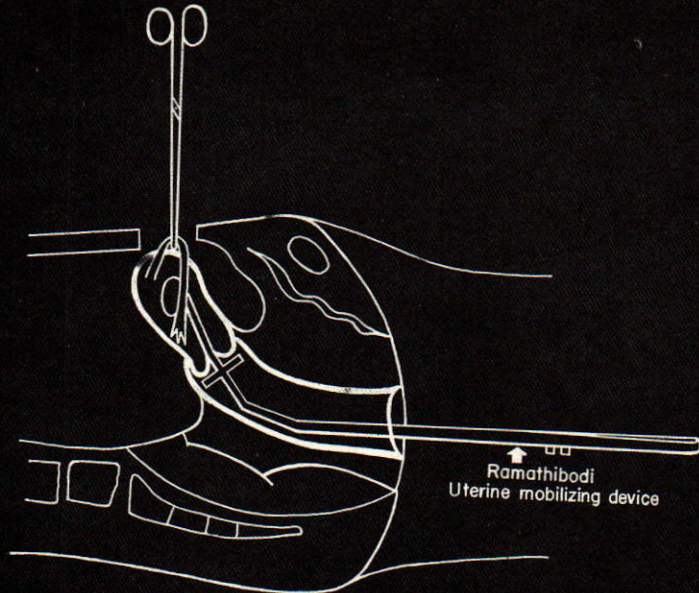
The need for a nationwide permanent contraception service led to the search for a suitable approach. In 1972, Dr. Vitoon Osathanondh of Ramathibodi Medical School invented many simple instruments for simplifying the technique of female sterilization. The best known instruments are Ramathibodi uterine mobilizing device or Vitoon's uterine elevator and Ramathibodi tubal hook. The new method of sterilization is called minilaparotomy, uterine elevation technique or minilap for short, which is performed under local anaesthesia and on an outpatient basis. The abdominal cavity is approached through a small suprapubic incision. The uterine fundus with fallopian tubes is brought underneath the incision by manipulation of the uterine elevator inserted into the uterine cavity through the vagina. The tube is directly visualized and then picked up on to the abdomen for occlusion, see figures. The patient can return home a few hours after the operation.

After a successful clinical trial at Ramathibodi Hospital, the technique was taught to physicians from all parts of the country. By 1976, more than 300 hospitals in rural Thailand were able to provide minilap service. The minilap has gained popularity not only in Thailand but also in 70 other countries and has now become an important sterilization method used throughout the world.

Minilaparotomy has a low complication rate. The equipment is simple and can be maintained easily. Physicians who are not highly specialized can learn the procedure in a short period of time and can perform it effectively. Sophisticated facilities are not required for the service set up.

In the Expert Committee Meeting on Safety of Voluntary Surgical Contraception, Manila, May 9-12, 1983, organized by the World Federation of Health Agencies for the Advancement of Voluntary Surgical Contraception, the Expert Committee considered minilaparotomy the safest female voluntary surgical contraception approach and recommended it as appropriate for national voluntary surgical contraception programmes.

Dr. Vitoon and his team were the recipients of an Award given by the National Research Council in the year 1976 in recognition of their outstanding contribution toward the betterment of Thai society.



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1. The diagram illustrates the principle of minilaparotomy, uterine elevation technique for female sterilization.
2. A 2 - centimetre skin incision is made with an ordinary scalpel about 2 cm above the upper border of the symphysis pubis.
3. With the incision held open by retractors and a proper manipulation of the uterine mobilizing device inserted into the uterine cavity through the vagina, the uterine fundus and the proximal part of the tube is brought into the field.
4. The tube is picked up on to the abdomen for occlusion.
5. The tubal lumen is occluded. A ligature is applied to the base of a loop of the tube and the top of the loop is cut off.

MICRO-HYDROELECTRICITY IN RURAL THAILAND

1. Introduction

During the cheap oil era, Thailand relied heavily upon imported oil for use in national development. The acceleration of the development programme resulted in a two-fold increase in the energy demand in the last decade. As a result, after the oil crisis, Thailand has had to spend over two thirds of her foreign earnings annually to cover oil costs.

The Fifth National Economic and Social Development Plan (1982-1986) has thus called for an acceleration in the development of indigenous sources of energy in order to lessen the nation's dependence on imported oil. In addition, to meet the

government's policy in upgrading the living standard of the rural people, the same plan aims at bringing electricity to 50,000 villages by 1986, thus doubling the current area serviced. As the country is relatively large (500,000 sq.km.) and the rural villages sparsely located, the extension of grid to cover the whole area is inappropriate, both technically and financially. The decentralized diesel powered generation cannot be adopted due to costly fuel. Moreover, it is against the national energy policy. A small indigenous renewable source of energy for decentralized generation is clearly the most practical solution.

1. Villagers participated in construction of weir

1.



