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Potential Collaboration in Science and Technology

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PREFACE

In November 1982, Indonesia's Minister of State for Research and Technology, Dr. B. J. Habibie, suggested to me that the National Research Council (NRC) hold a symposium in Washington, D.C., sometime during 1983 to serve as a catalyst in bringing together individuals from the U.S. academic, government, and industrial sectors to meet with a number of his Indonesian colleagues. The symposium would provide an opportunity for participants to look at potential U.S.-Indonesia collaboration in areas of major concern to Indonesia. The timing of the symposium was intended to coincide with completion of preparations for the Government of Indonesia's next five-year development plan, which would begin in April 1984. The areas considered at the symposium--which was a public event and therefore open to all interested individuals--were selected by Minister Habibie and agreed to by the NRC as being the most appropriate for mutual consideration.

We hope that the information presented at this symposium and in this report, which includes the presentations made by the Indonesian delegates and reflects the collective and individual contributions of participants during the working group sessions, will result in increased collaboration between Indonesia and the United States.

This symposium represents the first activity between BOSTID and the Indonesian government held in the United States. It is part of a larger program of cooperation that was begun in 1968 and has featured a series of workshops on food policy; industrial and technological research; natural resources; rural productivity; methodologies for planning, implementing, and evaluating research and technology; and manpower planning. BOSTID participation has been supported in the context of a science and technology loan from the U.S. Agency for International Development (USAID) to the Government of Indonesia. The program with BOSTID calls for two or three activities (panel discussions, workshops, seminars, or small advisory groups) to be organized each year.

All of the workshop participants and the chairman, in particular, are indebted to Jerome Bosken of the USAID mission in Indonesia and A. B. Van Rennes, U.S. technical adviser to Minister Habibie, for their assistance and advice. Also, they are indebted to Rose Bannigan, professional associate, Board on Science and Technology for International Development, who coordinated the symposium and whose sustained effort, erudition, and organizational skills made this meeting possible.

She was ably assisted by the symposium's secretariat, under the direction of Carol Richmond, administrative secretary, and by BOSTID staff members Susan McCutchen and Connie Reges.

In addition, appreciation is extended to Resources Management International in Indonesia, who donated their services to the National Research Council for the translation, initial editing, and printing of the scientific papers presented by the Indonesian delegates.

Walter A. Rosenblith

Walter A. Rosenblith
Chairman

CONTENTS

INTRODUCTION

Indonesia is now entering the final year of its third 5-year development plan (REPELITA III, 1979-1984). This plan and its predecessors have guided the government of Indonesia in its formulation and implementation of social and economic development activities. The fourth plan will commence in April 1984.

The first 5-year development plan (1969-1974) emphasized Indonesia's agricultural sector and its supporting industries, and the second 5-year plan (1974-1979) continued this emphasis, while promoting industries that process raw materials. The current plan (1979-1984) is also stressing the agricultural sector and self-sufficiency in food and the promotion of raw material processing industries. In allocating resources within the fourth plan, the government will seek not only to meet immediate needs but also to establish industries and the economic and social infrastructure needed to encourage future development. As part of its efforts to better acquaint the U.S. private and public sectors with the goals of the fourth 5-year development plan (REPELITA IV), the Indonesian Ministry of State for Research and Technology asked the U.S. National Research Council (NRC) through its Board on Science and Technology for International Development (BOSTID) to cosponsor a public symposium in Washington, D.C.

PURPOSE AND ORGANIZATION OF THE SYMPOSIUM

Held in Washington, D.C., October 3-5, 1983, this meeting was intended to act as a forum for exchanging information and identifying opportunities for mutually beneficial collaboration in the following areas:

- Marine sciences
- Postharvest technology, farm mechanization, and agro-industry
- Engineering and machine tool industries
- Telecommunications and electronics
- Land transportation industries
- Energy industries.

At the first day's opening plenary session, participants were welcomed to the symposium by Dr. Frank Press, president of the National Academy of Sciences (NAS), and Professor Walter A. Rosenblith, NAS foreign secretary and overall chairman of the symposium. His Excellency A. Hasnan Habib, Indonesian ambassador to the United States, gave the opening address (Appendix A). Professor Sukadji Ranuwihardjo, assistant minister for policy coordination, Ministry of State for Research and Technology, head of the Indonesian delegation, and cochairman of the symposium, also addressed the participants (Appendix B). In his remarks, Professor Sukadji stressed the importance of the topics under discussion to the Indonesian people and their government. He also described the important role that the government has played in Indonesia's industrial development by guiding the planning and policy-making for future development and providing protection from foreign competition.

Other members of the Indonesian delegation then summarized papers they had prepared to serve as a background for the next day's working group discussions. Appendixes C and D contain the symposium agenda and a list of symposium participants, respectively.

On the second day of the symposium, five working groups were assembled (the land transportation and energy industries groups met together). With the exception of the group addressing marine sciences, all participants met with Dr. Rahardi Ramelan, deputy chairman for industrial development, Agency for the Assessment and Application of Technology, for a short session that focused on Indonesia's industrial policies and plans for the coming decade. Dr. Ramelan outlined the various conditions that Indonesia must consider so that forthcoming industrialization will benefit a greater number of the Indonesian people. The working groups, which met for the balance of the second day, were asked to give special attention to technologies found in the United States that would be useful to Indonesia in meeting its development goals.

At a plenary session on the third and final day of the symposium, the working group chairmen read the conclusions that emerged from their groups and solicited comments from the audience. These comments, as well as other suggestions, were taken into consideration in formulating the final conclusions and recommendations found in this report.

ORGANIZATION OF THIS REPORT

Jointly organized and sponsored by the Indonesian Ministry of State for Research and Technology and the U.S. National Research Council, this public symposium was open to all concerned individuals in the public and private community. Thus this report contains observations and comments from all participants who attended the symposium. It also includes papers presented by the Indonesian delegation. Each Indonesian presentation is followed by a summary of discussions in the working group sessions on that particular topic. These summaries were prepared by the working group chairmen and rapporteurs. The reports have been edited to eliminate duplication, but they accurately reflect the discussions during the working group and plenary sessions.

This report of the symposium was prepared by Rose Bannigan of the BOSTID staff. The final draft was reviewed by the National Research Council and the Indonesian chairman and cochairman. Sabra Bissette Ledent, BOSTID consultant, and Sherry Snyder, BOSTID reports editor, edited the report.

PART I

MARINE SCIENCES

MARINE SCIENCES IN INDONESIA: PROBLEMS AND PROSPECTS FOR NATIONAL DEVELOPMENT

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INTRODUCTION

The physical environment of Indonesia is unique. Geographically, the Indonesian archipelago is situated between the Asian and the Australian continents and the Pacific and Indian oceans (Figure 1). The archipelago consists of 13,677 islands (excluding East Timor province) and has more than 81,000 km of coastline, probably one of the longest in the world. Indonesia has a total land area of over 1.1 million km^2, and its archipelagic and territorial waters (12-mile limit) constitute an additional 3.1 million km^2. The 200-mile exclusive economic zone enlarges the latter area by 2.7 million km^2.

Indonesia's territorial seas can be divided into several parts: the shallow Sunda shelf in the west; the Sahul shelf in the east; the deep ocean in the south; and the deep seas, straits, and channels in the middle. Various international expeditions (Challenger, Dana, Albatross, and Galathea) and regional and national expeditions (Siboga, Snellius, Baruna, and Raumphius) contributed to understanding the oceanographic features of these waters (see Soegiarto 1978).

The approximately 81,000 km of coastline consists of three different bottom types--rocky, sandy, and muddy--the distribution of which is partly governed by the strength of water energy (current patterns and wave actions). Along the coastline are various types of ecosystems such as coral reefs, mangrove, sago, nipa, and other swampy forests.

Because of its geographic location, the Indonesian archipelago is strongly governed by a monsoon-type climate. In general, the northwest monsoon lasts from December to February or March and the southeast monsoon from June to August. The remaining months represent the transition periods between the two monsoons. These monsoons strongly affect the oceanographic features of Indonesia and its adjacent waters (see Soegiarto 1978, Soegiarto and Birowo 1975).

The waters of Indonesia cover two-thirds of its territory. Thus how fully and wisely these waters are utilized in the coming decade will affect Indonesia's economy, its ability to meet the increasing demands for food and raw materials, its position and influence in the regional community of nations, its national resilience, and the environmental quality of the entire country in which the marine environment is a dominating physical factor.

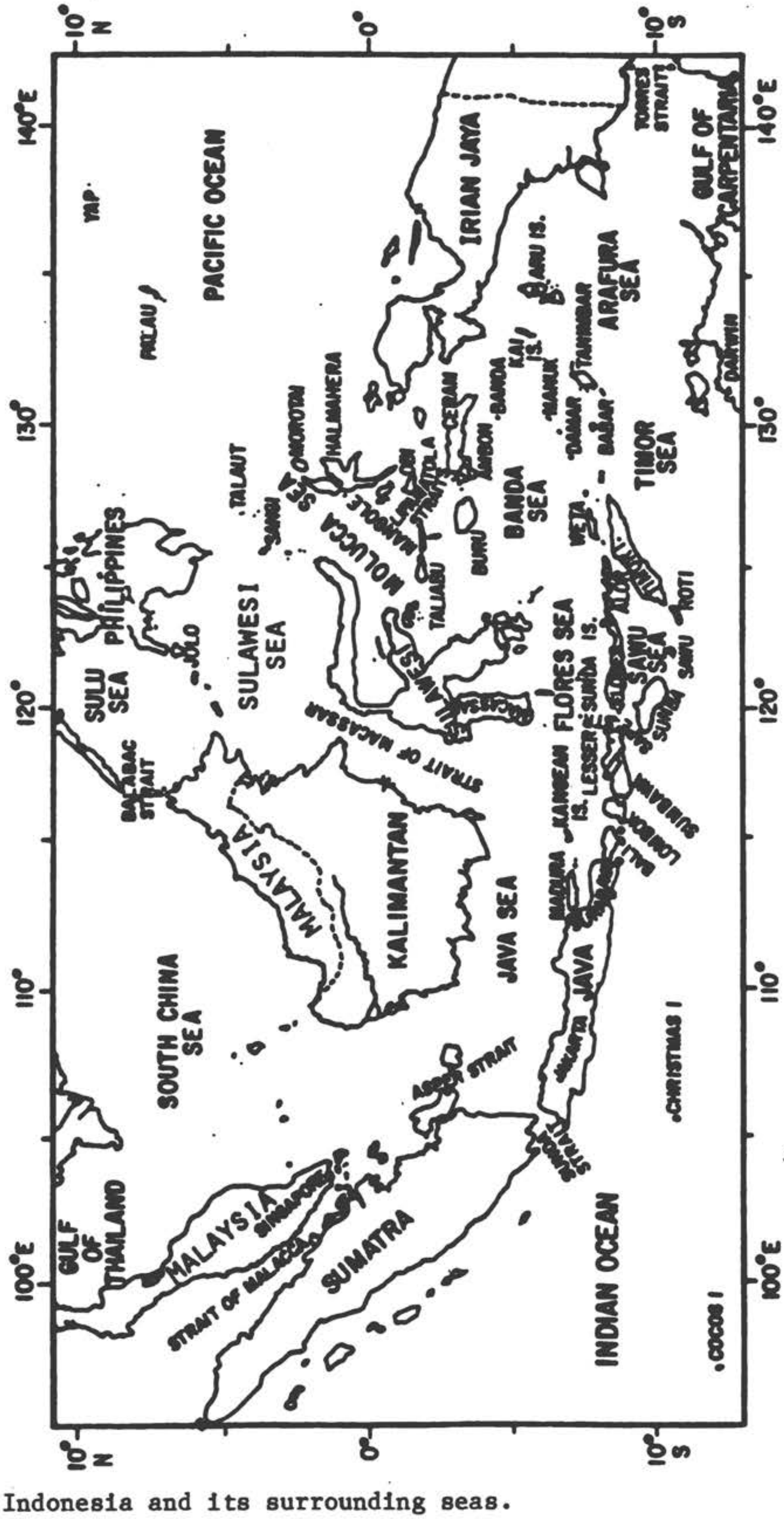


FIGURE 1 Indonesia and its surrounding seas.

For centuries the rich and diversified life in the seas has been an important source of food for the Indonesian people. Fish, crustaceans, molluscs, and seaweed are only a few examples. In addition, mineral and hydrocarbon resources have been tapped from the shallower waters. Indonesia's seas are also used for inter-island, regional, and international shipping and for trade, communication, recreation, and tourism.

The knowledge and experience needed to make decisions on alternative courses of action for developing resources from the seas are at present limited. Thus Indonesia's long-range plan must include a program to increase its capabilities in marine science. This program should focus on, among other things, improving communications and coordination throughout the marine science community, establishing a National Marine Data Center, upgrading the quantity and quality of manpower, and expanding and improving research facilities (see Broadie 1976, Comitini and Hardjolukito 1983, Doty and Soegiarto 1970, Soegiarto and Polunin 1981).

THE ROLE OF MARINE RESOURCES IN THE INDONESIAN ECONOMY

Fisheries

The use of marine resources in Indonesia is slowly growing to meet the increasing demands for food, energy, raw materials for industries, job opportunities, and foreign exchange. The current annual production of living aquatic resources is approximately 1.8 million tons--about 1.4 million tons from the marine sector and 400,000 tons from the freshwater and aquaculture sectors (Table 1). The annual rate of increase from the second to the third 5-year development plan (REPELITA II, 1974-1979, and REPELITA III, 1979-1984, respectively) was about 20 percent. This increase was, however, generally confined to the marine sector. The production from inland waters declined slightly from year to year, resulting in part from urbanization; absorption of the labor force into other sectors of the economy (e.g., logging industries); siltation and eutrophication in many lakes, swamps, and rivers; and a reduction in the number of mixed-culture practices caused by the increasing use of pesticides and herbicides in agriculture.

The Indonesian seas have the potential to produce a maximum sustainable yield of 4 million tons annually (Table 2). Thus the current production of 1.4 million tons represents only about 30 percent of the potential yield. The potential yield of freshwater capture and culture (including brackish water) is 2.3 million tons, which means that current production is only about 17.4 percent of the potential yield.

A strong upward trend has also become apparent in the volume and value of exports of living aquatic resources in Indonesia. Export activities are mainly dominated by shrimps and prawns. The export of fresh prawns was negligible before 1966, but from 1967 to 1969, the export value rose from US$25,000 to $877,000, followed by $3.6 million in 1970, and $13.7 million in 1972. The value of exports in living aquatic resources in 1979 was over $220 million.

TABLE 1 Production of Living Aquatic Resources in Indonesia, 1970-1980 (1,000 Tons)

Production	Year 1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Marine	825.2	828.7	844.7	895.3	960.4	999.6	1,043.0	1,158.0	1,225.0	1,318.0	1,397.0
Freshwater	409.4	412.8	420.6	368.2	375.3	389.9	405.0	414.0	420.0	430.0	488.0
Total	1,234.6	1,241.5	1,265.3	1,263.5	1,335.7	1,389.5	1,448.0	1,572.0	1,645.0	1,748.0	1,885.0
INDEX (1970 = 100)											
Marine	100.0	100.4	102.4	108.5	116.4	121.1	126.4	140.3	148.7	159.7	169.2
Freshwater	100.0	100.8	102.7	89.9	91.7	95.2	98.9	101.1	102.6	105.0	119.2
Total	100.0	100.6	102.5	102.3	108.2	112.5	117.3	127.3	134.0	141.6	152.7
COMPOSITION (%)											
Marine	66.8	66.7	66.8	70.9	71.9	71.9	72.0	73.7	74.1	75.4	74.1
Freshwater	33.2	33.2	33.2	29.1	28.1	28.1	28.0	26.3	25.9	24.6	25.9

TABLE 2 Estimates of Fisheries Potentials in Indonesia

Sector	Potential Production (10^6 t/yr)	Current Production (10^6 t/yr)	Current Production as Percentage of Potential Production
Marine	4.5	1.4	32
Freshwater			
Capture	0.8	0.4	50
Culture	0.3	0.1	30
Brackish and marine culture	1.2	0.1	9

Thus marine fisheries in Indonesia are gradually expanding, not only to meet the increasing demand for inexpensive animal protein but also to contribute to urgently needed foreign exchange. For the fishery industries to grow more rapidly, however, many constraints must be overcome such as the widespread need to develop technical skills; modernize equipment and fishing methods; expand the existing fishing grounds while looking for new ones; study the life cycle, migration, and population dynamics of economically important species; and seek new exploitable species.

Petroleum, Gas, and Minerals

Although most of Indonesia's petroleum production of about 1.5 million barrels per day (bpd) is still derived from the inland oil fields, an increasing proportion (about 33 percent) is coming from the offshore fields (Table 3).

Indonesia has also begun to exploit its offshore natural gas resources from, among others, the Arun (Aceh), Bontang (East Kalimantan), and Jatibarang (northern coast of West Java) fields. Natural gas from Arun and Bontang will mainly be exported to the United States, Japan, and South Korea, whereas gas from the Jatibarang field is used by the Krakatau steel plant at Cilegon, the Kujang fertilizer plant in Krawang, and households and factories in metropolitan Jakarta.

Many minerals are also found and, in some cases, mined in Indonesian coastal areas. They include tin, bauxite, nickel, iron sand, and gravel.

TABLE 3 Oil Production in Indonesia, 1970-1982 (1,000 Barrels per Day)

Year	Total	From Inland Fields	From Offshore Fields	Percent Offshore of Total
1970	854	854	0	0
1971	892	881	11	1.2
1972	1,080	1,011	69	6.4
1973	1,337	1,163	174	13.0
1974	1,391	1,146	245	17.6
1975	1,307	970	337	25.8
1976	1,420	993	427	30.1
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
1982	1,400			~33.0

MARINE RESEARCH AND NATIONAL DEVELOPMENT

To ensure that science and technology are strongly integrated with Indonesian development, the Indonesian Ministry of State for Research and Technology has established the Team for the Formulation and Evaluation of National Major Programs on Research and Technology (PEPUNAS-RISTEK). This team has formulated a national matrix on research and technology (Table 4) that lists the main program activities in each field and area of concentration. Government agencies, research institutions, and universities may then develop research and development proposals from the list.

Because marine research is a prerequisite for the rational, optimal development and management of marine resources and protection of the marine environment, an interdepartmental National Committee for Ocean Technology has been established. This committee is composed of experts and administrators from various fields of expertise and from various research institutions, government agencies, and universities. The three long-term objectives pursued by this committee are:

1. To develop an indigenous capability to live from and with the sea
2. To use the development of marine resources in support of national development and, particularly, equal income distribution
3. To manage marine resources and coastal areas for long-term socioeconomic gain.

The main functions of this committee are:

- To formulate a general policy for marine science and ocean technology development
- To formulate national programs and to coordinate and execute the systems management of all activities related to marine research and ocean technology
- To monitor all activities related to these fields.

For the fourth 5-year national development plan (1984-1989), the National Committee for Ocean Technology (1981) has formulated an interdisciplinary and interagency master plan program. This plan is centered around the marine science-related activities in the national matrix for research and technology (Table 4) and includes the following major programs:

I. Surveys and mappings
   a. General bathymetric mappings
   b. Mappings for navigational lanes
   c. Mappings for the delineation of national borders at sea

II. Inventory and evaluation of marine resources
   a. Fishery resources
   b. Potential of biological resources
   c. Energy resources
   d. Mineral resources
   e. Other geological resources

III. Studies of the marine environment
   a. Oceanographic features of the Indonesian and adjacent waters
   b. Coastal development and management
   c. Monitoring of marine pollution

IV. Coastal and ocean engineering, including the development of capabilities in underwater technology and offshore engineering.

The above major surveys and scientific programs are supported by three development programs: (1) manpower development, (2) establishment of a National Oceanographic Data Center, and (3) development of the relevant research infrastructure and facilities.