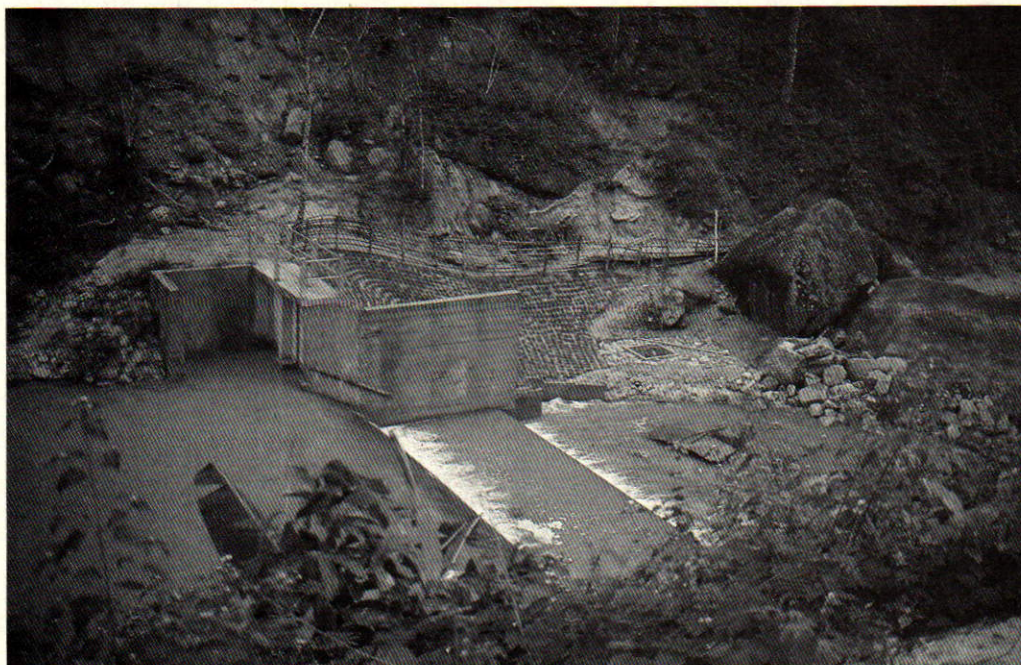
2. Micro-hydro for rural villages

As Thailand is a country situated in the tropical monsoon region with a fairly large area of mountainous terrain, the hydro potential is, therefore, substantially rich. Numerous sites are in the vicinity of rural villages and thus offer favourable conditions for decentralized generation. However, the constraint of the development lies in the high investment cost, especially in the case where generation equipment is imported and conventional construction methods, traditionally adopted in major hydro-development, are employed. Fully aware of this obstacle, the National Energy Administration, under the Ministry of Science, Technology and Energy, in 1978, launched a programme to enable the development of low cost micro hydrogeneration (below 200 kilowatts) for rural villages. This programme is made up of two parts, namely, the development and local manufacture of low cost and user oriented hydro-generating sets and, the implementation of new construction methods to reduce costs by co-operative management.



2. Headrace pipes were laid by villagers.

3. Weir after completion.



3. Development of Local Hydro-Generating Sets

The first type of turbine to be developed was the "Crossflow". Its simplicity of manufacture, together with its wide application (three to 100 metre heads) makes it highly suitable to local manufacturing capability and site conditions. The design is user oriented making it easy for non-technically trained villagers to operate and maintain at minimum cost. To cope with high head locations the Pelton turbine was

later developed thus fulfilling all range of needs. For regulation, the electronic load controller was also locally manufactured, as were the generator and control cubicles. The maximum unit size manufactured to date is 150 kilowatts. These locally manufactured hydro-generating sets cut investment in this sector by 50% when compared with their imported counterparts.



4. PELTON Turbine with alternator.

4. Construction by Co-operative Management

Another factor which has helped to reduce costs is the implementation of projects by co-operative management. Villagers participate in the construction of projects by contributing labour and locally available construction material free of charge. The government supplies the missing components including supervisory services and training programmes. The contribution from this partnership is valued and converted to share equity. The revenue from electricity

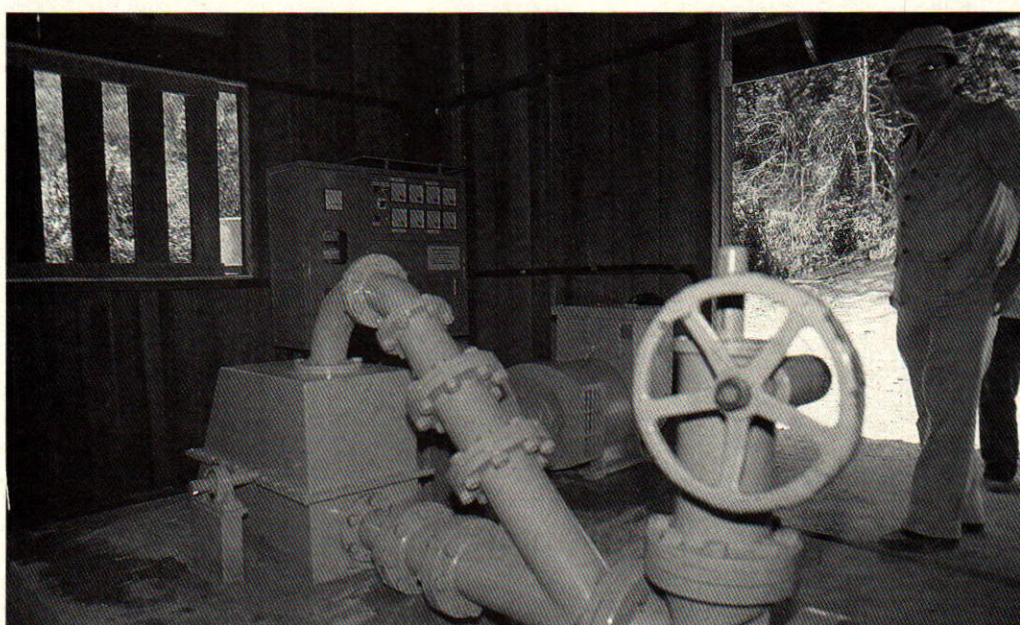
sales at the national tariff rate, after reduction of operating expenses, is divided amongst share holders.

5. Benefits

To date, twelve projects based on this model have been completed. The merits of this programme lie in the wide dispersion of low cost rural electricity, the saving of foreign currency, energy self-reliance and

the development of rural areas through self-help and co-operation which reflects a characteristic of Thai culture. It is also a show case of how technology capabilities can help develop the country.

5. *CROSS FLOW Turbine with alternator.*



6. *H.R.H. Princess Sirindhorn inspecting the project.*

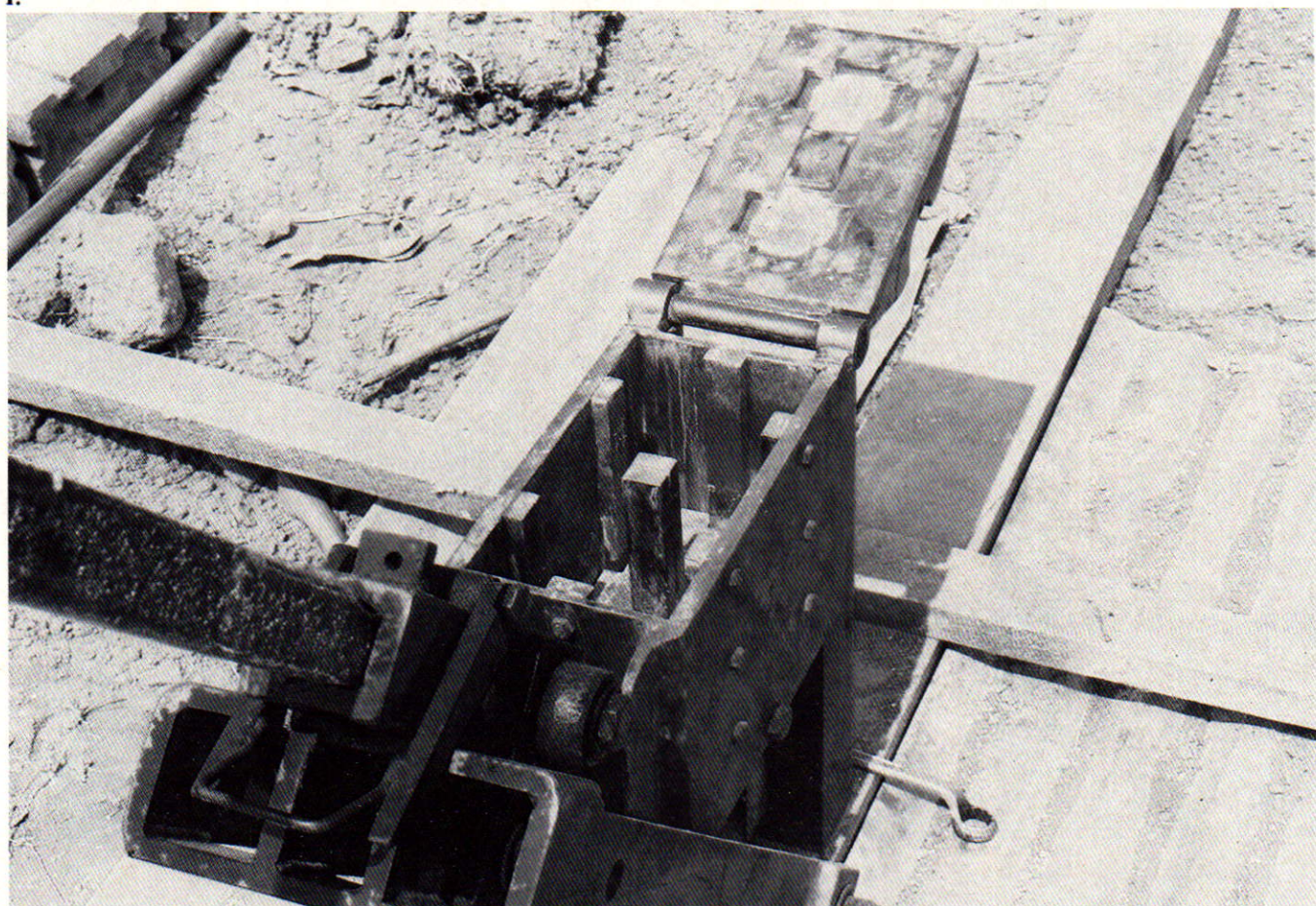
LOW COST HOUSING

Shelter is one of the four necessities of life. Throughout the history of mankind, housing has come in various sizes, shapes and materials. It also varies according to the availability of materials, climatic conditions and environment. These things also control, to a large extent, the life of the people.

In tropical countries, wood is naturally accepted as an all round, com-

petent and satisfactory building material. Even at the present time, wood still ranks first and maintains a permanent place as one of the most versatile construction materials. Other materials, such as brick, cement, soil, etc., have been popularly used in place of wood, particularly in large and multi-storeyed buildings.

1. Interlocking soil cement block pressing machine similar to that known as "Cinva-Ram".



Wood Versus Other Building Materials

Depletion of forest products in Thailand, like in most tropical countries, has occurred at an alarming rate. In many places, including Thailand, the situation is becoming acute. A shortage of wood, the conventional rural base building material on which the rural population has long been dependent, is very imminent. Furthermore, rural economy has fallen so low that most rural people cannot afford the alternative varieties of urban base building materials. In many regions of the world, however, soils have been used as a major ingredient for various forms of building materials, such as filling or building materials, paving floors or pasting walls, etc.

The Thai Institute of Scientific and Technological Research (TISTR) has,

since 1974, placed strong emphasis on the Rural Housing Development Programme in order to develop and promote practical and inexpensive building materials as an alternative to wood-base materials. Although the practice of using soil cement for building materials is not new, TISTR, in search of a suitable and durable wood substitute material, has placed emphasis on the development of soil cement technology, making full use of the vast terrain of the so-called lateritic soils. These soils have been used as the main ingredients in the development of soil cement block technology. The methodology has been improved, developed and adapted to the extent that the technology can confidently be given nation-wide promotion.