TABLE 4 National Matrix on Research and Technology

Area \ Major Program	Basic Human Needs	Natural Resources and Energy	Industrialization	Security and Defense	Social, Economic, Cultural, and Legal Problems
Terrestrial					
Seas and Oceans					
Air					
Environment					

CONSTRAINTS TO DEVELOPMENT

While there are many major constraints to faster development of Indonesia's marine science capability, the shortage of properly trained and properly rewarded personnel is probably the most important. Habibie (1981) has correctly pointed out that

> . . . any national development, in particular the national development of Indonesia in the years to come, depends very much on our ability to . . . optimize the interrelationships between the human resources, natural resources, and technology. In this scenario technology could function effectively and efficiently in the value added process if, only if, there is an adequate supply of well trained manpower in the social fabric of our society. This implies that the Indonesian people as a population mass should be elevated and converted into a human resource with an economic as well as a cultural potential. Only then, and not before, can natural resources be of benefit to the largest number of our people.

The problem of manpower development was also emphasized at the Panel Discussions on Science and Technology Planning and Forecasting for Indonesia, sponsored by Indonesia and the U.S. National Research Council and held in November 1982. The proceedings of these discussions present the findings and recommendations of the working group on marine science and underwater technology (National Research Council 1983).

The shortage of marine scientists and the slow process of developing manpower in marine sciences result in part from the educational system in Indonesia. Although the sea is the dominating physical feature of Indonesia's environment, its educational system is still terrestially oriented. The limited number of young people who enter marine sciences are generally university graduates who have not had proper training in this field. To alleviate this problem, a fishery-oriented program has been established over the past few years in many Indonesian educational institutions. Although this program still has many shortcomings, it is one step forward. Eleven faculties of fisheries now exist, with Bogor Agricultural University having the oldest, largest, and strongest faculty.

In late 1974, a National Seminar on the Sea was organized to formulate a policy on alternative courses of action and requirements for development of marine science programs. At the same time, the Ministry of Education and Culture laid out a basic policy on higher education in the country that encouraged each university to develop its own major science pattern (Pola Ilmiah Pokok or PIP). As a result, some universities have contemplated developing marine science, for example, Diponegoro University at Semarang, Central Java; Hasanuddin University at Ujung Pandang, South Sulawesi; and Pattimura University at Ambon, the Moluccas. Although preparations are under way for these three universities to become the leading educational institutions in marine sciences in Indonesia, it will probably take another 5 years before they can produce their first group of graduates. In the meantime, university graduates must be recruited from nonmarine science faculties, and, as can be expected, only a small fraction of the graduates from natural sciences are willing to enter marine science fields.

THE ROLE OF TECHNICAL ASSISTANCE

Indonesia receives technical assistance in three ways: (1) through bilateral arrangements; (2) through U.N. agencies; and (3) through international foundations or organizations such as the Ford Foundation, Rockefeller Foundation, International Development Research Centre (Canada), Max Planck Institute, and Humboldt Institute.

The U.N. agencies, such as UNESCO, the Food and Agriculture Organization of the U.N., and the U.N. Development Programme (UNDP), serve as the major sources of technical assistance in marine science. Because very limited assistance has resulted from bilateral arrangements, Indonesia is trying to increase the amount of technical assistance received through this mechanism from, for example, Japan, the United States, and West European countries, all of whom have given favorable responses in this regard. For technical assistance to be successful, however, it must be geared toward helping the developing nations identify their own needs and define their own programs and priorities. Foreign experts or consultants must work with local scientists, teaching basic science where needed and helping them formulate programs adapted to their special conditions.

The marine sciences are often perceived as one way in which industrialized countries can improve their advantage by benefiting from an increased use of the ocean and its resources. It is thus conceivable that at the Law of the Sea Conference, for example, the developing nations will favor strict controls over marine research conducted by developed maritime countries, while at the same time developing their own marine sciences so that they too can benefit from that knowledge. Possibly an agreement could be reached in which the more developed maritime countries will help the developing nations achieve that knowledge through bilateral technical assistance. Such assistance could be used to improve research facilities, for manpower development through training and fellowships, for purchase of science books and subscriptions to science journals, and to share expertise.

A few examples of current cooperative programs and technical assistance in the marine sciences and related fields in Indonesia are listed below:

- France, cooperative programs in oceanology carried out since 1978. Thus far 12 scientific cruises have been made using ORSTOM's (Office de la Recherche Scientifique et Technique Outre-Mer) research vessel, *Le Coriolis* (each cruise is called the Corindon--Coriolis cruise in Indonesia). The major scientific programs include geology and geophysics, marine biology, fisheries, marine pollution, tin exploration, and bathymetric mapping.

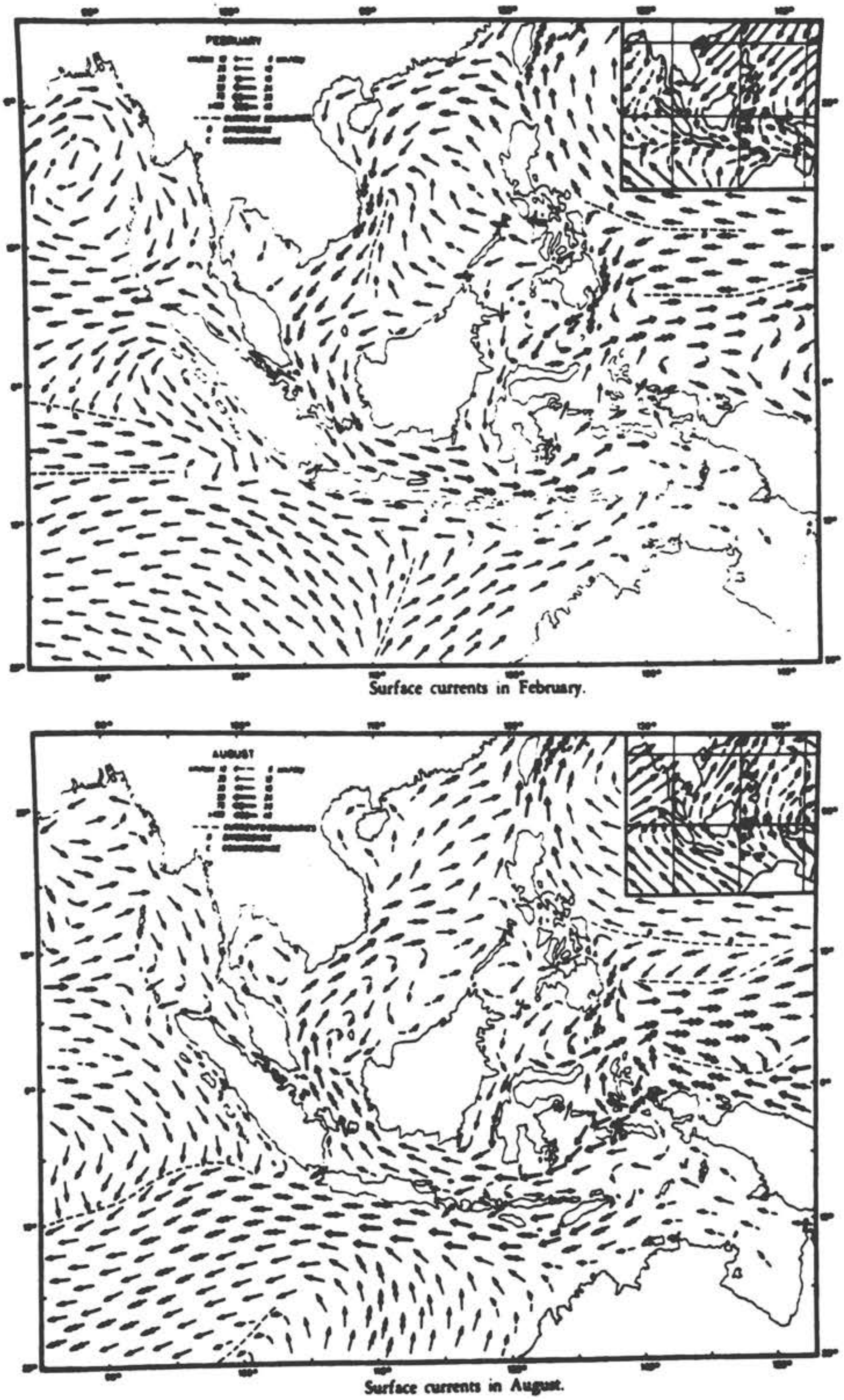
- Japan, cooperative programs in bathymetric mapping, fisheries, and mariculture.
- Federal Republic of Germany, cooperative programs in fisheries, stock assessments in the 200-mile EEZ (exclusive economic zone), and shipbuilding.
- Great Britain, marine biology educational programs in Semarang (Diponegoro University).
- The Netherlands, cooperative programs within the second Snellius Expedition with five scientific themes: geology of the Banda Arc, basin ventilation, pelagic system, coral reefs, and river inputs to ocean systems. One Dutch and six Indonesian research vessels will be utilized in this joint expedition, and the cruises will take place from July 1984 to July 1985.
- United States, programs in fisheries and aquaculture, survey of hydro-oceanography in the straits of Macassar and Lombok, aquatic resource development at Pattimura University and the National Institute of Oceanology/Ambon, and the National Research Council's technical exchange in marine sciences.

THE NEED FOR REGIONAL COOPERATION

Most of the shorelines of the Southeast Asian countries are influenced by water masses of the same origin. Thus the water circulation of one body of water has a direct or indirect effect on the patterns of other bodies of water in the region (Figure 2). During the northeast monsoon, for example, oceanographic patterns in the South China Sea have a direct impact on conditions in the Java Sea, the Sulu Sea, and the Straits of Malacca. Because similar kinds of fish and other economically important marine biota are harvested or cultured in the ASEAN (Association of South East Asian Nations) region, many similar factors--biological, socioeconomic, or technological--govern their productivity and their mode of exploitation.

The Southeast Asian countries also have similar environmental problems. Marine pollution, for example, recognizes neither physical nor territorial boundaries. In addition, inadequate facilities (research and pollution clean-up operations) and too few marine scientists and marine environmentalists plague each of the Southeast Asian countries. Regional cooperation is thus urgently needed to pool knowledge and enable manpower to carry out research and development on problems of common interest. Since marine environmental research, in most cases, is very costly, a system of regional cooperation would ease the financial burden of each member country and offer:

- Wider geographic coverage
- More representative samplings from different areas of the region
- Comparison of results.



Surface currents in February.

Surface currents in August.

FIGURE 2 Surface currents and wind flows (inset) in February and August, Southeast Asia. (Source: Wyrtki 1961)

The need for regional cooperation in marine science has been agreed upon by the Committee on Science and Technology of the Association of South East Asian Nations (COST-ASEAN). Two programs have been identified and formulated: (1) tidal studies of the ASEAN region, and (2) oceanographic studies of the ASEAN waters. In the American-ASEAN dialogue held in Washington, D.C. in 1979, the United States agreed in principle to support these programs. Indonesia is currently preparing a more detailed and integrated proposal that will be submitted to the United States for consideration.

The need for regional cooperation in marine pollution studies was agreed upon by the 1976 International Workshop on Marine Pollution in East Asian Waters (Penang, Malaysia) sponsored by FAO, the Intergovernmental Oceanographic Commission (IOC), and the U.N. Environmental Programme (UNEP). In June 1980, UNEP organized a meeting in Baguio City, the Philippines, to review the Draft Action Plan for the Protection and Development of the Marine Environment and Coastal Areas of the East Asian Region. The meeting approved the proposed plan and recommended that it first be implemented in the ASEAN region. Member countries of ASEAN are Indonesia, Malaysia, the Philippines, Singapore, and Thailand. Implementation and evaluation of the UNEP Regional Seas Action Plan is entrusted to the Coordination Body on the Seas of East Asia (COBSEA), which is composed of the members of the ASEAN Expert Group on Environment (see UNEP 1983). A draft of the second action plan has been formulated for submission to the UNEP governing council.

Another example of regional cooperation, but larger in scope and geographic coverage, is the UNESCO/IOC-Programme Group on the Western Pacific (IOC-PG WESTPAC), which was established in 1979 at a meeting in Tokyo. The 19 member countries of WESTPAC are spread in the western portion of the Pacific Ocean from the Bering Sea to New Zealand and from Indonesia to French Polynesia. They are participating in programs on physical ocean monitoring of the Pacific, the geology and geophysics of the northwestern Pacific, coastal transport of pollutants, and monitoring pollution through analyses of shellfish. Various workshops and training sessions were organized in 1980-1982, and several have been planned for the second half of 1983 (see Intergovernmental Oceanographic Commission 1981).

CONCLUSIONS

Until recently, decision makers were little aware of Indonesia's marine resources and therefore uncommitted to developing these resources to improve the quality of life and strengthen the economy. As a result, the marine sciences have been neglected for many years in Indonesia. Subsequently, when it was realized that Indonesia's future depended partly on how rationally the seas are used and managed, the marine sciences were not quite ready, and thus were not able to supply the urgently needed data and information on which to base policies for alternative courses of action. Thus technical assistance, through both U.N. agencies or bilateral arrangements, and regional cooperation are needed urgently. In the short term this assistance will help provide those data and information, but more important, in the long term it will help Indonesia develop its own capabilities for meeting the challenge of developing and managing its marine resources rationally for the betterment of Indonesia.

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WORKING GROUP REPORT:
MARINE SCIENCES

This working group approached its task of exchanging information and identifying opportunities for collaboration by reviewing the Indonesian draft master plan for marine science development for the period 1984-1989 (REPELITA IV) and focusing on areas in which U.S.-Indonesian collaboration could be uniquely beneficial.* More than 20 specific areas in which such collaboration might take place were identified. It was agreed, however, that only a small fraction of the areas can be pursued at any one time and that establishing priorities among them must be an Indonesian undertaking.

To facilitate this process and to establish an ongoing collaborative program between Indonesia and the United States in marine science and technology, it is recommended that a joint continuing committee of 3-5 members be formed and meet annually to review such collaboration. The collaborative possibilities identified by this working group fall into four general categories:

1. Manpower development
2. Technical exchange workshops
3. Surveys and field programs
4. Infrastructure development.

MANPOWER DEVELOPMENT

All recent observers of Indonesian marine science and technology identify manpower and infrastructure development as crucial to enhancing Indonesia's capability in this field. The critical need for manpower development in marine science has been addressed by two previous National Research Council reports on technical manpower (1983a) and on marine science (1983b). This working group concurred with the conclusions of both of these reports and recommended that a U.S.-Indonesian university network be established to:

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*The major programs of the master plan formulated by the National Committee for Ocean Technology for the fourth 5-year development plan (REPELITA IV, 1984-1989) are listed on page 13 of the preceding presentation by Dr. Soegiarto.

- Provide training (at the B.S., M.S., and Ph.D. levels) in technical skills for Indonesian scientists, researchers, and faculty.
- Develop cooperative U.S.-Indonesian programs in curricula development and joint research in marine science and technology.
- Provide opportunities to further expand Indonesian university facilities and capabilities (i.e., laboratories, specialized research and educational equipment, library holdings, etc.).
- Establish a system for matching Indonesian training requests with U.S. institutions suited to meeting those requests.

TECHNICAL EXCHANGE WORKSHOPS

Technical exchange workshops can be used to explore opportunities for U.S.-Indonesian collaboration in areas important to the 1984-1989 master development plan. For example:

- Development of Indonesia's fishery resources could benefit from collaborative workshops on mangrove-based food chains, diversified farming of coral reef ecosystems, and post-catch fish processing and distribution.
- Assessment of the resource potential of unexploited biological resources could be explored by workshops on the extraction of commercial marketable products from seaweeds (carrageenan, agar, etc.) and pharmaceutically active marine natural products.
- Development of underexploited mineral resources could result from workshops on underwater placer mining techniques for tin and phosphate ores.
- Possibilities for extending ocean thermal energy conversion (OTEC) technology to recover minerals (magnesium) and fresh water as well as energy could be explored by a workshop that would also keep Indonesian leaders abreast of the latest developments in OTEC technology.
- Coastal management efforts could be enhanced by sponsorship of a collaborative workshop in which U.S. experience in identifying data needs could be applied to Indonesian management models. Such a workshop could include an emphasis on pollution sources and monitoring and could pave the way for a general workshop on mechanisms for intercalibration and quality assurance of marine chemical data.

The workshop mechanism could also assist in the development of academic capabilities if it focused on specific examples such as developing ocean technology and engineering at the Institute of Technology at Surabaya, or marine science at any of the seven identified marine science universities. A national workshop on marine extension programs would publicize the potential benefits of such programs in Indonesia.

SURVEYS AND FIELD PROGRAMS

Surveys and field programs are expensive and time-consuming, but they are essential to developing Indonesia's knowledge of its marine resources. Intensive survey activity in cooperation with France (Corindon) and The Netherlands (Snellius II) will heavily occupy Indonesian marine scientists in 1984 and 1985, but plans for a marine geological survey of the energy and mineral resource potential of the geologically unexplored continental shelf seas of eastern Indonesia should be planned for 1986. Such a survey should include modern technology for assessing nearshore sources of artesian fresh water.

INFRASTRUCTURE DEVELOPMENT

In reviewing the prospective elements of REPELITA IV, the working group identified several specific projects and activities that, with U.S. participation, can help Indonesia fulfill the objectives of its master plan. These include:

- Technical Assistance in Marine Geology. It is recommended that U.S. institutions and scientists provide direct technical assistance to the Geological Research and Development Center and the Institute of Technology at Bandung in developing programs in marine geology.
- Establishment of an Indonesian National Oceanographic Data Center. It is recommended that the U.S. National Oceanic and Atmospheric Administration provide technical assistance to Indonesia, through the National Institute of Oceanology, to help establish a National Oceanographic Data Center in Indonesia.
- Mussel Watch Assistance. Indonesia has established a mussel watch program as a component of its effort to assess marine environmental quality. It is recommended that the United States provide technical assistance to assure standard and consistent sample preparation, handling, and analysis.
- Research Program Management and the Conduct of Research. It is recommended that U.S. universities, through exchange programs, cooperative research, and special seminars, assist Indonesian universities and institutions in expanding their marine research programs, with special emphasis on research methodologies and protocols as well as the management of complex field and laboratory research activities.
- An Antipollution Demonstration Program. The Agency for the Assessment and Application of Technology (BPPT) has expressed an interest in a cooperative U.S.-Indonesian activity to demonstrate antipollution techniques and to develop pollution abatement technologies. It is recommended that a joint program be developed between BPPT and U.S. universities, industries, and government agencies.

Participants in the marine science working group concluded that many opportunities exist for U.S.-Indonesian collaboration in marine science. Although this working group focused on activities that would help Indonesia meet the marine science goals of REPELITA IV, the focus should not leave readers with the impression that the identified projects are of benefit to Indonesia alone. The intrinsic scientific interest of the Indonesian seas--derived from their complex geologic origins, the complex oceanographic linkages between them, the rapid rate of environmental chemistry in thermal vents and tropical oceans, and the uniquely high diversity of Indonesian marine biota--all combine to make marine research in Indonesia of worldwide importance. Thus the identified collaborative projects will benefit world science even as they assist Indonesia in meeting its goals.

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PART II

POSTHARVEST TECHNOLOGY, FARM MECHANIZATION, AND AGRO-INDUSTRY

PROBLEMS AND PROSPECTS OF POSTHARVEST TECHNOLOGY IN INDONESIA

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INTRODUCTION

In 1978, agriculture was responsible for 34 percent of Indonesia's gross domestic product, which is substantially less than its contribution of 47 percent in 1970. This decline must be due to the commercialization of agriculture and the economy as it is transformed from primarily an extractive industry into a technology-based industry involving manufacturing, processing, transportation, and financing. Agriculture provides employment for approximately 30 million people in Indonesia or about 60 percent of the labor force (Lucas 1982).