2. Mixed soils are placed in the pressing block. This machine is easily operated by rural people.

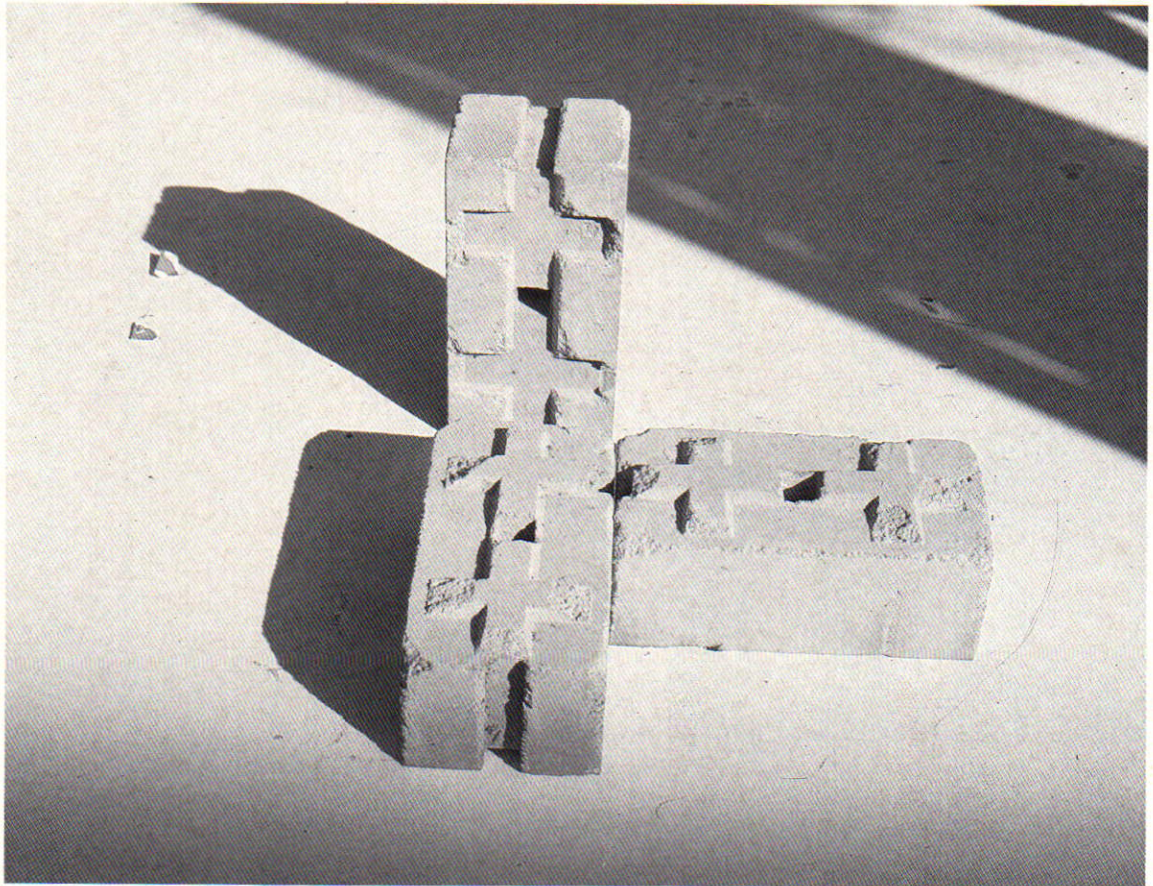
Soil Cement Block Technology

Soil-Cement is a mixture of a selected lateritic soil with a certain percentage of cement (10-15% by weight) and a proper amount of water. The correct proportion is best obtained by laboratory test with proper calculation. The soil cement block, after being pressed in a mould under a certain amount of pressure, is left to dry at room temperature without the use of baking. The block is quite durable as the required properties of soil cement block in the form of physical properties rather than chemical ones.

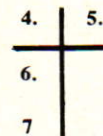
The TISTR Building Research Division realizes that one of the most important factors for rural development is the creation of appropriate rural building

materials. Soil cement blocks meet all criteria of rural development requirements, such as low cost, labour intensive production, locally available and, in many instances, a suitable replacement for wood. It is possible that other new local materials may be developed in the future, but at present, the soil cement block may be the key to the creation of a rural building materials industry. In fact, it is considered that a rural house built from a mixture of locally available material, such as SCB walls, bamboo windows and doors and a grass roof would be both practical and economical for the present day rural life of Thailand.

3.



3. Soil cement blocks may be interlocked by placing a steel rod through the open spaces or filling them with cement.



4. Stacking of soil cement blocks for wall building. Steel frames are set for the T-shape flying buttress portion of the wall in place of a post.
5. In a two-story house, wooden floor is set against the flying buttress. Steel rod reinforcement can be seen on the top.
6. Two storey house for rural community. Other local building materials may also be used.
7. One storey soil cement workshop recently completed for use as a ceramic house under the Queen's patronage, Special Handicraft Project.

BILATERAL, REGIONAL AND INTERNATIONAL CO-OPERATION PROGRAMMES

Thailand has been actively engaged in a number of bilateral, regional and international co-operation programmes on science

and technology for development. Examples of some of the on-going programmes are as follows:

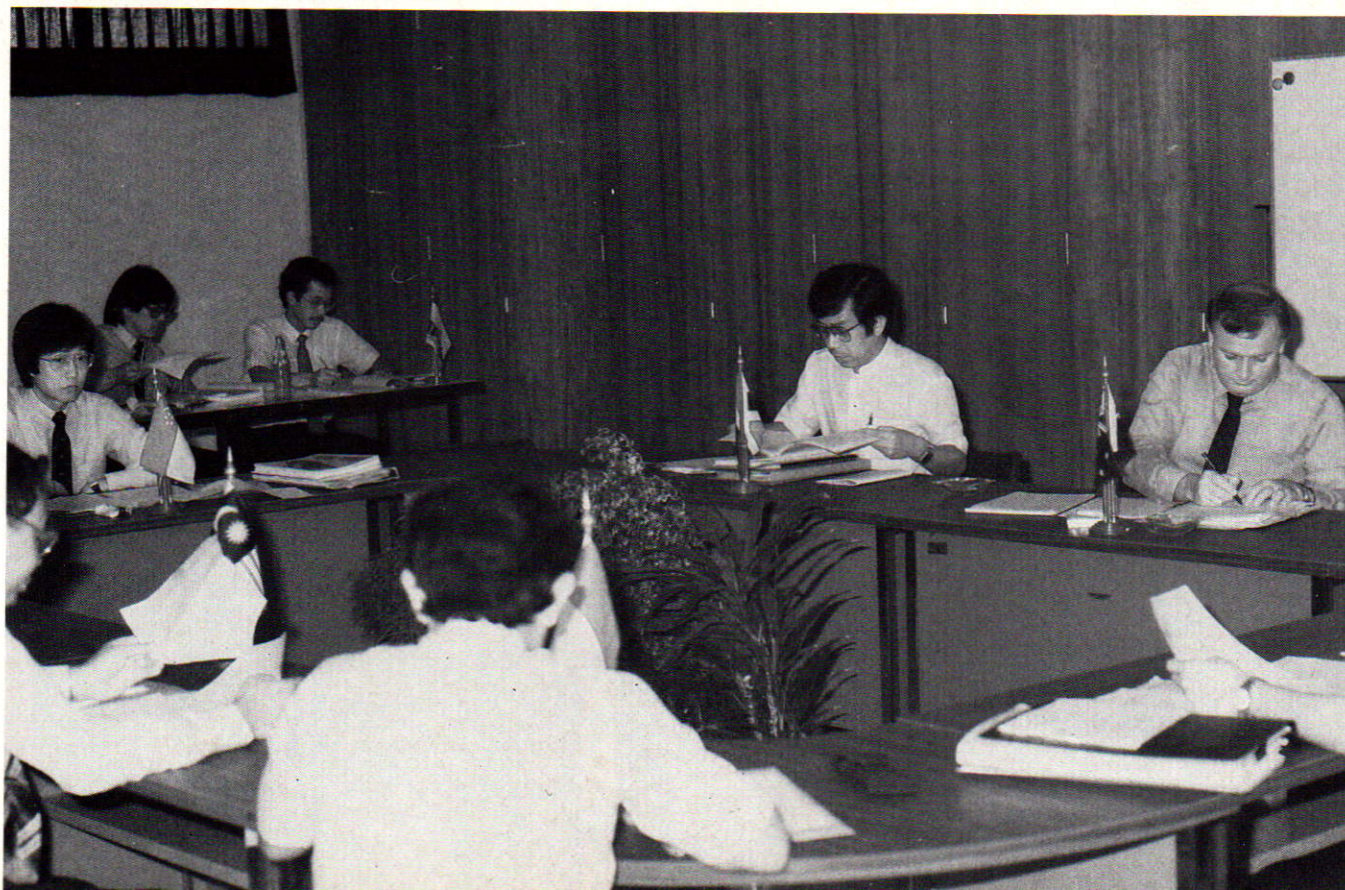
1. The ASEAN Committee on Science and Technology

The ASEAN Committee on Science and Technology (ASEAN-COST) was formed nearly a decade ago to establish guidelines for ASEAN co-operative efforts in utilizing science and technology for economic and social development and to co-ordinate intra-ASEAN scientific and technological activities. In the early stages undertakings concentrated on food and nutrition. Examples of such programmes are the Protein Project, the Food Wastes Project, the Food Technology

Research and Development Project, the Food Habits Project and the ASEAN Food Standards Project. Subsequent regional programmes of major importance are environment, energy, marine science and climatology. Financial assistance has been provided from major dialogue countries such as Australia, the U.S., the European Communities and UNDP. Negotiation for future co-operation is underway with Canada, Japan and New Zealand.

1. ASEAN Australian Consultative Meeting on Energy Project under the ASEAN-Australian Economic Co-operation Programme. Bangkok, 17 - 18 September, 1984.

1.



ASEAN-COST has identified and initiated works in 3 areas bordering frontier technology for her activities in the next decade, namely, biotechnology, micro-electronics and micro-processors applications and materials science.

The objectives and accomplishment of some of the ASEAN projects are briefly mentioned below:

(I) The ASEAN Protein Project is a regional co-operation project dealing with the development of low cost protein-rich foods in order to combat malnutrition in the ASEAN countries. Soya beans, among others, have emerged as an important source of raw materials. Infant food formulations, snack foods, and soya milk have been developed. The development of these and

other food products takes cognizance of the food-eating habits of the ASEAN people.

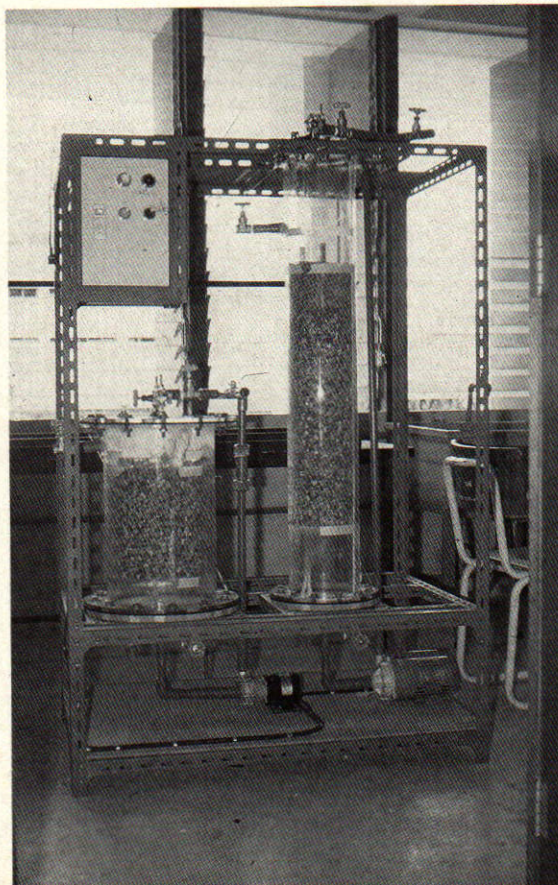
(II) The ASEAN Food Waste Materials project deals with the development of technology to turn food waste materials into useful products, thus negating pollution and, at the same time, improve efficiency in the utilization of food resources. Among others, biogas technology, membrane technology and fermentation technology have been developed by a team of ASEAN scientists working together in the region. Final products include human food, animal feed, fuels and chemicals, for example: animal feed developed from banana peels, human food from fish by catch, biogas from pineapple cannery waste and vitamin B 12 from cannery liquid waste.

3. Turning solid agro-industrial waste into fuel. Part of a programme for developing high-rate reactors to economically produce methane at an industrial scale from agro-industrial waste, e.g. pineapple peel, casava waste, etc. (ASEAN Food Waste Materials Project).

2. Pelitized mixed-fish feed which is a 1 : 1 mixture of ordinary feed and biomass which was grown in liquid waste from a pineapple processing plant. The mixed feed was found to have favourable effects on fish, e.g. increasing growth rate, rapid gonad development etc. (ASEAN Food Waste Materials Project).



2.



3.

4. Production of synthetic membrane from plastic waste. Membrane technology was chosen as technology appropriate for converting food waste materials into useful products. Development of locally produced membrane was carried out in answer to the technical and economical problems arising from using high-cost import membranes. (ASEAN Food Waste Materials Project).



4.

(III) The ASEAN Programme on Non-Conventional Energy Research was Launched in 1979. The programme covers new and renewable energy sources and energy conservation and is administered by a Working Group. Financial supports have been received from ASEAN dialogue-countries, notably

Australia and the U.S. The present major thrusts lie in research and development work on bio-mass for heat and power, utilization of low grade coal, energy system auditing and modelling, energy conservation and manpower training in energy planning and management.

5.

5. Construction of 2 m³ brick beehive kiln by trainees during the improved charcoal production technology training at RFD Charcoal Research Centre. The kiln requires 30 - 36 hr. operation with yield 35 - 40% based on O.D. wood input. The energy conversion efficiency is 55 - 60%.