Although Indonesia has the highest rice productivity at 2.9 t/ha among members of the Association of South East Asian Nations (ASEAN), it is among the lowest (except for the Philippines) in secondary crop productivity. This results from a long-standing agricultural policy that is heavily biased toward rice production at the exclusion of almost all other food crops. Thus most of the development funds, manpower, and other resources have been channeled to rice production in the form of construction and rehabilitation of irrigation systems.

For many years there has been much discussion in Indonesia of food crops and diet diversification. While some of this discussion has focused on nutritional needs, most has related to fears that the government may not be able to meet indefinitely the increasing rates of rice consumption which already require substantial rice imports.

Several programs and activities have been launched by the government to increase secondary crop production, but there have been no significant results. This is largely due to marketing problems and a lack of postharvest technologies to support proper handling and the industries that process secondary crop material into semi- or finished products.

As rice production increases, it leads to a number of problems connected with milling, storage, transportation, and distribution. For example, new production systems often bring confusion into the ranks of rice milling, storage, and transportation where workers still cling to old habits and work with rickety, outmoded equipment. Confusion and disorder at harvest time also plague many of the 12.26 million rice farming households throughout the country, especially during rainy season harvests.

Since both rice and secondary crops have suffered from postharvest losses and deterioration in Indonesia, this presentation will examine each, and in particular, the problems of postharvest technology, the use of by-products, the role of biotechnology, and human resource development.

POSTHARVEST PROBLEMS AND CONSTRAINTS

Rice

Production

Production of rice (Oryza sativa) and its per capita availability are the highest in the history of Indonesia. Steps taken in connection with the first and second 5-year development plans (1969-1979) to increase rice production and activities within the current third 5-year plan (1979-1984) have given excellent results (Table 1).

In 13 years rice production has doubled, while the harvested area has increased only slightly. In 1968, the production of milled rice was 11.67 million tons and per capita availability was 92.9 kg per year, while in 1980 the estimated comparable figures were 20.3 million tons and 137.3 kg per person per year (Figure 1).

This remarkable improvement can be attributed to several factors, most important of which is perhaps the willingness of Indonesian rice farmers to change traditional practices once they realize the value of new technology. Much credit is also due to the accelerated production program under the BIMAS (Bimbingan Masal) scheme, involving new rice cultivation technologies, an assured base price for rice, and intensive implementation.

A significant contribution to rice production has been made in the form of modern rice varieties, inorganic fertilizers, rehabilitation

TABLE 1 Production of Milled Rice in Indonesia Since Independence (1945)

Year	Production (10^6 tons)	Percent Increase
1945 (Independence)	7.80	
		44
1968 (First 5-year plan started)	11.67	
		90
1982 (Third 5-year plan)	22.30	

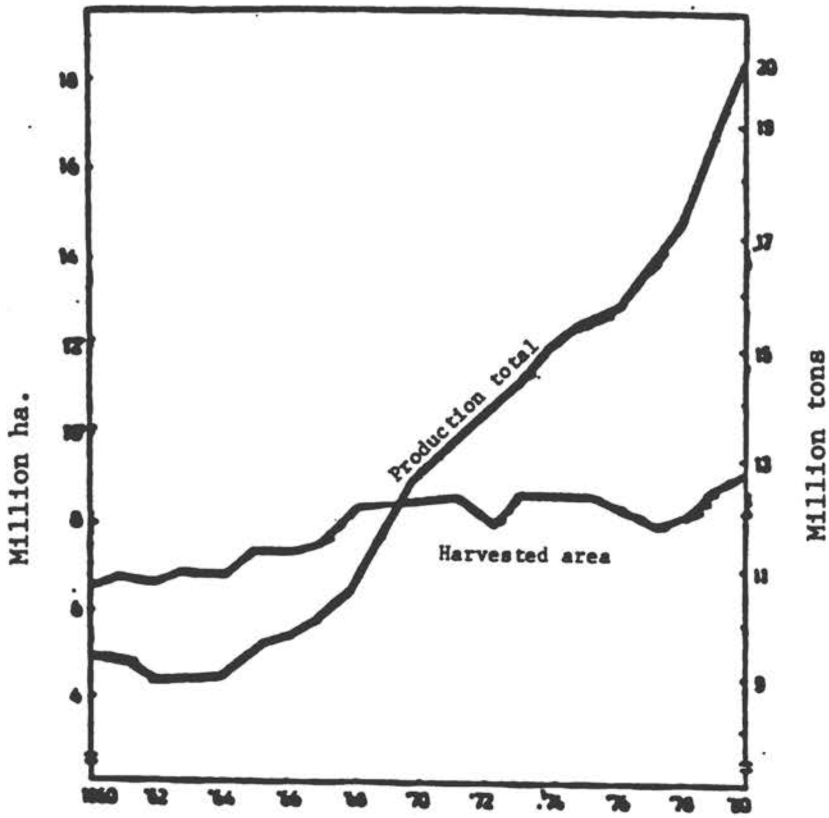

FIGURE 1 Total rice production and area harvested, 1960-1980.

and expansion of the irrigation infrastructure, and improved management practices. Among these factors, greater use of the high-yielding varieties introduced by the International Rice Research Institute (IRRI) in the late 1960s has had an especially powerful impact on rice production.

By 1977, almost all parts of Indonesia were affected by the brown planthopper (BPH), and losses were large in several areas. All of the varieties (traditional, nationally improved, and modern) grown in Indonesia before 1975 were susceptible, so a genetic source of resistance had to be found.

By 1980, variety IR-36 covered 36 percent of the rice-growing area and had a larger share in a single season than any other previously released variety such as IR-26, IR-32, and IR-38. Farmers preferred it not only because of its resistance to BPH biotype 2, but also because it matured almost 3 weeks earlier than IR-32 (the previously introduced BPH 2-resistant variety), reduced the risk of drought damage in double-cropped environments, and allowed them to grow a third non-rice crop such as soybeans. A total of 14 Indonesian-bred varieties have been released during the past decade.

In 1979, the government initiated a special rice intensification program called INSUS (Intensifikasi Khusus). INSUS is similar to BIMAS except that farmers are divided into production groups based upon irrigation practices, and each group decides which rice varieties, fertilizers, and pesticides are best for them. The role of government is to guide them technically and to provide credit if needed. Farmers in East Java who joined the INSUS program doubled their average rice yields from 4.8 t/ha to 8.7 t/ha. Non-INSUS farmers in the same area had average yields of only 5 t/ha.

Loss and Deterioration

In general, the provision of food is viewed in terms of a system of production, distribution, and utilization. In its attempts to improve this system, Indonesia has allocated most of its resources to production, neglecting distribution and utilization. Hunger and malnutrition can exist, however, in spite of adequate food production, resulting from an unequal distribution of food among nations, within a nation, within communities, and even within families. Loss and deterioration of available food resources further add to the problem. The reduction of postharvest grain losses, especially those caused by insects, microorganisms, rodents, and birds, can increase available food supplies, particularly in less-developed countries where the losses may be the largest and the need is greatest.

In September 1975, the growing international awareness of the need to reduce postharvest food losses culminated in a resolution of the Seventh Special Session of the United Nations General Assembly stating that further reduction of postharvest losses in developing countries should be undertaken as a matter of priority and with a view toward reaching at least a 50 percent reduction by 1985.

Although increasing food production by increasing acreage or yield per acre has always been a readily applied concept, reducing postharvest food losses to increase supplies has been a less obvious strategy. The reduction of losses requires identifying and eliminating the constraints to application of an existing technology. The major constraint may be a lack of finances, but it is equally possible that a lack of knowledge and trained personnel as well as political and cultural constraints exist.

Losses vary by crop, variety, year, pest and pest combination, length of storage, method of threshing, drying, handling, storage, processing, transportation and distribution, rate of consumption, and the climate and the culture in which the food is produced and consumed. Given such enormous variability, it is not surprising that reliable statistics regarding the type, location, causes, and magnitude of postharvest grain losses are not available.

At the production level, remarkable differences occur among regions as a result of different harvest and irrigation practices, drainage conditions, and seed varieties.

At the marketing level, most farmers in the major rice-producing areas sell undried, uncleaned paddy to buyers immediately after harvest. In areas where transport and processing facilities are poor, however, and given the severe conditions of temperature and humidity found in an oceanic, tropical environment, the paddy, which has a high-moisture content, spoils rapidly. The paddy/milled rice being marketed has high-quality characteristics that make it suitable for storage; otherwise, serious deterioration occurs during the storage period. In Indonesia, most private warehouses are found at rice mills. The National Bureau of Logistics (BULOG) and the village unit cooperatives (KUD) are in the process of erecting several new warehouses throughout the country.

At the processing level, since most farmers do not dry, clean, or transport paddy, in short periods of time huge volumes of undried and uncleaned paddy are transported to small-scale private processing plants or KUDs.

Surveys of postharvest losses of rice were carried out in East Java in 1980-1981 by BULOG and the Food and Agriculture Organization of the U.N. (FAO) during the rainy and dry seasons (Table 2). As shown in Table 2, the major losses occur during the storage, milling, and drying stages. These losses largely result from inadequate existing storage and rice mills in Indonesia which are unsuitable for good yields and high qualities of rice. Losses also occur after milling and during distribution and consumption. According to BULOG (1983), the total losses of rice from harvest to consumption may reach 25 percent.

Qualitative losses occur as well. These losses, mainly in the form of colored, damaged, and broken kernels, occurring during the storage, drying, and milling stages, reached 10 percent, 4.4 percent, and 9.5 percent, respectively (BULOG 1983).

Of Indonesia's 57,573 rice milling units (RMUs), which vary in size, 23,597 are the Engelberg type. Most of these are about 20-30 years old, resulting in losses in rice yields of as much as 252,026 t/yr (Solichin 1983). Recent discussion of how to overcome the RMU problem in Indonesia indicated the need to upgrade, replace, and construct new RMUs in certain areas. The government would like any new RMUs to be manufactured locally (Solichin 1983).

TABLE 2 Postharvest Losses of Rice in East Java, Rainy and Dry Seasons, 1980-1981

Stage	Rainy Season (%)	Dry Season (%)
Harvesting	0.89	0.63
Threshing	0.99	0.99
Drying	3.16	2.65
Storage	2.25	2.45
Milling	4.50	2.46

Source: BULOG (1983).

Secondary Crops

Diversification and Production

For many years there has been much discussion in Indonesia of crop and diet diversification. The diversification issue is significant as it relates to low-income groups and calorie-short diets because the diets of these groups, while often quantitatively inadequate, are far more diversified than the diets of those who are economically better off. The crops consumed disproportionately by the poor are gaplek (dried cassava) and corn. Accordingly, it appears on the surface that production increases in or lower consumer prices of these items provide greater benefits to the poor.

Some believe that diet diversification is possible through intensive nutrition education on the values of secondary crops (corn, cassava, mung beans, soybeans, peanuts) and of a balanced diet. The government is sincere in its commitment to secondary crop development, and it has the financial resources and institutional apparatus to launch an integrated program of production, marketing, and consumption.

At the end of REPELITA III, production of corn will be about 4.2 million tons; cassava, 17.3 million tons; soybeans, 0.85 million tons; peanuts, 0.60 million tons; sweet potatoes, 4.04 million tons; and mung beans, 0.13 million tons (Lucas 1982). There are, however, an additional 27 million ha of upland with a 3-8 percent slope available and suitable for secondary crop production.

Experiments have shown that yields can be doubled by applying economically optimal levels of fertilizers. Cropping systems research conducted at the Central Research Institute of Agriculture (CRIA) has shown that income from secondary crops can equal the income from two crops of rice in an irrigated sawah (rice field) with proper management practices. The potentials for increased secondary crop (palawija) production, along with continued donor assistance and a serious commitment of the government, give reason to believe that the major constraints to development of secondary crops can be overcome.

Problems of Marketing

Lucas (1982) has enumerated four reasons why the problems of marketing secondary crops are more complex than those for rice. First, compared to rice, the value of secondary crops per unit volume is much lower, which makes handling, transportation, and storage relatively more expensive. Second, because some of the secondary crops have a higher water content than rice, they are more perishable and more expensive to dry. For example, although rice can be stored without appreciable deterioration and lost value for several months, secondary crops such as cassava or sweet potatoes cannot be stored for the same length of time. Third, the production of secondary crops is more seasonal than that of rice because they are considered less important than rice and thus are planted around the rice production period using residual moisture, labor, and capital. Fourth, and perhaps the most important, marketing institutions and support services for secondary crops are not as well developed as those for rice.

Presently, there is no BULOG/KUD-type organization to handle procurement of secondary crops and no price support system. Farmers depend largely upon private traders who often exercise oligopsonistic power over them. Some indications of the inefficiency in marketing secondary products include (1) the wide temporal and spatial variations in prices, (2) high marketing margins, and (3) low farm prices in relation to production costs. These problems are discussed below.

Regional Price Fluctuations Price coefficients of variations across regions within the same period indicate the degree of price differences among major secondary crop marketing centers. Corn prices vary from 21 to 26 percent above or below the average price. Similarly, regional prices for mung beans vary from about 8 to 9 percent above or below the average price.

Seasonal Price Variations In estimating coefficients of price variations for corn during harvest time and off-season in the provinces of East Java, Central Java, Lampung, and South Sulawesi, it was found that corn prices in East and Central Java fluctuate seasonally about 46 percent above or below the average price. The lack of an effective price information system, transportation problems, and the difficulties in storing secondary crops over time or spreading harvests more evenly throughout the year all account for the wide price differences among secondary crop marketing centers.

Marketing Margins The marketing margin (sometimes known as the farm retail price spread), which represents the costs of transportation, handling, storage, waste, and the middleman's profit incurred as a commodity moves from the farm to the consumer, constitutes a high percentage of the consumer price. For soybeans, the farmer receives about 57 percent of the consumer price, while 43 percent goes to the various marketing agents. For corn, the farmer receives 67 percent; for peanuts and mung beans, about 77 percent and 70 percent, respectively, go to the farmers.

While there is no fixed proportion for what may be considered a reasonable marketing margin, it seems reasonable to assume that marketing efficiency could be improved and the marketing margins reduced with an improvement in the handling and transportation of secondary crops.

Negative Income and Expenditure Elasticities A major problem that constrains government efforts to promote development of secondary crops is the cultural bias against their consumption. Several statistical studies have shown that cassava and corn have negative income and expenditure elasticities, which means that as income increases, the demand for these commodities decreases.

It has been shown that as income increases by 10 percent, consumption of corn declines by 42 percent and of cassava by 55 percent, but this general pattern differs by urban and rural populations and by income groups. For example, in rural areas the expenditure elasticity for corn is 55 percent across all income groups, but it is positive for all income groups in urban areas.

The expenditure elasticity for fresh cassava is negative only for the high-expenditure group within both urban and rural populations; for gaplek it is negative only for the middle- and high-expenditure groups in rural areas. There is a limited potential for promoting direct human consumption of corn and cassava in both rural and urban areas. As a matter of policy, market development for these crops should be limited to industrial or commercial uses.

Agricultural By-products and Animal Feed

Land suitable for arable farming is used for cash and food crops rather than for forage crops because the former have priority over feed production. The other source of animal feed, cereal grains such as corn, can no longer be relied upon because of their increased consumption by humans. Eventually, it will be too expensive to feed corn or soybeans to animals.

A precise survey would be required to estimate the current uses of agricultural by-products and the amount available for use in animal feed. Current estimates, however, indicate that only a small portion of rice straw is used in paper factories and most sorghum stalks are used as fuel for manufacturing mud bricks, while sorghum stover is hardly ever used for livestock feed. Most maize cobs are used by small farmers as fuel for cooking; large-scale farmers either discard the cobs or sell them to a furfural-extraction plant. Untreated maize stover is sometimes used by small-scale peasant farmers, almost entirely for livestock feeding. In the large-scale maize-growing areas, however, the residue is seldom used to feed livestock; it is either plowed back into the soil or used for making contours (ridges). Most bagasse produced on plantations and at local small-scale sugar industries is used as fuel in sugarcane refineries. Very few if any sugarcane tops are used for livestock feeding by the "out grower" in sugarcane-growing areas. None of the sugarcane tops from sugar plantations are used for livestock feeding. Using the conversion index introduced by Owen (1977), Winarno (1983) has estimated the quantities of some of these field crop residues in Indonesia, based on grain and nongrain production estimates (Table 3).

Fortunately, the huge quantities of agro-industrial by-products can replace, to a great extent, the traditional sources of feed, and it is inevitable that Indonesia will soon have to resort to these by-products to feed its livestock. To use these by-products efficiently, it is essential to know something about their nutritive value and about how animals respond to their use.

It is evident from the nutrient content of these by-products that they cannot be used on their own to sustain an animal or support any

TABLE 3 Estimated Quantities of Some Field Crop Residues in Indonesia Based on Grain and Nongrain Production Estimates (1,000 Tons)

Commodity	Grain/Nongrain Production Estimates	Field Crop Residues	For the Year
Rice straw	26,633	23,633	1984
Paddy husks		9,600	
Maize stover	200	8,400	1983
Maize cobs		1,050	
Sorghum stalks	120	240	
Cassava leaves and stalks	17,300	1,730	1984
Sugarcane tops	204,200	51,100	1981
Sugarcane bagasse		40,800	
Sugarcane molasses		8,200	
Cocoa shells	1,500	9,200	1981
Coconut water	1,578	592 (million liters)	1981

Note: The conversion index for crop residue to grain is 1:1 for paddy rice; 2:1 for maize, sorghum, and millet; 1:4 for sugarcane top to cane; 1:5 for bagasse to cane; 6:1 for cocoa shell; and 300 ml/coconut for coconut water.

SOURCE: Winarno (1983).

kind of production. Thus their successful use for fattening cattle requires understanding their limited nutritional value and hence the need for specific supplements.

Field by-products generally have a low nutritive value because of their relatively high lignocellulose content and low content of protein and other nutrients. The nutritive value of these materials can be improved by adding nutrients and correcting the nutrient imbalance, and solubilizing or cracking the lignin layers coating the cells so that the enzymes of microorganisms in the digestive tract of the animal can digest the cell contents.

Whenever there is pressure on the land, the livestock suffer. Unfortunately, livestock owners are more concerned with the number of animals they own than their productivity. This, of course, greatly offsets the structure of the national herd and the introduction of better management practices and adequate nutrition. Where nutrition is poor, disease intrudes, necessitating use of government funds for improvement of animal husbandry. This dilemma is further accentuated by the low input of science and technology into livestock production, specifically nutritional science and feed biotechnology.

PROSPECTS FOR THE FUTURE

Storage, Handling, and Processing

Farm Storage Structures

About 60 percent of agricultural production is still consumed in rural areas, where most of it is maintained by subsistence farmers in inadequate storage facilities. The 30-40 percent of production that constitutes the marketable surplus is handled with comparatively more attention to the prevention of insect attacks, mold growth, and rodent depreciation.

Under tropical and subtropical climatic conditions, most agricultural crops, particularly cereals, pulses, and oilseeds, are infested in the field by rodents, pests, and disease prior to harvest. New technologies that combat these infestations need to be introduced systematically within Indonesia.

Because the traditional types of storage structures are the most compatible for rural conditions in Indonesia, attempts have been made to improve the local structures by making them both insect-proof and suitable for fumigation. These improvements are easily made by placing structures on stilts that can be made rodent-proof by inverting a metal cone on them.

Paddy is susceptible to attack by *Sitotroga cerealella* and to some extent by *Plodia interpunctella*. The type of storage structure used and its size are related to the amount of damage caused by *Sitotroga cerealella*, that is, the smaller the storage structure, the greater the damage caused. The depth to which *Sitotroga cerealella* can attack is limited to 15 cm. Thus paddy stored in bamboo and mat structures suffers attacks on all sides, while that stored in masonry structures suffers from attacks of *Sitotroga* only at the top layers.