2. US-Thai Renewable Non-Conventional Energy Project

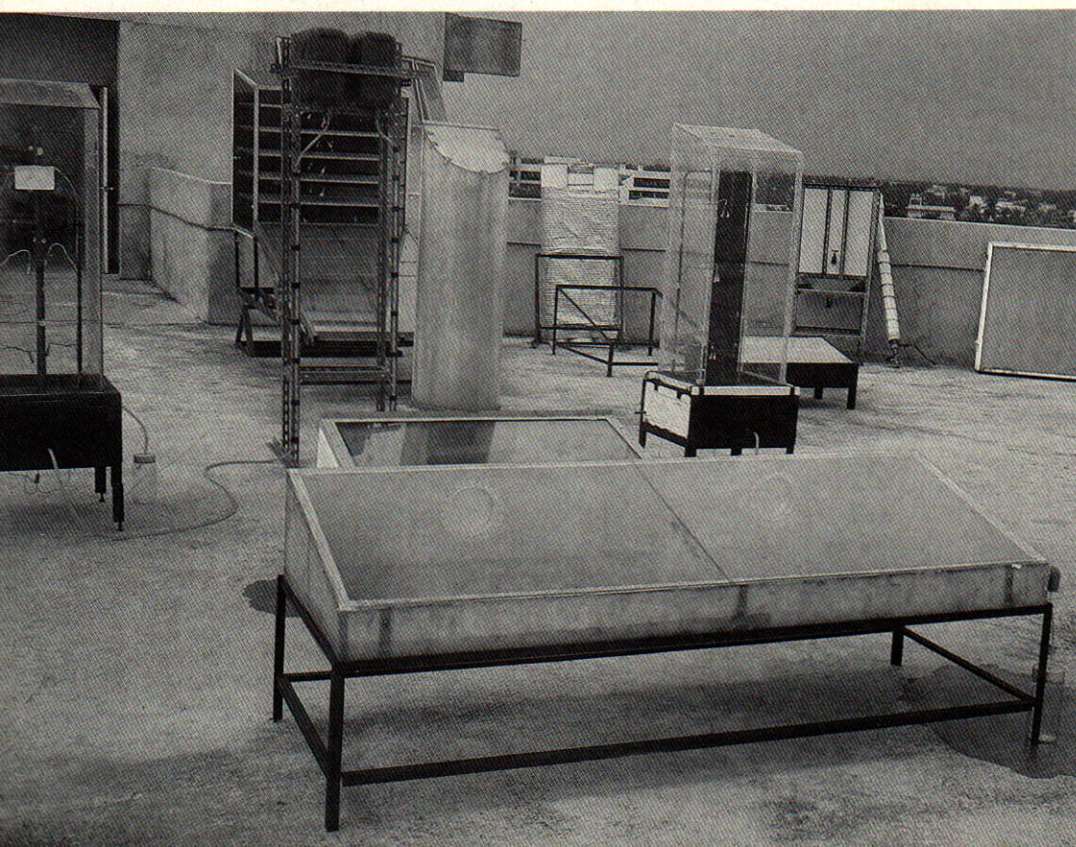
A co-operation project on renewable non-conventional energy development between the US and Royal Thai governments commenced in 1979. The project consists of 14 R & D components covering bio-mass, solar, wind and micro-hydro energy resources. A sum of US\$ 4.5 million has been provided by the U.S. government for the costs of equipment, materials, expert services, training,

technical meetings, etc., while the Royal Thai government provides, in kind, contributions such as researchers, buildings, local travelling expenses, etc. While researchers are provided by fourteen government agencies and universities, the project management is handled by the National Energy Administration.



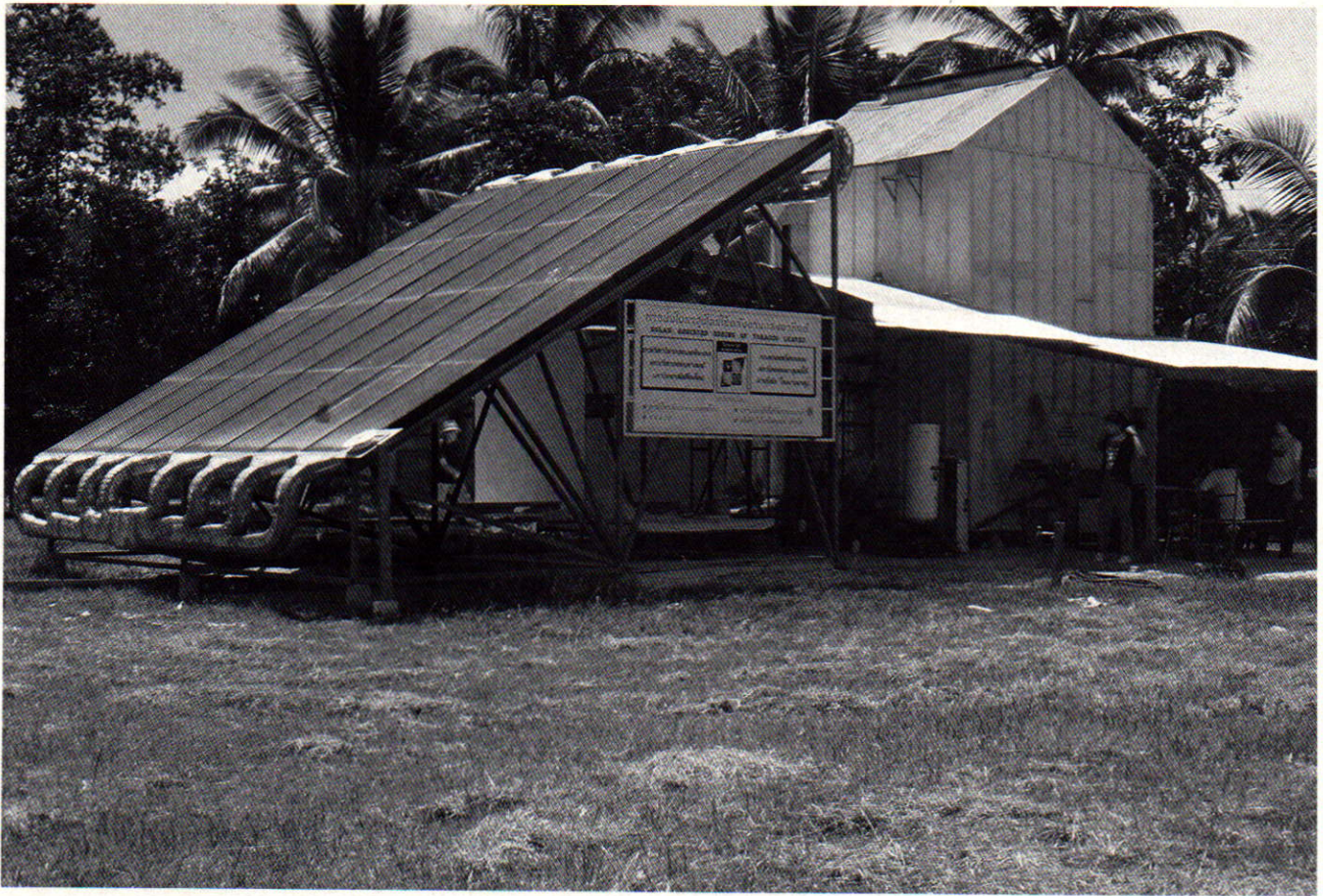
6.