Developing an Integrated Program

Heavily populated developing countries account for less than 20 percent of the world grain trade. Although part of the problem is, of course, a lack of purchasing power, perhaps more important is the shortage of grain-handling infrastructures. A few seaborne grain terminals exist, but there are no central silos located in consumer areas to serve as storage for food reserves. Worse, from a production point of view, is the almost total lack of harvest reception silos. All of this necessitates importing substantial amounts of basic food supplies from abroad.

This lack of storage infrastructure means that farmers in many areas of developing countries must dispose of their crops at distressed prices. In some areas, for example, farmers who do not have storage facilities sell their crops to merchants immediately upon harvest. They are then forced to buy them back later in the season to meet their own needs.

The infrastructure for a storage system is not simply a single silo (grain elevator) at a port; it is an integrated program to ensure that foodstuffs can be handled, processed, and passed on to the consumer at the lowest possible price.

When bulk rough rice is imported, a mill should be built to process it at the port. In addition, a feed mill should be constructed alongside to process the milling by-products and local foodstuffs such as copra, cassava, and sugar-tip molasses and other by-products. Only when the logistical outflow from the import silos is assured can the overall advantage of the seaborne grain trade be exploited. Changes in the dynamics of the existing rice and export costs will lessen the milling margins, thereby keeping prices down. The local foodstuff industries can then be developed.

Indonesia, through the government program to accelerate the export of nonpetroleum commodities, should pay more attention to quality and quantity of exportable commodities and thus conform quality to the standard of the importing countries. Since most importing countries are well developed, they have high standards of sanitation and quality. This fact should be kept in mind when raw materials are purchased from farmers in rural areas.

Integration of the most effective production, processing, marketing, storage, and warehousing techniques with the export and import of agricultural produce is urgently needed in Indonesia. A series of investments should be made in port facilities and the internal logistic networks to support the national and international grain trade. Post-harvest handling and distribution as part of an integrated grain handling and storage system should also receive increased emphasis throughout the developing world.

Biotechnology and Agriculture

The term "biotechnology" encompasses a wide range of scientific methods and applications. While traditional plant breeding works with whole plants, the relatively new genetic engineering works with cells, each of which contains all the genetic information about, and can be grown back into, the whole plant. In a world where the current population of 4 billion is expected to double in less than 20 years, the agricultural applications of biotechnology are even more crucial than its medical uses.

Biotechnology in Food Processing

Fermented foods are important components of diets in many parts of the world, especially Southeast Asia. Indonesia is considered one of the richest nations in traditional fermented foods, and these products often make an important contribution to the human diet as sources of protein, calories, and vitamins (Winarno 1981).

Although several kinds of fermented foods originated in Indonesia, for the purpose of this presentation only two are discussed: tempeh and oncom.

Tempeh Known locally as tempe kedelai, tempeh is a white mold-covered cake produced by fungal fermentation of dehulled, hydrated (soaked), and partially cooked soybean cotyledons. The mold grows throughout the bean mass, knitting it into a compact cake that can be sliced thin and deep-fat fried or cut into chunks and used as a protein with rice or as a meat substitute in soup. Rhizopus oligosporus has been identified as the most characteristic and best adapted mold for production of tempeh (Steinkraus et al. 1960, Hesseltine and Shibasaki 1961).

One interesting discovery has been that tempeh made with the pure mold Rhizopus oligosporus contains very little vitamin B_{12} compared with tempeh made by traditional processing. The mystery was solved when it was found that a specific bacterium Klebsiella pneumoniae, a nonpathogenic strain (Curtis et al. 1977) present in commercial samples of tempeh, produced vitamin B_{12} (30 micrograms/gram) during fermentation. Thus certain bacterial species can be very beneficial from a nutritional point of view.

Reportedly, tempeh had a beneficial effect on dysentery patients in the prison camps of World War II. The antibacterial activity of growth inhibitors produced by Rhizopus oligosporus during tempeh fermentation has been reported (Wang et al. 1960). Although antibacterial tests indicate that the compound produced by Rhizopus oligosporus does not exhibit a broad spectrum of activity, it is very active toward some gram-positive bacteria. This may partially explain why the Southeast Asian people possess a wonderful resistance to disease even though they are constantly exposed to overwhelming sources of infection and their diets are frequently inadequate.

Development of Tempeh Production Most tempeh production in Indonesia is still in the form of relatively small commercial operations, using the traditional techniques with slight modifications, if any. Twenty years ago, research was undertaken to upgrade the production process to medium-scale operations (Steinkraus et al. 1965).

Recently, Winarno and Bharat (1981) introduced several types of simple equipment for tempeh production. With this equipment, soybeans are dehulled and dried by passing them through a mechanical burn mill (Alpa KL), and the hulls are removed from the cotyledon by passing them through an aspirator.

Steinkraus has reported (1981) that acidification of the beans, considered to be an essential step, particularly in large-scale processing where food spillage organisms could reside in large batches, can be accomplished by adding 1 percent v/v lactic acid to the soaking or cooking water. In this production process, the inoculum is mixed with drained, cooled cotyledons in the mixer, and the inoculated beans are then spread on dryer trays, covered with a layer of wax paper, and incubated at 37°C (98.6°F) and 90 percent humidity. Using this procedure, fermentation is completed in less than 24 hours. The tempeh is then cut into 2.5-cm squares and put on trays that are placed in a circulating hot air dryer at 104°C. Finally, the product is dehydrated to less than 10 percent moisture and packaged in polyethylene bags for distribution. Because of the low moisture content of the final product, the shelf life of tempeh can be extended for a long time.

The commercial tempeh industry in Indonesia has now adopted wooden dryer trays similar to those described above. Trays are lined with plastic sheeting that is perforated to allow air access to the mold. In the future, it is conceivable that the use of tunnel fermenters will permit soybeans to be cleaned, dried, hulled, soaked, and cooked continuously, requiring approximately 20 hours in processing time.

Tempeh fermentation has been applied to a wide variety of bean types (Gandjar 1977). A new type of tempeh combining wheat and soybeans has been developed by Hesseltine and Wang (1979).

Tempeh has been rapidly adopted by American vegetarians. It is increasingly available in U.S. health food stores and even large supermarkets.

Oncom Peanut presscakes, used principally as animal feed for a long time, contain fibers and undigestible components that make them undesirable for human food. Centuries ago, however, the Indonesians developed a fermentation process that converts this essentially animal feed into a food suitable for humans: oncom (Steinkraus, undated). This food is used in the daily diet of some 25 million people.

Oncom is prepared by allowing a mold to grow on peanut presscake for about 48 hours. The active microorganisms used in oncom production are *Rhizopus oligosporus*, which produces a black oncom, and *Neuspora sitophila*, which produces red or orange oncom. Enzymes produced by the mold deeply penetrate into the substrate, making the protein, lipids, and other components more digestible and at the same time more flavorful.

Like tempeh, oncom also produces vitamin B_{12} in substantial amounts (23-31 micrograms/gram). Thus the biofermentation technology of oncom production should be studied and developed to better utilize this agricultural by-product.

Biotechnology in Agricultural Pest Control

Insect Physiology Insects can tolerate remarkable degrees of traumatic and biochemical shock, they breed easily, and, moreover, they possess high enzyme concentrations and turnover rates that make them particularly suitable for metabolic studies (Winteringham 1959). Fundamental differences in the biochemistry of insects and mammals may provide a sound basis for the development of more selective toxicants. The study of insect physiology and biochemistry has, however, resulted in a misleading approach to the development of such physiologically active compounds inimical to insect life.

Wyatt and Kalf (1957), while carrying out studies on trehalose and other carbohydrates in insect blood, observed that insect blood contains only minute amounts of sugar and abundant reducing substances (most of which are not sugars). They identified the nonreducing disaccharide, L,L-trehalose, as a major sugar of insect plasma. This trehalose could be a major source of glucose in insects (Chefurka 1959).

Insect blood has many peculiarities, including a high concentration of amino acid, a low buffering capacity, and an absence of immunological constituents. The blood of most vertebrates contains about 50 mg of amino acids per 100 ml, while the free amino acid content of a variety of insect species ranges from 295 to 2,340 mg/ml of plasma. These figures offer many possibilities for interesting studies in biochemical taxonomy.

Nontoxic Protection for Food Grains Factors possibly governing the selective toxicity of chemical compounds and the resistance of insects to them have been reviewed by Majumder and colleagues (1964). The ecological and physiological selectivity of insect pests has not, however, been investigated with respect to development of selective pesticides. Sodium chloride (NaCl), for example, is toxic to stored products in insects while potassium chloride (KCl) is nontoxic.

In Indonesian investigations, it has been found that the toxicities of calcium salts in different forms--such as hydroxides, carbonate, sulphate, nitrate, phosphate--and calcium organic salts--calcium citrate, calcium tartarate, calcium lactate, etc.,--are related to the calcium and phosphate ratios. Even within the homologous series such as MCP, DCP, and TCP (monocalcium phosphate, dicalcium phosphate, and tricalcium phosphate), the toxicity increases with the increasing ratio of phosphorus to calcium.

Magnesium salts invariably enhance the population by increasing fecundity and growth (Majumder and Banu 1964). Vitamin B in combination with TCP produces a synergistic effect, and glucose in combination with vitamin B and TCP furthers the potential action of calcium and phosphorus.

Experiments have shown that a combination of 94 percent TCP, 4 percent glucose, and 1 percent thiamine or niacine, known as a nontoxic protectant, incorporated at 1 percent concentration in such foods as breakfast foods, instant foods, and rice and wheat products, could act as a major inhibitor of insect development in these products during storage and distribution. Besides reducing insect infestation, the toxic protectant could also enrich the product nutritionally.

By-product Utilization

An estimated 50 million tons of unconventional feed resources are currently available in Indonesia from farms (crop residues, manure) or agro-industries (sugar mills--bagasse, pith). The cost of these resources is usually low, and they can be readily collected because they are concentrated on farms and in sugar factories, for example. This potential food represents a vast reservoir of cheap nutrients that can be converted into milk and meat.

In some locations where there is a surplus of by-products, complete animal feed or improved roughage can be manufactured on an industrial scale. These types of manufactured animal feed are still unfamiliar, however, to Indonesia. The development of new feed resources and improved knowledge of modern livestock nutrition and the application of modern feeding systems are normally seriously neglected. New systems must be devised for large-scale applications in agro-related industries and small-scale applications to meet the needs of small farmers and landless livestock owners.

It is recognized that conventional protein and energy feeds such as oilseed cakes, legumes, and grains are too expensive for ruminants. The cheapest and most effective substitute for protein is urea; for energy, molasses; and for forage, treated crop residues.

Feeding poultry wastes as a source of protein to ruminants is a well-established practice that is applied worldwide (Shah and Muller 1982). These wastes are available in most countries either at low cost or free of charge, and they can, in general, supply 30-90 percent of the protein requirements of ruminants.

There is no doubt that treatment of the crop residues discussed will increase both the nutritive value of the residue and intake levels by ruminant livestock. A more comprehensive economic study is needed, however, to evaluate the merits of these increases. The practicability of treatment methods, especially for small-scale farmers, also needs further study.

The utilization of such vast quantities of farm by-products should not be left entirely to private entrepreneurs. A national policy is needed in this important field, which in the final analysis embraces the various facets of national development.

Human Resource Development

Supply and Demand

In an agrarian country like Indonesia, national economic growth must center on agriculture. Although impressive rates of growth have been recorded, the objectives of meeting basic human needs have not been satisfactorily achieved. Growth and development are not synonymous in the same way that increased food production is not synonymous with equitable food distribution.

The third 5-year development plan (REPELITA III) emphasizes development of agro-industries, both for domestic consumption and for export drive. Such development programs need, however, enormous human resources, particularly men and women skilled in agricultural product processing, including food processing.

Because land on Java is becoming increasingly scarce, Indonesians are being encouraged to farm the poorer soils found on islands outside Java, but moves in this direction will require greater mechanization of agriculture, both preharvest and postharvest. Thus the scope for manufacturing pre- and postharvest agricultural machinery and implements is correspondingly very large. Except for large tractors, domestic industry has had to develop a capability for manufacturing such equipment as hand tractors, mini-tractors, irrigation pumps, sprayers, rice threshers, hullers, polishers, and milling units (Habibie 1983, also see Appendix E).

Twenty-seven universities currently offer courses in the agricultural sciences. In the areas of postharvest technology and food science and technology, however, courses are available only at three universities with a total student body not exceeding 1,000 students, and about 200 graduates per year specialize in postharvest technology and food science. About 20 persons have doctorates in food science and technology.

Five research centers exist for the fields of food technology and postharvest technology, two of which, the Food Technology Development Center (FTDC-IPB) and CRIA, have reasonably good supporting staffs and facilities.

Skilled Manpower

Between 1971 and 1981, the labor force in Indonesia increased from 42.7 million to 55.3 million. Surprisingly, unemployment figures are very low--3.6 million (4.47 percent) in 1971 and 2.2 million (2.1 percent) in 1980. Half-time jobs (working hours less than 36 hours per week), are, however, held by 45 percent of the labor force.

Unemployment in Indonesia does not stem from lack or scarcity of available jobs but from lack of manpower with proper skills. Of the existing available jobs in 1982-1983, only 50 percent have been filled, indicating the extreme importance of skills training. Thirty-four training centers currently exist in Indonesia. Managed by the Ministry of Labor, these centers focus particularly on training in the fields of agriculture, industry, and management, and they have the capacity to train 65,000 persons per year. This capacity must double or triple in the coming years.

Vocational schools in postharvest technology must offer a skills-oriented education to fulfill the industrial demand for skilled craftsmen. Such an education must consist of about half practice and half related applied theory, covering engineering, laboratory work, postharvest technology, and food processing and technology. Twenty-two skills-oriented vocational schools are now offering courses dealing with agriculture and pre- and postharvest technology including food processing. Each school could produce 80 graduates per year, but only 5 of the 22 have reasonably good support facilities. Many of these schools (largely those publicly supported) are being developed and rebuilt by loans from the World Bank, the Asian Development Bank, and through other bilateral arrangements.

The government has also developed several programs that offer limited skills training. These programs, operated by the Ministry of Manpower, are run through fixed or mobile training centers located throughout the country and offer training that ranges from industrial and agricultural vocations to home economics and business vocations. Unfortunately, the training program on postharvest technology is still very limited. Training is usually limited to 3-4 months per course, and follow-up courses are offered. These programs are particularly intended to train and retrain existing industrial personnel as well as new job seekers.

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FARM MECHANIZATION AND THE DEVELOPMENT OF AGRO-INDUSTRY

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INTRODUCTION

Rural development in Indonesia has accelerated in recent years, resulting in major advances in the welfare of the people. The well-documented increase in rice production from 12 million tons in 1970 to 23 million tons in 1982 resulted from improved rice varieties, farmers' abilities to grow an additional crop during the year, rehabilitated irrigation systems and thus improved water management, and increased use of fertilizers.

Along with the increased yields and improved cropping patterns, farmers' incomes have improved. Real wages for agricultural laborers have been increasing for the first time in many years, and the opportunities for employment in agriculture and in nonagricultural activities in urban areas have improved throughout Indonesia. Thus, for perhaps the first time, the combination of these trends appears to be bringing about a major economic advance strong enough to overcome the problems created by declining revenues from falling export prices. These trends have had a major impact on agro-industries, which are beginning to supply the equipment for farm mechanization.

The dependence of countries at early stages of development on imported technologies often results in a failure to recognize the potential that exists for expanded employment and income opportunities in the small- and medium-scale agro-industry sector. This is particularly true in countries that have a high proportion of their labor force in agriculture and that derive a significant share of their gross domestic product from this sector.

Modernization of the agricultural sector is characterized by a growing demand for purchased inputs, e.g., fertilizers, pest control chemicals, seeds, and equipment. In addition, as agricultural incomes increase, there is a commensurate increase in the level of spending for consumer goods. The importance of these production and consumption linkages to the agricultural growth process has been emphasized by a number of scholars who point out that the choice of a development strategy establishes a structure of linkages and incentives that exerts a continuing influence on the economy. The strength of these linkages depends on the distribution of income from farm production and the consumption propensities of various earners. Import substitution in production and consumption also affects the linkages. Using a variant of the Social Accounting Matrix (SAM) model, this paper will attempt to specify the impact of these linkages on agricultural employment and income in the Indonesian economy.

Advances in rural development in Indonesia have created a major demand for specific types of mechanization for agriculture, even in densely populated areas of Java, and thus a demand for industries to produce these machines. For example, two-wheeled paddy tractors are being used increasingly to plow the rice fields of Java. Hullers are used to mill rice at the village level, replacing the women who normally pound rice all day long. Rice is transported to the village by vehicles rather than by women carrying bundles on poles balanced on their shoulders. At first, these changes reduced the demand for agricultural laborers, but since 1978, several studies have clearly indicated that mechanization of agriculture is being promoted because of an insufficient supply of farm laborers. This shortage has been particularly noted at harvest and soil preparation times in Sumatra, and even in overcrowded Java because of the demand for laborers in urban areas.

To support this rural development, industry must be able to provide low-cost farm equipment that is suited to the varied agro-ecosystems of Indonesia. Indonesia can no longer rely on high-priced farm machinery imported from abroad, and farmers should no longer have to face delays because of a lack of spare parts. The price of farm equipment should no longer be determined by production costs in other countries and transportation costs to Indonesia. Rather, this country should produce the necessary water pumps, tractors, threshers, dryers, and milling equipment.

Indonesian researchers are in the process of determining which types of mechanization are needed for specific locations, for example, densely populated Java and sparsely populated Sumatra and Kalimantan, and what effects mechanization have on employment and the incomes of small farmers.

As the mechanization of agriculture progresses, the production of machines in Indonesia also increases. As shown in Table 1, Indonesia has a number of agro-industries producing a wide range of farm and estate machinery. In 1982, 2,891 water pumps for irrigation were produced by nine manufacturers, although their combined capacity was more than 12,000 units per year, and 768 hand tractors were produced by four enterprises with a capacity of more than 3,000 units per year. Other Indonesian enterprises manufacture equipment for sugar factories and coffee, cacao, palm oil, tea, and cassava processing.

EXPERIENCES WITH AGRICULTURAL MECHANIZATION

The introduction of farm mechanization by the private sector began as early as 1920 at a large sugar estate in Java. At almost the same time, another sugar estate was developed by a missionary in Flores. Serious development did not begin, however, until the 1950s when a farm mechanization division was created within the Ministry of Agriculture

TABLE 1 Capacity and Actual Production of Agro-industries Producing Farm Machinery in Indonesia, 1982

Type of Machinery	Number of Enterprises	Total Capacity per Year (units)	Actual Production per Year (units)
Rice milling equipment	3	2,920	2,333
Paddy thresher	8	5,289	957
Rice polisher	4	3,650	941
Rice huller	9	8,568	2,139
Rice dryer	4	1,310	173
Mini (4-wheel) tractor	1	500	65
Hand (2-wheel) tractor	4	3,360	768
Palm oil processing equipment	5	375	96
Water pump	9	12,209	2,891

SOURCE: Badan Litbang Industri Departemen Perindustrian. 1982. Informasi Potensi Produksi April 1982.

with the objective of increasing food production. Thus farm mechanization can be traced from this period.

From 1960 to 1970, the development of farm mechanization in Japan and Europe appears to have had a strong impact on the private sector of Indonesia with or without government participation. Japan, well known for its small-scale agriculture, developed various tools and machines--a water pump, sprayer, hand tractor, and rice milling unit--suitable for small-scale agriculture in Indonesia, and both the government and private sectors showed interest in the distribution of these farm tools and machines. Credit programs were provided for the purchase of new farm equipment. In addition, the agricultural universities--Bogor Agricultural University, Bandung Institute of Technology, University of Gadjah Mada--began to open new departments of farm mechanization.