6. The improved design model "RFD-1" charcoal stove development under USA-RTG Technical Co-operation on Renewable Non-conventional Energy Project. The peak heat utilization efficiency under laboratory test is 32-34% at charcoal load 400-500 gm. The pottery liner is heat refractory.



7.

7. Solar Stills with horizontal and vertical absorbing surfaces developed under the U.S.-Thai Renewable Energy Co-operation Project.



8.

8. Solar Assisted Tobacco Curing Barn Developed under the U.S.-Thai Renewable Energy Co-operation Project.

3. UNESCO Regional Networks on Science and Technology

The Unesco Regional Office for Science and Technology has set up five regional networks on Utilizations of Rural and Urban Wastes, Housing for Low-Income Groups, Alternative Energy Sources, Appropriate Technology for Rural Development and Instrumentation and Control. Activities of the five networks, funded mainly by Unesco, cover technical conferences, workshops and training, research and development and study tours at national and regional levels. Each network has a national contact point representative at a government agency or university. Regional activities of the networks are co-ordinated by Unesco Regional Office and National Commission and Network Secretariats.

4. Thai-U.S. Co-operation in Science and Technology

The Agreement between the Kingdom of Thailand and the government of the United States of America on Co-operation in Science and Technology was signed in Washington in April, 1984. The principal purposes of the Agreement are to strengthen the scientific and technical capabilities of both countries and to broaden and expand relations between the scientific and technological communities of both countries. Co-operation under this agreement will be undertaken in areas pertaining to agriculture, health, energy, space, environment, natural resources and hazards and such other areas for science and technology relevant to agricultural and industrial development. The co-operation may take almost any form as may be mutually agreed upon.



9.

9. *Forced Convection Solar Hut Dryer developed under U.S.-Thai Renewable Energy Co-operation Project. The solar hut dryer functions simultaneously as a dryer and a storage barn.*

U.S.-THAI SCIENCE AND TECHNOLOGY CO-OPERATION

U.S.-Thai science and technology co-operation may be said to have originated in the activities of private citizens and organizations in the nineteenth and early twentieth centuries. One lasting U.S. non-governmental contribution was the creation, mainly with the Rockefeller Foundation funding, of the first medical school in Siam — which was later to become one of the best of its kind in this region of the world.

Formal government-to-government co-operation was not fully developed until World War II. In 1950, three agreements were signed: Educational and Cultural Agreement, Technical and Economic Agreement, and Military Assistance Agreement. Co-operative efforts of the following two decades were notable for their focus on building an infrastructure in Thailand — vital physical facilities such as roads, bridges, ports, dams, as well as human resource development. During this period, direct U.S. aid amounted to nearly \$200 million. The purpose of infrastructural investment was not simply to strengthen the Thai economy but also to raise the level of rural welfare and provide access to the countryside.

The 1970's witnessed a decline in bilateral assistance, when multilateral institutions, such as the World Bank and the Asian Development Bank, became principal suppliers of capital for major development projects in Thailand. With the onset of the 1980's, American-Thai co-operation assumed a new dimension. The focus has now shifted to science and technology, partly to deal with new challenges such as the energy crisis, and partly to meet increasing demands of various sectors in Thai society — universities, industries, as well as government agencies — for a new development approach — that is, development based on science and technology.

U.S. science and technology assistance, in fact, has been an integral part of Thai-U.S. post-war co-operation. The creation of the Asian Institute of Technology (AIT), originally conceived in 1959 as SEATO School for Engineering, was mainly financed by USAID. Indeed, from 1959 to 1973, when the School was changed to AIT, the United States fund accounted for more than 52 per cent of its financial resources. Moreover, since World War II, USAID alone has subsidized about 12,000 Thai students to pursue advanced studies and research at American universities.

Science and technology co-operation continued in various forms. Examples include the USAID-funded creation of a "Remote Sensing Training Center" at AIT and the related projects for developing a system to use remote sensing data for resource development planning and implementation.

All these and many other co-operative ventures have accounted for a substantial part of what may be referred to as postwar "technology transfer" to Thailand. However, the major problem in the science and technology co-operation between the two countries was its lack of specific direction. Co-operative projects were sporadic and isolated. They needed to be orchestrated with a clear vision of how they could contribute to national development. The first major attempt to provide a strategic framework for U.S.-Thai science and technology co-operation was initiated by the Ministry of Science, Technology and Energy in 1983 — an initiative which led eventually to the signing of an agreement on co-operation in this area on April 13, 1984. The purposes of the agreement are principally to strengthen the scientific and technological capabilities of both countries by encouraging and facilitating direct contacts and co-opera-

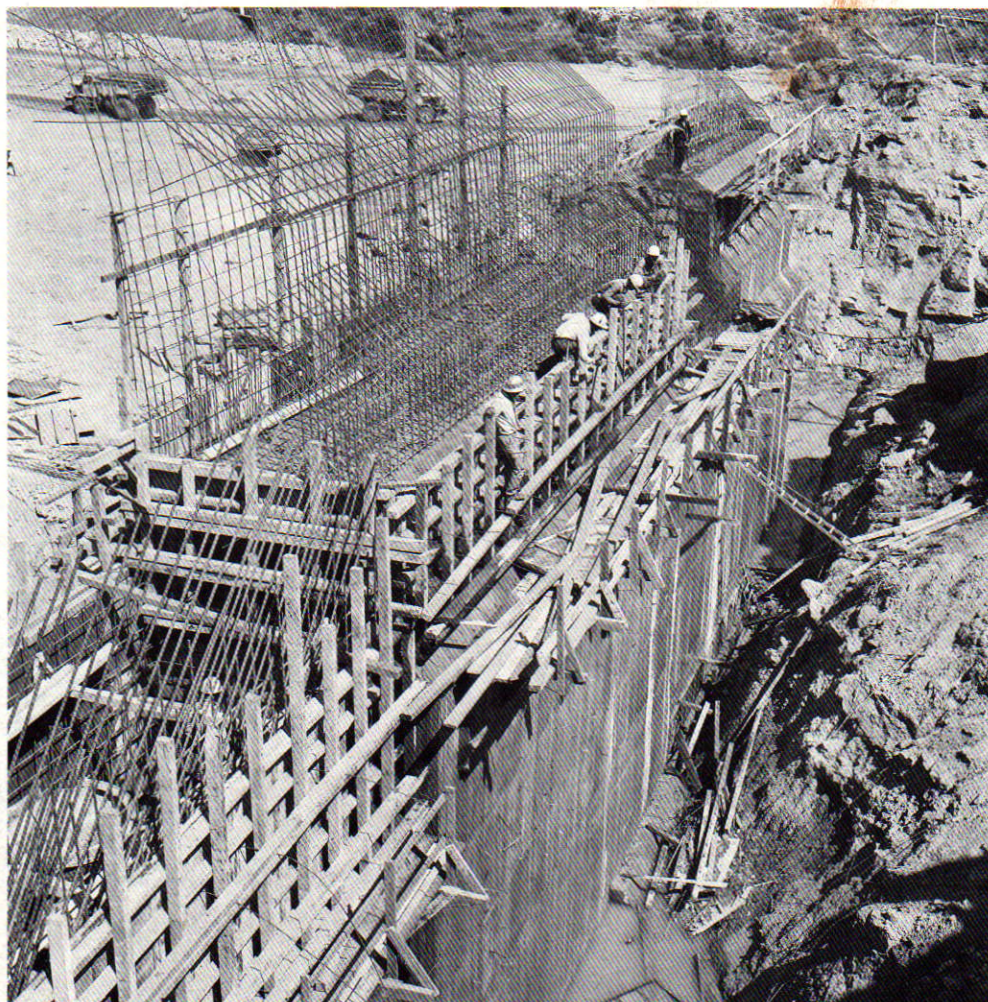
tion between government agencies, universities and research centres, as well as private firms and organizations of the two countries.

The Agreement covers a wide range of co-operation areas — from agriculture to

space. It not only provides a framework for increased co-operative efforts in these areas but also serves as a formal basis on which leaders of both countries can give their political support.



1. 2.



1. Opening ceremony of the new highway Khorat - Nongkhai on January 27, 1965 by H.E. Mr. J.M. Wilson, Minister to the American Embassy.
2. Highway under construction.



3. The signing ceremony on agreement between the kingdom of Thailand and the United States of America on Co-operation in Science and Technology during Prime Minister Prem Tinsulanonda's visit with President Reagan on April 13, 1984 by A.C.M. Siddhi Savetsila, Minister of Foreign Affairs for the government of the kingdom of Thailand and Mr. George P. Shultz Secretary of State for the government of the United States of America.

CANADIAN-THAI SCIENCE AND TECHNOLOGY CO-OPERATION

Canadian-Thai relations, which have experienced a remarkable growth in recent years, are notable for development co-operation. It is in the light of co-operation in this area that the science and technology dimension of the relationship must be seen. Canada's development assistance to Thailand may be said to date back to the very beginning of their diplomatic relationship — that is, more than twenty years ago. Recent developments, however, indicate that science and technology co-operation has assumed increasing importance.

Initial development aid focused on education and manpower training. Aid was also provided for family planning, rural electrification, fisheries, and technical assistance. Recently, Canada and the five ASEAN countries concluded an agreement which aimed at industrial development and commercial co-operation and which would serve to enhance technology transfer in the industrial sphere. The year 1982 may be said to have marked a significant milestone in Canadian-Thai development co-operation with the establishment of core country status for Thailand. And during Premier Trudeau's visit to Bangkok early in January 1983 Thailand and Canada reached three agreements, including a development co-operation agreement.

The purpose of this accord is to promote economic and technical co-operation for development. It serves to broaden and

co-ordinate existing as well as future co-operative efforts. One such effort is worth mentioning here. This is an agreement on a five-year development co-operation program which CIDA concluded with the National Economic and Social Development Board. This agreement aims to assist the Thai government, under the Fifth Development Plan, with the

(1) acquisition of the technological capabilities and expertise necessary to make the best use of capital flows to both the public and private sectors;

(2) management of Thailand's natural resources; and

(3) alleviation of rural poverty.

In pursuant to these goals, Canada directs its assistance primarily to (1) modern-sector development with a special emphasis on three sub-activities, namely, energy, minerals, and trade and investment promotion; (2) rural development, particularly in the Northeast; and (3) human resource development and institution building. Currently, various projects have been launched with CIDA support, including the CUSO Northeast Thailand Project; the Rural Electrification Project, and the Airborne Geophysical Survey Project. There is also technical assistance, including the newly initiated Rattanakosin Scholarships Program, to various government agencies, such as DTEC, NESDB, PTT, the Department of Fisheries, and EGAT.

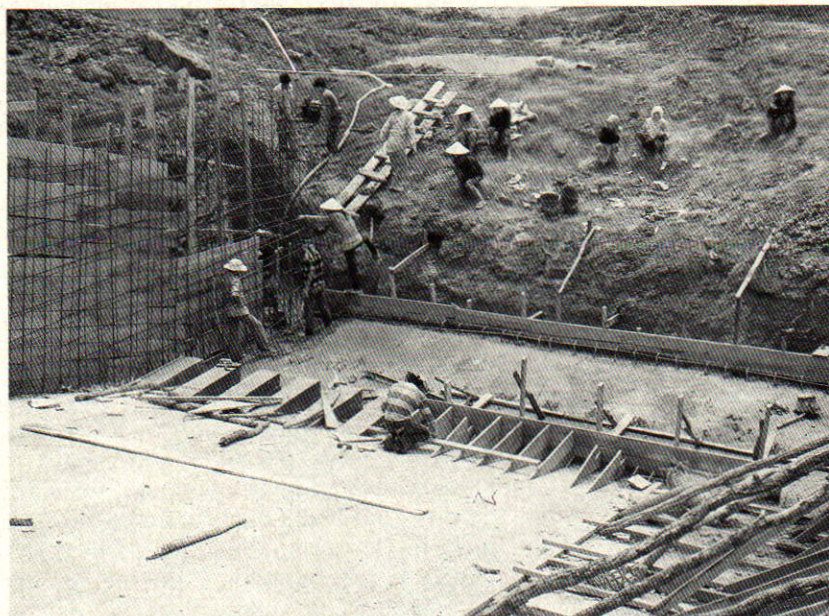


1. Ban Mou Mon Water Supply Project - funded in 1983 - a water tank was installed over an artesian well - Udon Thani Province.

1.



2.



3.

2.,3 Ban Suk Charoen Project - funded in 1982 in Nakhon Phanom Province - a dam and spillway were constructed.

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