During the 1970s, the disastrous brown planthopper attack resulted in an expansion of research activities in an effort to overcome future losses. New resistant varieties were introduced and were supplemented by improved pest management practices that were strictly observed by farmers. One of the key pest management practices was that of simultaneous planting, or planting within a short interval of time. The result of this innovation was somewhat surprising because for the first time it was realized that labor shortages could occur even on a crowded island like Java.

The pace of technological advance and adoption by the rural communities accelerated. The traditional method of harvesting, using the hand-held ani-ani, was considered inadequate for increased production and the shorter duration of harvest. In addition, in some areas short maturity meant a shift in harvest time to the peak of the rainy season, which created problems in drying, storage, transportation, and related activities.

Responding to the power requirements of the agricultural sector, farmers have begun to utilize one of the main solutions to these problems: farm mechanization. The old large-scale Engelberg rice mill is obsolete and has been replaced by hullers. The traditional rice drying floor had to be supplemented with mechanical drying equipment. The ani-ani was replaced in many areas by the sickle. Better road systems were required to facilitate transportation of farm produce. Hand tractors were needed in some regions. In short, the Green Revolution and the adoption of short-maturing varieties led to a greater demand for farm mechanization for preharvest, harvest, and postharvest activities. The farmers of the early 1970s had very little choice, however, in the technology offered them. Complicating this situation, locally designed products were low in quality and relatively high in price and could not compete with imported products.

Based on experience with mechanization during this decade, the following were considered significant:

- Simple agricultural tools and machinery appeared to be suitable for small-scale farming in Indonesia, and the impact of these machines on productivity was significant.
- In response to total dependence on imported spare parts, small-scale support industries began to develop.
- Small-scale rice mills were extremely efficient, and within one decade large rice mills disappeared almost completely.
- Factories producing small-scale farm machinery began to appear.
- Methods for evaluating agro-technical performance were applied, but basic research on machine design was not initiated.

Consequently, policymakers concluded during this period that mechanization plays a key role in development. Mechanization must, however, be in harmony with the overall technical, economic, social, and political objectives of national development.

A developing country normally passes through three periods in its production of agricultural machinery. The first period is characterized by the importation of most farm machinery. In the second period, the designs for machinery are brought into the country by local manufacturers and produced in the country. During the third period, national enterprises create their own designs which are more suited to local conditions and thus more efficient in the varied agro-ecological environments of the country. Indonesia is presently in the second period of agro-industrial development.

Higher levels of agricultural mechanization require the introduction and operation of a large number of interrelated support activities and arrangements to ensure that mechanization is used efficiently at the farm level. In this regard, a chain of measures is required, but any missing link in that chain may nullify the impact of one or more of the other links. The classic example is research that produces useful mechanization innovations. If, however, formal linkages between research and the local manufacturers are not provided or are weak, the impact of these innovations on efficient mechanization may be drastically reduced.

Although Indonesian agriculture is still based primarily on hand tool technology, there is need to begin development of support measures that meet the requirements of higher levels of mechanization. Although the need for these measures may not be recognized currently, primarily because of attention given to the severe problems of employment and income distribution, the government's emphasis on increasing agricultural productivity and expansion of agricultural land outside Java requires the immediate acceleration of mechanization. This requirement clearly indicates that Indonesia will move ahead with the promotion of agro-industries to supply the needed farm machinery. All research, testing, and development aimed at selecting and introducing any form of mechanization will be undertaken only in a problem-solving context. Problems will be defined by farmers or by engineers and others who are working full time at the farm level, as they are experienced in machinery use and management. A national mechanization strategy will ensure that mechanization research is properly related to appropriate technology, income distribution, and employment.

Most concepts of economic development recognize that development means shifting the agricultural labor force to the nonagricultural sector, first in relative terms and second in absolute terms. This shift creates a labor scarcity in agriculture, which in turn makes the introduction of agricultural machinery feasible and desirable. As shown in Table 2, there was a shift of this type between 1970 and 1980. In relative terms, the percentage of the labor force in agriculture decreased progressively from 1971 to 1980. In absolute terms, the labor force in agriculture appears to have declined rather sharply in 1980. Not surprisingly, labor shortages were felt in 1980 during the peak period of land preparation, even in the most populous areas in Java. The situation must have been even more pronounced in areas near the urban centers of the outer islands.

Economic theory also postulates that an increase in the real wage indicates that demand for workers is greater than the supply. As indicated in Figure 1, real wages in agriculture definitely increased from 1971 to 1980. The real wage decreased slightly until 1977 and then tended to increase, especially in Sumatra, Kalimantan, and Sulawesi. This again is strong evidence of the shift of the labor force from the agricultural to the nonagricultural sector, which seems to have taken place in 1978.

TABLE 2 Labor Force Absorption by Sector in Indonesia, 1971-1980

	Agriculture		Nonagriculture	
	Number	Percent	Number	Percent
1971	24,936,349	66.3	12,691,307	33.7
1976	24,117,283	61.6	18,188,954	38.4
1978	31,545,399	60.9	20,234,960	39.1
1980	28,040,462	54.8	23,150,990	45.1

SOURCE: Central Bureau of Statistics. (Biro Pusat Statistik) 1977, 1982. Statistical Yearbook of Indonesia. Central Bureau of Statistics, Jakarta, Indonesia.

THE CONSEQUENCES OF MECHANIZATION RESEARCH

Several Indonesian research organizations, in cooperation with the International Rice Research Institute (IRRI) and funded by the U.S. Agency for International Development (USAID), have carried out an intensive research effort on the consequences of farm mechanization in two provinces in Indonesia. This analysis was based on Indonesia's national input-output matrix and focused on the impact of production and consumption on alternative strategies for mechanization of rice production, as an example of the importance of the linkage effects.

In the model used, alternative technologies for rice production were represented by separating the rice sector in the national input-output table into 18 subsectors according to various levels of farm mechanization and associated irrigation water and topography. Similarly, the agricultural machinery sector was separated into five subsectors composed of seven types of rice production machinery. Finally, five groups of consumers with different consumption parameters and different resource ownership patterns were defined.*

Model simulations examined an increase in consumer spending for rice equal to the amount produced on 1,000 hectares of land in each rice production subcategory. The model output, obtained by using one mechanization strategy for one rice subsector compared to another, indicated the impact of the selected strategy on incomes and employment.

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*For a complete specification of the model described here, see: C. S. Ahamed and B. Duff. 1983. Farm Mechanization Strategies in an Economy Wide Model: Indonesia. IRRI Consequences of Mechanization Project Paper No. 75. Paper presented at a Seminar on Agricultural Mechanization sponsored by the Ministry of Agriculture and IRRI, Jakarta, Indonesia, September.

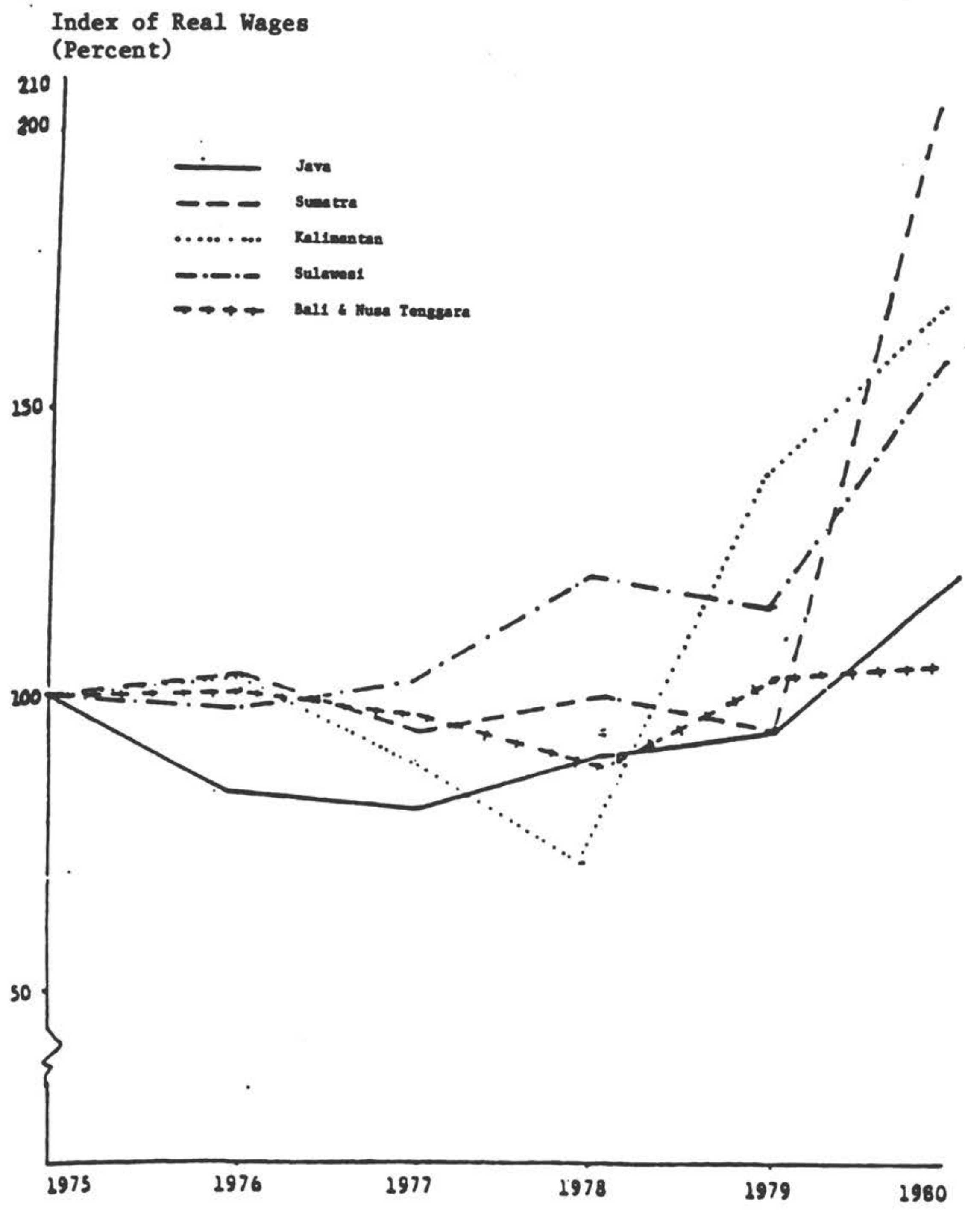

FIGURE 1 Changes in the real wage index for casual man labor (hoeing) in Indonesia, 1975-1980. Source: Central Bureau of Statistics (Biro Pusat Statistik). 1975-1980. Agricultural Surveys. Central Bureau of Statistics, Jakarta, Indonesia.

Employment in the rice sector consists of both family and hired labor. However, as nonrice employment was calculated from labor coefficients in the national input-output table, it refers only to hired labor. A change in employment arising from mechanization results from production and consumption effects. Production effects were separated into three components: (1) first-round direct effects--that is, the initial change in employment--in the rice sector resulting from machine use; (2) equilibrium direct effects in the rice sector arising from subsequent production and consumption linkages for rice; and (3) indirect effects that show changes in labor use in nonrice sectors through forward and backward production linkages. Consumption effects are indirect by nature and signify changes in employment in nonrice sectors arising from the income flow from a given level of technology. These effects take into account the possibilities of import substitution in consumption.

The consumption and production effects on employment that arise from mechanization under various water regimes are shown in Table 3. According to the first row in the table, if expanded rice acreage is attained by increasing production from an irrigated subsector using a locally manufactured power tiller rather than an animal power source, employment would increase 5-15 times that obtained from a similar change in land preparation techniques under rainfed conditions. As expected, the first-round direct employment impact of moving from animal power to the power tiller is always negative, and the decline is largest in the rainfed subsystem.

According to the third row in Table 3, the decline (increase) in net employment from the adoption of threshers and reapers is lower (higher) than that resulting from the substitution of weeders and transplanters for manual weeding and transplanting. The decline in direct employment is also lower than in the previous case, implying that employment in the sector remains high.

Looking across the rows of Table 3, it appears that the combined employment effects of introducing power tillers/mini-tractors, weeders, transplanters, reapers, and threshers increase as one moves from simple to improved gravity to pump irrigation. The results shown in Table 3 imply that, in most cases, microstudies using farm employment data overestimate the net displacement of labor associated with mechanization. The indirect consumption effects may, however, either reinforce the direct labor displacement effect or offset it, depending on the consumption patterns of the household classes receiving higher incomes. It is evident that the higher the level of mechanization, the larger the gain from improved irrigation. Thus low productivity caused by poor water control and inadequate inputs is responsible for low employment, not mechanization.

Table 4 indicates that meeting increased demands for rice by moving 1,000 hectares from carabao to power tillers/mini-tractors leads to a much higher increase in the incomes of hired labor in irrigated regimes than in rainfed systems. The income of hired labor progressively increases from simple to improved gravity and to pump irrigation.

The use of weeders and transplanters rather than manual weeding and transplanting has the largest impact on hired labor income, even more

TABLE 3 Changes in Employment (Man-years) Resulting from Changes in Mechanization Corresponding to a 1,000-Hectare Change in Paddy Land from One Subsector to Another

Change Examined in Rice Production	Rainfed					Gravity I				
	Direct		Indirect			Direct		Indirect		
	First Round	Equilibrium	Production	Consumption	Total	First Round	Equilibrium	Production	Consumption	Total
1. Carabao to power tiller/mini-tractor (weeding, transplanting, reaping, and threshing are done manually both before and after change)	-46.8	121.1	2.5	18.0	94.8	-7.2	214.0	22.5	304.6	533.9
2. Hand weeding and transplanting to weeder and transplanter (land preparation, reaping, and threshing are done mechanically both before and after change)	--	--	--	--	--	-23.7	-444.8	9.5	-40.9	-499.9
3. Hand threshing and harvesting to thresher and reaper (land preparation is done mechanically and weeding and transplanting are done manually)	--	--	--	--	--	-24.8	-383.7	10.8	-15.5	-413.2

TABLE 3 (Continued)

	Gravity II					Pump				
	Direct		Indirect			Direct		Indirect		
	First Round	Equilibrium	Production	Consumption	Total	First Round	Equilibrium	Production	Consumption	Total
1. Carabeo to power tiller/mini-tractor (weeding, transplanting, reaping, and threshing are done manually both before and after change)	-36.0	322.6	46.6	1,132.5	1,465.7	-9.0	631.1	-79.1	883.7	1,427.6
2. Hand weeding and transplanting to weeder and transplanter (land preparation, reaping, and threshing are done mechanically both before and after change)	-59.4	-417.2	28.9	-31.7	-479.4	-22.9	-89.6	14.89	290.3	192.69
3. Hand threshing und harvesting to thresher and reaper (land preparation is done mechanically and weeding and transplanting are done manually)	--	--	--	--	--	-27.7	-78.1	10.25	319.37	223.8

SOURCE: C. S. Ahamed und B. Duff. 1983. Farm Mechanization Strategies in an Economy Wide Model: Indonesia. IRRI Consequences of Mechanization Project Paper No. 75. Paper presented at a Seminar on Agricultural Mechanization sponsored by the Ministry of Agriculture and IRRI, Jakarta, Indonesia, September.

TABLE 4 Changes in Income (1,000 Rupiahs) Resulting from Mechanization Corresponding to a 1,000-Hectare Change in Paddy Land from One Subsector to Another

	Rainfed			Gravity I			Gravity II			Pump		
Change Examined in Rice Production	Hired Labor	Operator	Land-owner	Hired Labor	Operator	Land-owner	Hired Labor	Operator	Land-owner	Hired Labor	Operator	Land-owner
Carabao to power tiller /mini-tractor (weeding, transplanting, and threshing are done manually both before and after change)	3,874	4,618	5,451	51,218	62,204	62,888	85,072	92,424	88,777	108,917	69,081	93,240
Hand weeding and transplanting to weeder and transplanter (land preparation, reaping, and threshing are done mechanically both before and after change)	---	---	---	-44,859	43,242	27,349	-40,848	67,596	52,816	-24,176	89,158	39,600
Hand threshing and harvesting to thresher and reaper (land preperation is done mechanically and weeding and transplanting are done manually)	---	---	---	-18,541	26,252	25,204	-12,404	35,709	29,342	-12,493	52,233	49,000

than the change from manual threshing and harvesting to thresher and reaper. Operators derive the greatest benefit from these changes. As with employment, the decline in hired labor income diminishes with a higher level of irrigation, and operator and landowner incomes are generally higher.

In relation to landowners and operators, hired labor gains more or loses less with a higher level of irrigation. Looking across rows in the table, the combined effect of all machines on income of household classes becomes more favorable as the level of irrigation intensifies. On the other hand, intensity can offset the inequitable effects of mechanization.

Increased food production through the modernization of agriculture could mean large growth-inducing linkages with other sectors of the economy, especially agro-industrialization. These linkages primarily arise because the new food grain technology normally requires increased purchases of current and capital inputs and, more important, because of the increased demand for goods and services produced in other sectors of the economy. The increased marketing of food grains and consequent higher cash farm incomes provide important elements in the linkages. The size of the linkages depends on production structure, consumption behavior, nature of import substitution, and initial distribution of income.

Because of the nature of production and consumption linkages, sound planning requires knowing how the benefits from food grain technology are distributed, the consumption patterns that accompany increased incomes of various socioeconomic classes, the capital-labor ratios in the industries experiencing increased demand, and the nature of other constraints (such as stability of supplies, import linkages, etc.) to expansion of these industries. Because of its sheer size, the rice sector offers a particular opportunity for a net increase in employment through changes in consumption expenditures arising from the substitution of various alternative production patterns. A study of the factors suggests that consumption linkages are higher for sectors giving relatively more income to hired labor. Thus, in the case in which growth results from increased food grain production, long-run equity and production considerations may be highly complementary.

Although this analysis used data on rice production, there is evidence to indicate that these trends are also occurring for other food crops experiencing major changes that require linkages with agro-industries.

STRATEGY FOR FUTURE DEVELOPMENT

It is possible to distinguish between long-, medium-, and short-term policy options and to identify which type of strategy to apply:

- Long-term Policy Option. This policy option holds that farm mechanization is necessary for development, and that agriculture should be able to provide a new source of energy in the future. The program to support this policy option must include:

-- Development of basic abilities in farm mechanization to establish viable agro-industries
-- Initiation of energy farms such as the one developed in Lampung
-- Tapping more energy sources in agriculture, such as the transformation of waste into energy.

• <u>Medium-term Policy Option</u>. The objective of this policy option is to ensure the capabilities of farm mechanization-related adaptive technology. A program to support this policy must include:

  -- Development of an engineering capability in order to produce, with domestic resources, farm machinery suitable for the farmer's economic scale
  -- Establishment of an educational system compatible with the development of farm mechanization
  -- Design of programs that will lead to the long-run option.

• <u>Short-term Policy Option</u>. This option deals with:

  -- Research to identify the current needs for mechanization and to monitor constraints and consequences
  -- Development of an R&D capability that will support the current farm mechanization program in line with the goal of increasing production and farmers' incomes
  -- Development of the services needed by farmers to adopt farm mechanization practices and an extension capability.

The short-run policy option coincides with recommended programs discussed earlier in this paper. The problems raised by this option are far from easy, requiring resourcefulness and innovation.

WORKING GROUP REPORT: POSTHARVEST TECHNOLOGY, FARM MECHANIZATION, AND AGRO-INDUSTRY

Based on a long, wide-ranging discussion of the problems of postharvest technology, farm mechanization, and agro-industry, this working group recommends implementation of a mechanism for developing and integrating agriculture-related programs, businesses, and training in Indonesia.

The programs, businesses, and training included in this recommendation concern, respectively:

- Programs
  - -- Postharvest technologies (approximately 25 percent of existing production is now lost)
  - -- Secondary crop development
  - -- Waste utilization (50 million tons of by-products are not utilized)
  - -- Innovative mechanization (farm labor efficiency must be improved and drudgery removed)
  - -- Biotechnology (new varieties and disease- and pest-resistant plants can be evolved or seed produced)
  - -- Rural industries such as seed and fertilizer and those that produce and distribute small machinery and plant materials.

- Businesses
  - -- Postharvest conservation
  - -- Processing
  - -- Storage
  - -- Analysis
  - -- Breeding
  - -- Manufacture of machinery.

- Training
  - -- On-site research
  - -- Continuing education workshops in specialized areas.

CENTER FOR AGRO-INDUSTRIAL DEVELOPMENT

Because of the location, time-dependence, and specificity of postharvest losses and agro-industrial development opportunities in

Indonesia, it is recommended that a center for agro-industry be developed at the Serpong Research Center. This might be accomplished by utilizing the present laboratory facilities more effectively.

In October 1982, a Workshop on Technology for Increasing Rural Productivity in Indonesia, sponsored by the U.S. National Research Council and the government of Indonesia,* recommended that a biotechnology center, concentrating on plant variety development, be established in Indonesia. This panel suggests that this concept be expanded into a center for agro-industrial development and that biotechnology be an important component of such a center. This center will serve as a mechanism for promoting the development of agriculture-related business and domestic and foreign private investment, and as an incentive for the best young minds to make their careers in these potentially rewarding areas. It is envisioned that this center will play a catalytic role in promoting development and industrialization in Indonesia.

Areas of Interest to be Encompassed by the Center

Postharvest Technology

Postharvest losses of rice in Indonesia are reportedly about 25 percent, making this a primary area of concern. If these losses can be halved, an additional 2.8 million tons of rice will be available annually (based on 12.5 percent of 22.3 million tons produced), thus eliminating the need to import rice and making surplus rice available for export.

The postharvest technology group will include, at a minimum, a biologist, a cereal scientist or food technologist, an economist or marketing specialist, and an agricultural engineer to cover pest control, marketing and distribution, quality and milling properties, and drying and storage problems of rice. In time, it may be necessary to augment this range of expertise to include postharvest problems of secondary crops (*palawija*), horticultural crops, and fish.

Staff at the center will identify points in the food chain where losses are occurring and make recommendations to the government regarding policy changes and incentives that could reduce losses and result in technical improvements.**

Secondary Crops

Secondary crops--cassava, peanuts, mung beans, soybeans, and coconut, for example--require processing to transform them into products with

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*National Research Council. 1983. Technology for Increasing Rural Productivity in Indonesia, Report of a Workshop. National Academy Press, Washington, D.C., USA.

**These needs and functions are discussed at length in the 1978 report, *Postharvest Food Losses in Developing Countries* (National Academy of Sciences, Washington, D.C., USA).

high consumer acceptability and to add value to the raw agricultural commodity. Many opportunities exist for the development of innovative processes in this area. In some cases, it will be helpful to foster linkages with established food companies already possessing good technological competence.

Biotechnology

Recent developments in biotechnology and genetic engineering provide ample opportunities to develop new plant varieties and disease- and pest-resistant varieties of secondary crops. With its long history of indigenous fermented foods such as tempeh and the large amounts of agricultural waste material generated each year, Indonesia can benefit significantly from the application of new biotechnologies to develop new products and stimulate industrialization. As urbanization and the standard of living increase, modern, higher-value versions of traditional products ("instant tempeh," corn flakes, etc.) offer these kinds of opportunities.

Innovative Mechanization and Development of Small Farm Equipment

Simple, small-scale, low-cost equipment is needed to reduce the drudgery of hand labor on the farm and to develop postharvest and small-scale processing equipment industries to enhance the productivity of the rural sector. In the postharvest area, there is a special need to develop industries that manufacture rice mill components and process feed and biomass. The small tools needed for these industries must be designed in such a way that they can be fabricated in a blacksmith's or similar artisan's workplace.

Planning

Strategic plans and individual industry feasibility plans will continue to be prepared for all new industrial endeavors. Economic analyses, to be completed prior to initiating development, will take into account the characteristics of each particular business environment (i.e., price and credit policies, infrastructure, legal or managerial constraints) from a systems viewpoint to ensure the proper scaling and scope of each industry.

Manpower Development

Mechanisms will be developed to facilitate the completion of graduate degree research on-site, in collaboration with foreign institutions. Continuing education programs will be developed on management and business training, postharvest technology, biotechnology, and equipment design and development, and integrated with job placement in the new and existing industries. Training in agribusiness is likely to produce practicing businessmen rather than teachers of agribusiness.

Functions of a Center for Agro-industrial Development

In concentrating on the areas described above--biotechnology, postharvest technology, innovative postharvest mechanization, and commercializable production technology--the Center for Agro-industrial Development will seek to attract the collaboration of foreign organizations, industries, and governments.

The Center's agribusiness component will focus on the development of large-scale, integrated agro-industrial projects or plantations or processing units, and the development of scaled-down manufacturing processes for the small farm economy. Agribusinesses may take any form --from a single nationwide business to many small independent businesses scattered throughout rural areas to a linkage with a well-established foreign industry.

For large-scale operations, the center will facilitate market arrangements (buyers will be assured by back-up expertise for development, planning, and control) and provide general assistance in storage technology, processing capability, and new resource inputs. In short, it will help large-scale operations increase their effectiveness.

The center will also greatly enhance the effectiveness and quality of life of small operators and farmers. It will establish business development units at the village level so that new inputs can be effectively applied to this sector. These inputs will include the products of new businesses such as food processing technologies, handling and storage devices, seed and plant material of improved varieties, plant protectants, inorganic fertilizers, and irrigation tools and technologies. Yield improvements will be more cost-effective, and processing needs can be estimated when inputs are applied in a coordinated manner. The examples given above include seed varieties and agricultural chemicals because of their potential, and agricultural and processing equipment because of the many simple, easily developed adaptive technologies that can be produced and distributed on a cost-effective, affordable basis.

Organization of the Center

It is suggested that the advisory board of the Center for Agro-industrial Development include representatives of U.S. industry and academia. The advisory board will include technical and business experts in agricultural economics, farm mechanization, postharvest technology, food technology, biotechnology, and crop improvement. The board will identify appropriate agribusiness opportunities and business partners, both domestic and international, for Indonesia. With this guidance, the center can contribute substantially to the evolution of new agro-industries on a short- and long-term basis.

PART III

INDUSTRIALIZATION

INTRODUCTION

Working groups at this symposium covered four areas of industrialization considered to be of major importance to Indonesia:

1. Engineering and machine tool industries
2. Telecommunications and electronics
3. Land transportation industries
4. Energy industries.

These areas are included in this section under the major heading of "Industrialization" because of the many relationships among them. Since engineering and machine tool industries constitute the basis of a country's total manufacturing capability, this area is presented first. Thus subsequent areas do not discuss manufacturing needs in detail but focus rather on topic-specific technologies and government proposals on types of policies and programs to accelerate their development.

In this regard, Achmad Az, deputy for development and promotion, Indonesian Investment Board, stated in his presentation to the plenary session of the symposium:

> The objective of developing the manufacturing sector, particularly the metal and machine manufacturing industries, is to increase the number of enterprises that can in the future produce the equipment needed by the manufacturing sector itself, thereby establishing a domestic capability. In this regard, the development of manufacturing industries producing raw and ancillary materials should also be undertaken. In strengthening the manufacturing sector, more steps must be taken to encourage development of the private sector. The government can then focus more on developing the infrastructure and a conducive climate for manufacturing activities, and the education and training needed to master technologies and develop engineering skills and production management capabilities.

Early in the working group sessions, the energy industries and land transportation industries groups decided to merge to permit a more integrated approach to their topics. Later in the day, they were joined by the working group on engineering and machine tool industries who responded to Ir. Yogasara's presentation, "Design and Engineering and the Plant Machine and Equipment Industry."

In several areas, insufficient time and the number of presentations scheduled precluded formulation of a systematic set of recommendations for collaboration with the government of Indonesia. Thus institutions in the United States that can provide additional information on specific industries as well as specific technologies mentioned by working group participants are listed at the end of each area discussed.

DESIGN AND ENGINEERING AND THE PLANT MACHINE AND EQUIPMENT INDUSTRY

Eman Yogasara
Director General of Basic Metal and Machinery Industries,
Ministry of Industry

STATUS OF THE METAL AND MACHINE MANUFACTURING SECTOR

In Indonesia, the metal and machine manufacturing sector, including machinery and equipment for industry, can be divided into those works built early in the twentieth century and those built in the 1970s and later. The difference between the two groups lies not only in their age, but more important, in the different factors that promoted their growth.

The Early Manufacturing Sector

The machine manufacturing works found in Indonesia in the early part of this century were largely service units that repaired and made spare parts for sugar mills (which at that time were expanding rapidly), road-building equipment, and a few other basic types of equipment. Two factors promoted the development of this kind of manufacturing:

1. Sugar mills (and other processing plants for estate products) required substantial repair work and spare parts.
2. International transportation was not as developed as it is now, and the transport of goods was expensive and time-consuming.

In other words, an expanding domestic market and a type of natural protection helped the growth of this industry in the early part of the century.

As the plantation business (sugarcane, rubber, coffee, tea, etc.) fluctuated, and other facilities (rice mills, irrigation systems, bridges, railways, etc.) requiring repairs, machinery, and spare parts were introduced and developed, the machine industry diversified its products. This adjustment was not too difficult because, in general, machine plants were designed to handle works on order and simple metalworking processes were involved, such as casting, machining, and (plate and structural) fabrication.

As a result of the slow growth in sectors on which this industry traditionally relied--plantations, agriculture, and infrastructure--and aggravated by improvements in international transportation, particularly after World War II, these early machine plants have suffered. Very few, if any, new investments in either software or hardware have been made since in these plants. These enterprises have, nevertheless, gained some know-how in the design, engineering, and manufacture of a number of processes and machinery and equipment types.

The Present Manufacturing Sector

The second category of plants, built in the 1970s and later, have grown under quite different conditions than those existing before World War II, largely as a result of relatively rapid economic development and well-developed international communications (trade and transportation).

The fairly rapid economic development of the 1970s, which required a wide variety of metals and machinery, accompanied by favorable government investment policies, stimulated new investments in the metal and machine industrial subsector. This has led, for example, to the establishment of steel and aluminum mills; agricultural equipment manufacturing plants; plants for the manufacture and assembly of engines and components, automotive vehicles, and railway cars and components; shipbuilding industries; and manufacturers of electrical cables, transformers, and generators. Plans are also being made for the construction of oil platforms.

The new metal and machine manufacturing plants generally work on a regular and continual basis (serial production). The use of foreign technology, either through technical assistance or licensing, is common.

POTENTIAL FOR THE FUTURE

The large construction projects undertaken since the early 1970s--such as manufacturing plants for cement, fertilizer, petrochemicals, paper, oil and gas, steel and iron, electric power generation--have given the machine industry the opportunity to serve as subcontractors for construction work and installation of machinery and electrical facilities, as well as manufacturers or fabricators of such items as buildings, storage tanks, pressure vessels, and even complex piping. While limited, these opportunities provide training in the fields of project design and engineering, procurement, construction management, trial running and commissioning, etc.

Although certain types of industries have still not proven their ability to design a complete factory and to run it efficiently, the potential for the successful completion of such tasks is clear-cut, based on the facts that:

- Many plants have been built and are operated in Indonesia.
- Although the design responsibilities rest with the overseas designers, the national machine industry has participated in the construction of factories.
- Most of the fieldwork has been done by national companies.
- Certain types of goods and equipment have been built domestically.

In the fourth 5-year development plan (REPELITA IV, 1984-1989), the government will promote domestic capabilities in the design and manufacture of machinery and equipment. Government-owned enterprises currently dominate machine manufacture and design, but the government is encouraging the private sector to take a more active role in this field.

DESIGN AND ENGINEERING AND THE PLANT MACHINE AND EQUIPMENT INDUSTRY

In constructing a plant, an owner must decide to either:

- Appoint a main contractor to be responsible for the plant's completion on a turnkey basis.
- Appoint a main contractor to be responsible for the plant's construction management (cost plus fee) and to have final responsibility for the plant's performance on a turnkey basis.
- Appoint several main contractors to work on well-defined packages, while the owner has the responsibility for coordination.
- Build the plant himself.

For some small plants, such as an ice or oxygen plant, and some larger plants, the chief contractor may be the manufacturer of the main machinery or equipment. Many owners prefer this arrangement because they believe the manufacturer knows best about what to do.

Design and engineering are skills that translate a process into a plant design and, through construction, into a plant. Design and engineering capabilities are always tied to a performance guarantee that is agreed upon beforehand. Growth of these capabilities will promote growth in the machine industry.

A plant is essentially a system of machines that works as a unit to produce a desired product. This set of machines can be grouped into the following categories:

- Buildings
- Piping and vessels
- Machines--standard and customized
- Electrical equipment and facilities
- Instruments.

Since the technology for new processes and kinds of machinery is continually developing, the promotion of design and engineering and machine industries should be supported by research and development in these fields. This promotion is aimed at supporting priority sectors such as:

- Agriculture: sugar, oil palm, rubber, coffee, tea, etc.
- Mining: oil and gas
- Industries: steel and iron, cement, paper, fertilizer, petrochemicals

- Electric power: generating plants, transmission and distribution gears
- Telecommunications.

Although still limited, capabilities in design, engineering, and machine manufacturing have begun to grow in these areas.

WORKING GROUP REPORT: ENGINEERING AND MACHINE TOOL INDUSTRIES

The government of Indonesia has ambitious plans for industrialization. Discussion in this working group centered on the building of satellite industries and smaller companies in Indonesia that might support the primary licensees and producers of such products as automobiles, railroad cars, construction equipment, sea-going vessels, power-generating equipment, and electrical and nonelectrical machinery. Because Indonesia intends to provide high employment in these industries, a high direct-labor input and relatively low-technology machinery will be used to fabricate products, components, and subassemblies.

These industries will, in turn, be based on a machine tool industry that produces standard, manually operated machine tools. Although such machines will provide for maximum employment, they will, nevertheless, necessitate extensive training of employees, since machine operators will be responsible for both efficiency and quality. Indonesia's plan to contract with prime licensors, who will then have to train industrial workers, is to be applauded. The Indonesian government may, however, wish eventually to strengthen central training schools for operators and technicians to support its industries.

To aid in obtaining U.S. licenses to manufacture standard machine tools, it is suggested that Indonesian officials send a list of the types and sizes of machines desired to the National Machine Tool Builders Association, McLean, Virginia, USA. This association will then make Indonesia's needs known to all major U.S. machine tool manufacturers.

Indonesia has also recognized the need for suppliers of cutting tools and services to maintain the tools, dies, and molds used in the production of components and products. As industrialization progresses, machine components such as motors, bearings, and hydraulic equipment must also be provided. The provision of these goods and services should also be part of the government's industrialization plans.

EFFICIENCY

Because high direct-labor content and genuine manufacturing efficiency may not be completely compatible, it is suggested that the small plants in communities be combined, giving them together the capability to produce a finished component or subassembly. Thus, rather than a single stamping plant or a lathe plant, one plant might produce welded subassemblies from stamped parts, or different sizes of gears, or similar but different-sized shafts with threads, splines, etc. It is highly recommended, however, that each plant be defined in terms of the volume of production required, the types of operations performed, and the degree of precision needed. It is this working group's experience that these factors define a manufacturing atmosphere and that employees find it difficult to work in other atmospheres. For example, a tool and diemaker will make the most precise and the most costly ashtray imaginable. Precision is part of his or her mindset.

The arrangement just outlined will allow operators to concentrate their skills within a specialty (rather than having to be skilled general machinists), will permit all employees to be knowledgeable about the operations and productivity of the company, and will identify the sole source of responsibility for both quality and quantity. The prime licensor could be a major help in organizing a network of such suppliers, but the Indonesian government should participate in its implementation.

HIGH TECHNOLOGY

In some areas of manufacturing, Indonesia will have to become familiar with the use of certain high-technology processes if it is to compete in the world marketplace. Processes such as numerical control, computer control, and automated flexible manufacturing as well as adaptable high-production systems already exist worldwide, but they are still in the early stages of development. The only way to acquire such high technology is to buy these systems and equipment and use them. This technology cannot be taught or learned in the classroom or in books; it requires a long-term working relationship between suppliers and users to develop an understanding of the operation, support, and maintenance of facilities. With its present $30 million program for a computer control machining center located at the aircraft company PT NURTANIO, Indonesia seems to be taking a positive step in this direction. It is recommended that this center be used for learning and training as well as for manufacturing.

ECONOMIC AND POLITICAL PROBLEMS

During this group's discussion, two economic and political problems were cited. First, the tax structure in Indonesia must be such that it encourages the formation and growth of small- to medium-sized plants. The incentive to invest and to perform is based on an after-tax gain. Second, the laws dealing with sole agents, although understandably important to Indonesia, are a detriment to reaching agreements with some offshore manufacturers. It is necessary to deal with international companies that have a good reputation for stability, performance, and continued service and support, and this can best be achieved by careful selection of licensors. The difficulties currently found in terminating agreements with Indonesian agents are not common elsewhere in the area of international trade and commerce, and they may tend to inhibit some licensors from committing resources to Indonesia.

The technology exists in the United States for providing nearly all of the capability that Indonesia is seeking. U.S. participation will depend, however, on how the Indonesian government defines its priorities. From the standpoint of U.S. companies, it is in their best interest to be the primary licensor whenever possible. To the extent that this can be achieved, they are more likely then to participate in providing U.S. manufacturing technologies and equipment.

CONTACTS

Institutions that may be able to provide appropriate information or contacts include:

Foundry Equipment Manufacturers Association
1133 15th Street, N.W.
Washington, D.C. 20005, USA
Telephone: 202/429-9440
Attn: Mr. Peter J. Engel

National Machine Tool Builders Association
7901 Westpark Drive
McLean, Virginia 22102, USA
Telephone: 703/893-2900
TWX: 7108310031-NMTBA-MCLN
Cable: INMATOOL
Attn: International Trade Department
(Represents contract metal-working industry. Member companies design and manufacture tools, dies, jigs, etc.)

National Tooling and Machining Association
9300 Livingston Road
Ft. Washington, Maryland 20744, USA
Telephone: 301/248-6200
Attn: Marketing Department

PROSPECTS FOR THE ELECTRONICS AND TELECOMMUNICATIONS INDUSTRIES IN INDONESIA

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Indonesian Institute of Sciences (LIPI)

INTRODUCTION

Indonesia is the world's largest archipelago, extending between Asia and Australia. This country has a land area of 1,175,000 km^2, and its 13,677 islands stretch 5,120 km from east to west, roughly the distance from Moscow to London, and 1,770 km from north to south.

The total population of Indonesia is estimated at 150 million, and it is the fifth most populous country in the world. Indonesians are basically of Malay heritage and are divided into approximately 300 ethnic groups which speak about 365 languages and dialects (although a common language, Bahasa Indonesia, has been designated).

In expanding its economy, Indonesia regards communications as the arteries of the nation, facilitating the flow of goods for export and import as well as providing inter-island communications. Thus telecommunications and electronics play an extremely important role in Indonesia's 5-year development plans.

Indonesia's geographic configuration and social conditions create problems, however, in the fields of electronics and telecommunications. Telecommunications are crucial to facilitating the government's administration of Indonesia's 27 provinces, its economy and business, and defense, and they have a great influence on the social conditions of the nation.

CURRENT STATE OF THE ELECTRONICS AND TELECOMMUNICATIONS INDUSTRIES IN INDONESIA

Typical of any developing country in which the electronics manufacturing and assembly industry emerges almost overnight, Indonesia's electronics industry, after a relatively short time span, no longer reflects local demand. Spearheaded by international companies, the electronics and telecommunications industries have begun to export a small range of products.

Most production is still in consumer goods, although considerable diversification has been achieved in the past 7 years. At first, the electronics and telecommunications industries obtained licenses from abroad to assemble radio and television receivers. Later, at the recommendation of the government, they began to make parts such as wooden and metallic cabinets and plastic, Bakelite, and rubber parts, followed by the manufacture of coils, transformers, chokes, loudspeakers, intermediate frequency (IF) transformers, and printed boards. Fifty-six factories are now building radio and television receivers, 17 of which have a very close relation with their partners abroad. The 39 other assemblers are in a free market situation, which means that they are not dependent on a single source.

The electronics and telecommunications industries are not limited to the classical electronic entertainment products. They are beginning to branch out into sophisticated equipment such as small-capacity earth stations, television transmitters, radio broadcasting transmitters, radio communications, personal computers, integrated circuits, and semiconductor devices.

Role of the Government

The government of Indonesia plays an important role in guiding industrial development in accord with a carefully prepared economic development plan, and it has laid ground rules to facilitate private investment by both domestic and overseas sources. To enhance the growth of the electronics industry in particular, the government recently established an Electronics Industry Working Group, under the coordination of the Ministry of State for Research and Technology. This working group will assist the minister of research and technology and the minister of industry in preparing and studying the further development of the electronics industry in Indonesia. A glimpse of its work list for the current year may well reflect what is in store for the electronics industry in the future:

- To study and recommend the direction for further development of the electronics industry
- To recommend simplified administrative procedures through intensified study
- To present proposals for special laws and regulations governing the electronics industry
- To coordinate the growth of related industries with the growing demand for electronic component manufacturers and assemblers
- To upgrade the quality of industries producing locally made electronic products, etc.

Industrialization involves economic as well as political, defense, and social goals. Nevertheless, standards of efficiency in production, financing, marketing, and labor must continue to play a major role in industrialization so that end-products are within the reach of society and can compete both in the overseas market and with imported goods in the domestic market. Since the beginning of the new order, the direction of the general industrialization process in Indonesia has become increasingly clear, and it will become even more apparent in REPELITA IV (1984-1989). In the current 5-year development plan (REPELITA III), the industrial sector is expected to play an important part in realizing:

- The equal distribution of development and its results
- Rapid economic growth
- National stability that is healthy and dynamic.

After economic stability is achieved, the government will not spare any effort to improve the investment climate, fully realizing that international cooperation and partnerships for mutual benefit are the way to achieve rapid progress. As steps toward accelerating economic growth, a number of arrangements have been made and promotional measures taken for encouraging foreign investment.

Indonesia has, in only a few years, become another center for electronics development in Southeast Asia as a result of these promotional measures adopted by the Indonesian government and the provision of the incentives necessary to develop domestic industries as well as attract overseas capital and modern technical achievements. According to the findings of experts, many favorable factors emphasize the advantages of Indonesia as a possible base for electronics manufacturing investments:

- With its estimated population of 150 million, Indonesia has a large domestic market in addition to its overseas market.
- Indonesia, the world's largest archipelago, is located across an important international trade route.
- Low-cost, productive, abundant labor is available in Indonesia.
- Indonesia has maintained a stable economy with well-controlled cost-of-living and foreign exchange rates.
- Indonesia is well known for its political stability and a labor force that is not known to strike.
- The government has and will continue to encourage development of the electronics industry.

Current Manufacturing Capabilities

Over 100 factories and assemblers are currently manufacturing electronic products in the areas of household appliances—for example, radio receivers, cassette recorders, television receivers, refrigerators, fans, and air conditioners—and office equipment—for example, calculators and personal computers.

Of the overview manufacturers, only five are making professional equipment: PT INTI (national telecommunications manufacturer), LIPI-LEN (National Electronics and Electrical Research Institute), PT RFC (private telecommunications manufacturers), PT Hausma, and PT Erindo Utama. Most of these industries have grown as a result of opportunities provided by the foreign investment regulations (PMA) in the form of joint ventures with foreign companies or investors, or in the form of licensed industries dealing with consumer electronic products. These industries use local raw materials, although some still use the trademark of their overseas partner which already has a good reputation in the domestic market. With this method, however, a royalty must be paid to the partner, and this can be quite expensive. Thus some progressive industries are using their own trademark.

Consumer electronic products are largely used to fulfill domestic demand, while electronic components such as semiconductor devices, integrated circuits, etc., are exported by applying the "bonded warehouse" regulation. The professional electronics industries, mainly producing communications equipment, broadcasting equipment, etc., primarily market their products to government bodies, the military, and a very few private companies. Consumption of these products is still below industry capacities, one reason being that much of the financing for development in this field depends on foreign credit, which means purchasing equipment from credit-granting countries. Nevertheless, the Indonesian manufacturers of telecommunications equipment are still striving to meet the demands of the government and private companies.

The results of such efforts are encouraging, evidenced by the fact that these companies still exist, yet the professional electronics industries must gain a better knowledge of advanced technology, which is rapidly progressing, and acquire more experts and skilled engineers. Manufacturers must endeavor to increase their knowledge by entering into licensing agreements with industries of developed countries.

In another direction, however, the government of Indonesia established in 1980 a National Team for Controlling the Procurement of Materials and Equipment for the Government (Team Pengendali Pengadaan Baran/Peralatan Pemerintah). Formed under the minister of state-secretary, this team includes the minister of state for administrative reform and the vice chairman of the National Planning Board (BAPPENAS), the junior minister for domestic production, and representatives of the Department of Finance, Department of Industry, Department of Trade, National Planning Board, Investment Coordinating Board (BKPM), and Bank of Indonesia (the central bank of Indonesia). The main task of this team is to control the price of materials and equipment used by government bodies and to ensure, as much as possible, that all have been produced in Indonesia. With these regulations and control systems and with a united industrial force, Indonesia is ready to begin the vital task of supporting and improving its electronics and telecommunications industries.

PROBLEMS AFFECTING THE ELECTRONICS AND TELECOMMUNICATIONS INDUSTRIES

Almost all electronics or telecommunications industries in Indonesia can be classified as small or medium. Some common disadvantages faced by them because of their size are:

- Insufficient capital for the establishment or utilization of even some of the standard modern scientific methods, services, and facilities directed toward enhanced productivity such as work/study, stock control systems, efficient documentation.

- Inefficiencies and diseconomies resulting from underutilization of production aids such as high-output, numerically controlled machine tools; service equipment; specialists; and staff and facilities for testing, quality control, and marketing.
- Restrictions imposed by the undiscovered or untapped local, national, and international demands for certain products.
- Lack of adequate skills or basic facilities within companies for systematic work orientation, management, engineering, vocational training, efficient and up-to-date accounting and cost accounting, etc.
- Lack of modern technical know-how for handling production, organization, management, and marketing problems and a dearth of technically qualified and experienced personnel.
- Shortage of foreign exchange and inadequate facilities for importing essential raw materials and machinery as well as an ability to develop simultaneously a market for goods in the countries from which machinery and raw materials are imported.
- The traditional domination of the policy- and decision-making, planning, administrative, and management spheres by nontechnical personnel, many of whom are linguists, historians, and lawyers. This results in a lack of appreciation of technical industrial problems and the usefulness of modern scientific methods and techniques in solving them.
- Difficulty in translating indigenous R&D achievements into production, engineering, and marketing. Almost all industries are reluctant to implement indigenous R&D achievements into their production, and this is one reason that Indonesia's Research and Development Institute must implement and manufacture its own achievements.

To achieve harmonious industrial growth capable of producing the ideal economic development, relations must be balanced between large, medium, and small industries. However, to assist the small- and medium-scale industries, the government must act as a leader in ongoing collective research (both basic and applied). This task falls to the government as it would be very difficult to find a private company that possesses all of the facilities for research, development, and analysis.

A relationship between industries of all sizes and Indonesia's Research and Development Institute is desirable because the industrial sector must, in fact, bear two burdens: increasing income and distributing that income equitably. Although increased income can be easily achieved by large-scale industries which are generally capital oriented, these industries are less capable of equitably distributing that income because they absorb little labor. The latter task could be better carried out by the small- and medium-scale industries active in the international competition, but they would have to be supported by R&D activities carried out by the government. Ensuring the development of both large-scale and small- and medium-scale industries would be difficult without linkages among them. Previous efforts to link them have not yet jelled.

Indonesian industries experiencing the highest growth figures (Table 1) are those that produce consumer goods that replace imports. At a glance, these kinds of industries seem healthy, but in fact they suffer from internal ailments. Their survival depends heavily on the import of raw materials and production equipment, thus subjecting them to the price fluctuations and economic situations outside the country.

THE FUTURE PROSPECTS FOR ELECTRONICS AND TELECOMMUNICATIONS IN INDONESIA

The problems described above indicate that past industrial development policies had their weak points and possibly mismanagement, all of which serves to indicate that the policy on industrial development is still far from effective. Remedial treatment for the industrial sector must involve efficiency, quality, prices within reach of the public, and forward and backward linkages, all necessitating more effective management. Efforts to remedy industrial development during REPELITA III (1979-1984) appear to have made a good start, and policies taken by the government at the end of REPELITA II (1974-1979) helped provide a suitable climate for REPELITAs III and IV. Based on observations, the following directions and courses of action taken by the Indonesian government have been the most appropriate:

- Developing basic industry as a source of the goods needed for development and for small- and medium-scale industry, while at the same time serving as a source of foreign exchange.
- Developing small- and medium-scale industries that produce substitutes for imported goods so that several production units use basic goods available within the country which could also conserve foreign exchange.
- Encouraging and increasing research activities with priorities established for short-, medium-, and long-term development.
- Setting up communication channels among government, users, and industries. With accurate calculations and careful guidance, industrial growth will likely be accelerated.

The future demand for electronics and telecommunications products--of which the government sector is the largest user--will probably mean good prospects for the electronics and telecommunications industries in Indonesia. Indonesia's demand for electronics is especially difficult to quantify because it depends on many factors that are constantly changing, for example, social needs, the purchasing power of the public, the capabilities of industry and technologies to stimulate and absorb new electronic developments, and suitable economic environments to support financial spending.

Forecasting the growth of the telecommunications field is not so difficult because this field is largely controlled by the government. Telecommunications equipment is needed by such government sectors as the state telecommunications enterprise (Perum Telekomunikasi), the state oil enterprise (P.N. Pertamina), the military, local government, and

TABLE 1 Production of Assorted Industrial Products in Indonesia, 1977-1983

Product	1977-1978	1978-1979	1979-1980	1980-1981	1981-1982	1982-1983
Radio receiver	1,000,000	1,536,000	1,018,800	1,110,492	1,154,900	1,589,947
B/W TV receiver	460,000	687,600	574,000	631,400	643,620	653,498
Color TV receiver	--	45,600	85,800	98,670	203,311	--
Mobile radio cassette	--	--	560,500	616,550	672,039	355,911
Bulb	24,800,000	30,360,000	29,901,600	33,788,808	36,491,900	30,399,919
Refrigerator	29,300	26,400	47,400	73,470	53,604	59,998
Dry battery	442,000,000	420,000,000	462,000,000	526,740,000	263,570,000	576,600,000
Wet battery	575,000	690,000	1,747,200	3,319,680	3,651,600	3,521,000
Fan	--	--	228,000	490,200	524,300	755,967
Electrical transformer	1,200	1,400	1,375	2,331	3,890	4,660
Picture tube (CRT)	26,700	55,000	25,000	59,812	73,181	--
Electrical motor	150	500	200	563	700	1,470
Electrical generator	--	--	8,279	8,820	16,875	7,523
Telephone exchange and PABX	--	--	130	2,832	37,120	3,960
Satellite earth station/TVRO	5	20	30	100	18	20
TV transmitter	20	10	20	150	40	30
Radio transmitter communication	--	15	20	25	20	15
Radio transceiver	200	150	160	450	150	200

the Department of Communication. According to a presidential decree, the telecommunications network and operations must be managed by the state telecommunications enterprise or at least be under the control and coordination of that state enterprise. The demand for telecommunications in Indonesia up to the year 2000 can be seen in Tables 2, 3, 4, and 5.

Digital methods of handling data and communication traffic are gradually being introduced in Indonesia so that the capacity and performance of these methods can meet future communications demands when used with microwave systems, followed by optical systems at a later date. Thus a general shift to digital systems can be expected to continue. Some decisive questions for the communications network are whether such a shift is technically possible, whether it is desired by customers, and whether this benefit can be provided at a price they are willing to pay. In recognition of these questions, priority will have to be given to the operational and economic aspects when developing future systems.

As mentioned above, the establishment of electronic industries largely depends on the demand for electronic products, particularly consumer products. Radio and television receivers represent the home appliance electronic needs and radio transmitters represent the professional requirements. The demand correlation between GNP growth and electronic industrial production is, however, used as a method of forecasting. The forecasting is quite careful and not so optimistic, but conditions are encouraging since, at the same level of GNP, the distribution ratio of television receivers is much better in Indonesia than in Korea and Japan even though Korea began producing television receivers 14 years after Japan, and Indonesia began production 8 and a half years after Korea. This is a result of communications improvements, such as the launching of the satellite PALAPA and expansion of television and radio networks. Forecasts of the demand for consumer electronics in Indonesia have been made until the year 2000 as shown in Figures 1 and 2. These forecasts are based on (1) an assumption of population growth to between 214 and 265 million by the year 2000, and (2) certain assumptions regarding growth of the per capita gross domestic product by the year 2000.

The future of the electronics and telecommunications industries in Indonesia appears to lie in the area of smaller scale, highly skilled, specialized operations as well as in its current production of consumer goods. The electronics industry is progressing to a stage at which it could become an important supplier of certain products, equipment, and components to industrialized countries.

The areas in which the greatest concentration of efforts will occur, however, are products that do not call for large production runs. These products will be specialized rather than consumer goods as they are value intensive and thus not as affected by freight costs when exported to distant markets. In these highly skilled technical fields, Indonesian small- and medium-scale manufacturing have an advantage. The government of Indonesia has, nevertheless, provided a number of laws and regulations to create a favorable investment climate, and large-scale manufacturing will be established by joint ventures.

TABLE 2 Planned Replacement and Installation of Telephone Switching Equipment (Line Units)

REPELITA	Number of Line Units to be Replaced	Number of Line Units to be Installed	Total
IV, 1984-1989	80,800	262,000	342,800
V, 1989-1994	37,600	511,000	548,600
VI, 1994-1999	406,500	808,000	1,214,500

TABLE 3 Telephone Development Up to the Year 1999 (Line Units)

Telecommunication District	REPELITA IV, 1984-1989		V, 1989-1994		VI, 1994-1999	
	Analog	Digital	Analog	Digital	Analog	Digital
I	--	6,000	5,000	11,000	6,500	80,000
II	--	6,000	--	7,000	--	24,500
III	--	14,000	1,000	4,000	1,500	22,500
IV	57,000	168,000	49,000	295,000	--	600,000
V	5,000	20,000	5,500	35,000	--	90,000
VI	--	14,000	1,500	35,000	1,500	80,000
VII	10,000	21,500	6,500	60,000	4,500	200,000
VIII	1,800	8,500	2,000	2,000	3,000	18,500
IX	--	--	2,000	7,000	2,000	20,000
X	1,000	10,000	1,000	12,000	1,500	30,000
XI	--	--	600	3,000	600	11,400
XII	--	--	1,500	2,000	1,500	15,000
TOTAL	74,800	268,000	75,600	473,000	22,600	1,191,900
	342,800		548,600		1,214,500	

TABLE 4 Telex Development Up to the Year 2000 (Line Units)

Telecommunication District	Year 1984	1989	1994	1999-2000
I	1,100	1,800	2,800	4,200
II	1,200	1,200	1,600	2,400
III	500	1,000	1,500	2,200
IV	7,600	15,000	22,000	34,000
V	700	1,500	2,200	3,300
VI	800	1,700	2,700	4,000
VII	1,500	2,800	4,300	6,600
VIII	300	500	700	1,100
IX	1,100	1,100	1,400	2,000
X	650	1,000	1,400	2,000
XI	100	200	300	500
XII	150	300	400	600
TOTAL	15,700	28,100	41,300	62,900

To secure skilled technicians and craftsmen for this field, the number of electronics departments of every college has been increased and substantial government funds have been allotted to training technicians.

THE ROLE OF INDUSTRIAL RESEARCH AND DEVELOPMENT

Industries in advanced countries are fully aware of the important role that research and development play in progress, and large industrial firms invest part of their earnings in research to further their own interests. In the competitive world of today, it is not possible to rely on established technical skills and production procedures. Sales techniques and even administrative and industrial relations must be continuously modernized to retain their competitive power. Industries must maintain contact with the faculties of universities and colleges of advanced technology, and the mobility of research staff between industrial and academic institutions must be encouraged. Technical information centers are being supported to ensure that industry is kept abreast of developments in technology. In some countries, trade unions keep a watchful eye on the firm's investment policies to see that sufficient resources are devoted to research and development.

Even small firms that lack resources are establishing research facilities on a collective basis. Industrial research promoted by government, as highly important as it is, is not geared to the needs of individual industrial enterprises and cannot substitute for indigenous

TABLE 5 Projected Inter-island Channel Demand, 1984-2000

Year	Island Group	Java	Sulawesi	Kalimantan	Sumatra	Maluku
1984	Java	13,460	426	282	1,260	108
	Sulawesi	750	72	48	48	18
	Kalimantan	474	48	30	48	12
	Sumatra	2,910	60	72	372	30
	Maluku	396	48	18	342	48
1989	Java	18,840	552	366	1,644	132
	Sulawesi	1,044	90	54	66	30
	Kalimantan	654	54	36	54	18
	Sumatra	3,780	78	90	492	36
	Maluku	551	54	30	48	54
1994	Java	27,084	828	576	2,448	180
	Sulawesi	1,500	132	96	96	36
	Kalimantan	936	96	60	108	24
	Sumatra	5,244	108	120	900	60
	Maluku	768	72	36	72	72
2000	Java	43,710	1,404	990	5,082	348
	Sulawesi	2,310	216	150	186	66
	Kalimantan	1,704	150	108	216	42
	Sumatra	7,476	162	186	1,548	66
	Maluku	1,308	132	66	162	150

research undertaken by an industry to solve its own problems and advance its own interests. In Indonesia, only a few industrial concerns have established their own research facilities to meet their requirements.

Center for the Development of Research, Science, and Technology

Because the small- and medium-scale industries are lacking facilities and highly skilled engineers for conducting research and development activities, a government research organization is strongly needed to assist these industries. In October 1976, presidential decree no. 43 was issued and stipulated the guidelines for constructing the Center for the Development of Research, Science, and Technology (PUSPIPTEK) in Serpong. This project is meant, within certain limits, to make facilities available for the tasks of the Ministry of State for Research and Technology and nondepartmental government agencies such as LIPI, BATAN

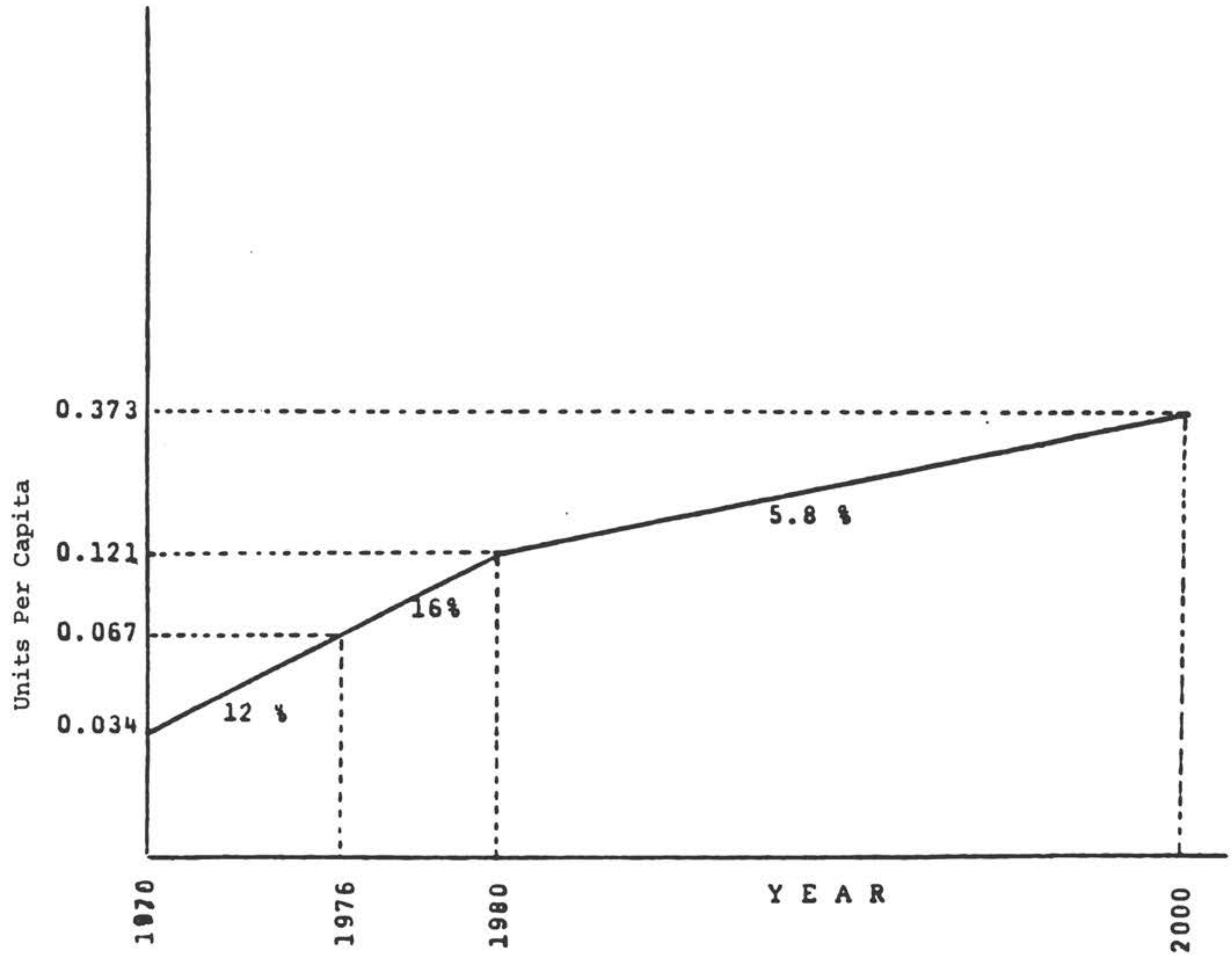

FIGURE 1 Demand forecast for radios in Indonesia.

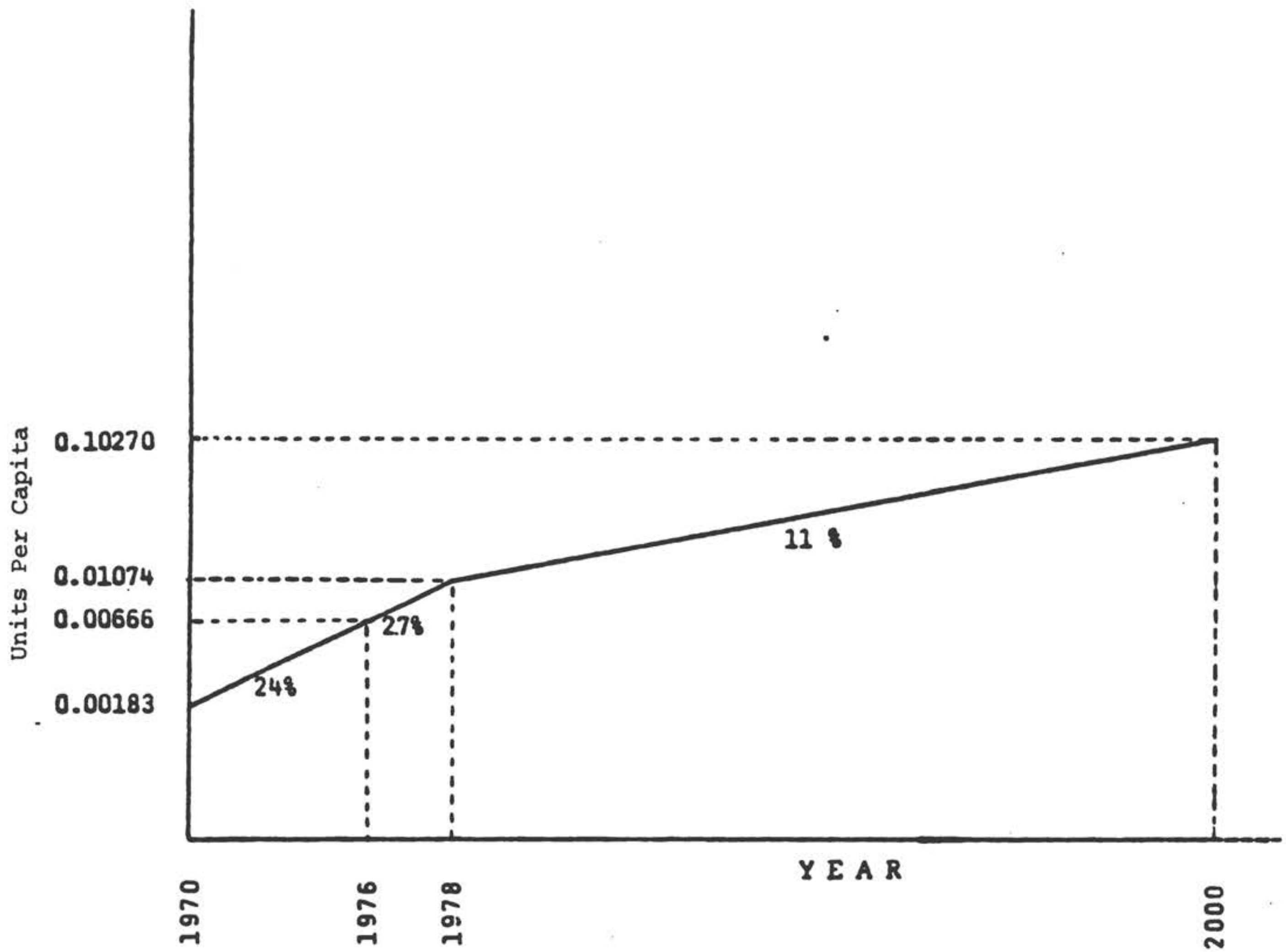

FIGURE 2 Demand forecast for televisions in Indonesia.

(National Atomic Energy Agency), BAKOSURTANAL (National Resource Survey and Mapping Agency), BPPT (Agency for the Assessment and Application of Technology), and LAPAN (National Aeronautics and Space Institute). A comprehensive, well-developed plan for PUSPIPTEK has been compiled on the basis of five facilities:

1. Research and development facility to serve as a center for research and to provide scientific services and technological applications to meet the needs of industry and society.
2. Office facilities to serve as a center for coordinating, directing, and implementing policies on research, science, and technology.
3. Public service facilities to meet the needs of the scientific community and to increase the awareness and knowledge of the general public concerning the role and development of research, science, and technology.
4. Settlement facilities such as a housing complex to serve the welfare of research workers and other employees who, because of the nature of their work, must have homes near their place of work.
5. Utilities such as electric power generators, water purifiers, workshops, fire extinguishers, and other maintenance facilities.

Electronics industrial research centers can assist industries that lack adequate research facilities, but it is difficult to know in advance what information and what kind of activity is most useful to a given industry. This difficulty is clearly demonstrated by the sometimes disconcerting nature of the help individual industries seek on their own premises. If the industry as a whole is to be radically improved by collective research, a start must obviously be made by collecting individual information and obtaining direct assistance.

Basic and applied research, which are virtually impossible for small- and medium-scale industries relying entirely on their own resources, are vital for improving production techniques. Because the future industrial potential of the country thus depends on them, such research is regarded as the main responsibility of a technical research center.

National Electronics and Electrical Research Institute

As outlined in Indonesia's first 8-year overall development program (1962), the Indonesian Council for Science (MIPI) and the Department of National Research were merged in 1967 into the Indonesian Institute of Sciences, which now has 10 national research institutes. These institutes are responsible for investigating and exploiting the human and natural resources of Indonesia and giving guidance in the development of industries in their respective fields.

One of these institutes is the National Electronics and Electrical Research Institute (Lembaga Elektronika Nasional--LEN), located in Bandung. The main task of this institute is to conduct research and to transfer and adapt technology for the benefit of mankind in general and for the Indonesian people in particular. Work is undertaken especially in electrotechnical fields as well as basic research, applied research, and long-term R&D in the fields of electronics, communications, components, computers, and electrical engineering. This institute was established in 1962 as the Electrotechnical Project, and in 1965 it was inaugurated as the National Electronics and Electrical Research Institute by the government of Indonesia.

For its range of activities, the institute's laboratories provide comprehensive and authoritative research and application services. Work related to certain professional applications of electronics and electrical as well as computer technology, or work on behalf of other government laboratories and establishments, involve a close and valuable relationship with the users. Experience gained from civil and military contracts has also been valuable in providing objectives for future applications and techniques. Government interest in civil and military applications has caused the institute to be involved on a cooperative basis with many industrial firms and other governmental establishments.

WORKING GROUP REPORT: TELECOMMUNICATIONS AND ELECTRONICS

The working group on telecommunications and electronics found the paper by Dr. Sumaryato Kayatmo, which provided the background and issues in this important field, both informative and stimulating. His lucid personal commentary at the opening of the working group's session was particularly helpful.

In reviewing possible U.S.-Indonesian collaboration in the field of telecommunications and electronics, this group is in full agreement that the ongoing development of Indonesia's telecommunications system, oriented to serving the national economy, defense, education, and national political cohesion, should continue to be of high priority. This is especially true for a nation so widely dispersed physically, economically, and demographically. Important to this development is the need to expand national capabilities for maintenance and management based primarily on domestic resources. Linked to this is the need to continue development of domestic electronics manufacturing in carefully selected product lines.

The working group is impressed with the array of serious constraints that must be overcome in reaching these goals in telecommunications and electronics, including scarce capital, shortages of trained technical and managerial personnel, and the established presence of foreign expertise that tends to dominate these fields.

STRATEGY FOR DEVELOPMENT

Important planning and coordination steps have already been taken, but the overwhelming impression of this working group is that an explicit statement of a long-range, comprehensive, and integrated strategy for development of the telecommunications system and its supporting substructures is still not available to Indonesia. Such a strategy statement would be useful in the coming months as an input to REPELITA IV, but, unfortunately, several years are required to develop this statement, and work has not yet begun. A model currently being considered in Indonesia--the proposed strategy for development of Indonesia's engineering industries which may be under way with World Bank financing--may be useful, but this strategy too is not complete.

The task in telecommunications may be more complex than that in other sectors because of the competitive interests in this field scattered among a number of government ministries and agencies. Adding to this complexity are the apparent lack of a strong data base and perhaps the fact that the task of planning in this field is much more difficult than it is often judged to be. (Modern planning in telecommunications requires the availability of many computer programs which are often iterative, particularly for planning a telecommunications network under budget constraints with the inevitable complex trade-offs.) This area may offer a particularly good example of the need for foreign technical assistance from an entity that has both the expertise and the required technical tools.

In the working group's discussion of the strategic planning process, a number of areas were identified for special attention:

- Sources of foreign assistance. Here the criterion should not be expertise alone, but expertise with true independence.

- The composition of the planning group. The diversity of interests among ministries of the Indonesian government will present unusually sensitive problems.

- The role that the private sector might play in operations of the telecommunications system. It is suggested that the established policy of the Indonesian government requiring government ownership of telecommunications facilities be reexamined. Benefits might be found in carefully controlled foreign private sector participation in telecommunications systems operation in selected regions or in selected functions.

- The degree of integration of telecommunications planning with that in other sectors and development programs--for example, support of the government's transmigration policy through advance preparation of telecommunications infrastructure in the destination regions, substitution wherever possible of effective telecommunications for transport investment, support of expanded employment through the creation of strong maintenance and service industries (as well as labor-intensive manufacturing wherever appropriate).

- Emphasis on the role of education and training in building a competent domestic engineering base. This should include improving links between the Indonesian university system and the universe of telecommunications and electronics, as well as further exploitation of training opportunities within industry in Indonesia and abroad as a condition for the approval of private sector investment in this field.

- Measures to inhibit the internal and external "brain drain" from domestic industry and the universities--for example, salary adjustments, or the creation of autonomous institutions free of governmental salary constraints (approaches that have been successful in some cases in other economies).

- Exploitation of the potential for increasing the telecommunications capacity of existing facilities--for example, utilization of the single sideband, 32 Kb/s (32,000 per second) international standard, to develop PCM (pulse code modulation) capacity.

- Selective support of domestic equipment manufacturing--for example, expanding integrated circuit fabrication for both domestic and foreign markets in joint ventures as in Taiwan, Singapore, and Malaysia. Such support could achieve economy of scale and effective technology transfer, including the transfer of management technology. The world demand in this field will probably expand at 20 percent per year for a substantial period, and Indonesia is likely to have a comparative advantage in low-cost assembly labor for some time to come.

- Possible establishment of a system of standards to ensure quality control of manufactured products as well as to increase their domestic content.

- A review of the role of technical institutions in Indonesia in "filtering" fast-moving world technology into telecommunications and electronics (as opposed to performing R&D for its own sake).

In many of these areas, U.S. institutions and companies can and would like to contribute. They would be quite willing to do so under conditions that ensure Indonesian control of policy and the development of long-range national autonomy in these critical technological activities.

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LAND TRANSPORTATION INDUSTRIES

Rahardi Ramelan
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The Republic of Indonesia has more than 13,000 islands, of which 3,000 are populated. This geographic situation and the nation's 150 million people have created a need for several types of transport systems, including marine, air, and even land. Because transportation is vital to citizen participation in national development, strong land transportation industries are a priority of Indonesia's national development program. In Indonesia, land transportation industries can be classified as automobile, motorcycle, rolling stock, and railway. Each industry has its own particular role which is described briefly in this presentation.

AUTOMOTIVE INDUSTRY

Historical Background

Transport facilities--particularly automobiles--and sufficient infrastructures are very important in Indonesia for encouraging national growth and business mobility. In 1950, Indonesia's automotive business began to sell automobiles of different makes. In general, this industry has been and will be developed according to the following phases:

- 1950-1970, Speculative import oriented. During this phase, many sole agents sold their respective automobiles on a commercial basis.
- 1970-1974, Basic structure formation. Several companies started to transfer automobile technologies by performing a simple assembling process. The assembling capacity in 1970 was almost 4,500 units.
- 1974-1980, Industry formation. Since the very beginning, the automotive industry has been largely managed by the private sector. In 1974, the government began to get involved in the private sector by introducing a program of industrial development and control. A permanent interdepartmental committee was set up in 1978 to program and control the growth of the Indonesian automotive industry.
- 1980-1990, Infrastructure formation. Within this period, the automotive industry should be able to produce completely an Indonesian automobile built from domestically made components.

Current Status

Clearly, the Indonesian automotive business has grown with the cooperation of foreign industry, but this growth, especially that of the automotive component industry in 1978, was not as smooth as expected. This resulted from the many mistakes made with the types of automobiles produced domestically and a lack of regulations to oblige the sole agent or the principal to invest in component production.

Between 1979 and 1982, the government issued a number of integrated decrees on full manufacturing efforts, so that use of local components became compulsory. As the first step toward developing this industry, the government began with commercial vehicle production which, it was believed, would have a positive impact on national economic growth. This production is being increased in such a way that the ratio of commercial vehicles to passenger automobiles will be 8:1.

Decrees concerning use of local components and a "rationalization" program were also issued in 1979 and 1980, respectively. According to the decree of 1979, the cabin, rear body, chassis, frame, and fuel tank must be provided locally under the responsibility of the related sole agent/principal (Table 1). In recent years, the number of makes/types of automobile has been reduced from 57/140 to 30/72, as a result of forming the 24 assemblers and 23 sole agents into only 8 groups. Those government actions may have, in fact, increased automotive production to over 200,000 units in 1981 (Table 2).

To complete the local component program, government policy is being concentrated on the main automotive components. Six automotive manufacturers have been approved to fabricate engines: Mitsubishi, Isuzu, Toyota, Daihatsu, Mercedes Benz, and Hino (Table 3). Mitsubishi and Dana Corporation were also given approval to produce axles and propeller shafts locally. Brake systems may be produced by Akebono and Bendix; other components are still in the evaluation process. A schedule for the local manufacture of these main components was recently announced by the Department of Industry (Table 4).

Future Prospects

In completing its so-called value-added process, the Indonesian automotive industry, together with the government, wishes to enter a new phase of automotive technology transfer in which the automotive industry integrates technology from different sectors programmed by the government. Local design capabilities should be developed as well. In preparation for this phase, the government has established several relevant facilities and programs, including:

- A structure testing laboratory where the component or complete body structure can be tested on a full scale, statically and dynamically.
- An automobile testing center for examining automobile performance. One is in operation; a second will be ready in 1984.
- A national truck program to lead to the design of a commercial truck that uses existing components.

TABLE 1 Decree of the Minister of Industry, Republic of Indonesia, on Local Components (No. 168/M/SK/1979)

NO.	LOCAL MADE COMPONENT	COMMERCIAL VEHICLE: I 0.75 - 1 Ton			COMMERCIAL VEHICLE: II 2 - 2.5 Ton			COMMERCIAL VEHICLE: III 3.5 - 5 Ton			GENERAL PURPOSE VEHICLE			BASIC UTILITY VEHICLE			REMARK
	CATEGORY / YEAR	1980	1981		1980	1981		1980	1981		1980	1981		1980	1981		
1.	Tyre	■			■			■			■			■			Assembling of all Categories of Commercial Vehicles should have used no. 1 to 10 domestic / local made components in 1980
2.	Paints	■			■			■			■			■			
3.	Battery	■			■			■			■			■			
4.	Shock absorber	■			■			■			■			■			
5.	Leaf spring	■			■			■			■			■			
6.	Safety glass	■			■			■			■			■			
7.	Radiator	■			■			■			■			■			
8.	Muffler, Tail pipe	■			■			■			■			■			
9.	Plastic & rubber parts	■			■			■			■			■			
10.	Seat & frame	■			■			■			■			■			
11.	Wheel rim	■				■				■							
12.	Cabin	■				■			■			■		■			Sole Agent's responsibility
13.	Rear body	■				■			■			■		■			
14.	Fuel tank	■				■			■			■		■			
15.	Chassis frame	■				■			■			■		■			
16.	Ornament			■			■			■			■			■	Will be determined later
17.	Bus body			■			■			■			■			■	
18.	Oil & air filter			■			■			■			■			■	
19.	Spark plug			■			■			■			■			■	Will be determined later
20.	Engine			■			■			■			■			■	
21.	Transmission			■			■			■			■			■	
22.	Wheel drum			■			■			■			■			■	
23.	Brake & clutch lining			■			■			■			■			■	
24.	Axle			■			■			■			■			■	

TABLE 2 Vehicle Production and Market Summary, 1978-1982

Vehicle Production	1978	1979	1980	1981	1982
Commercial	84,167	75,268	134,801	160,311	133,653
General-purpose	9,127	9,023	17,568	24,980	25,234
Passenger car	15,373	14,264	22,413	27,383	29,664
TOTAL	108,667	98,555	174,782	212,674	188,551
Vehicle Market					
Commercial	79,703	79,489	134,089	157,745	133,634
General-purpose	8,115	9,528	16,425	24,246	25,050
Passenger car	15,469	13,975	24,842	25,813	30,096
TOTAL	103,287	102,992	172,356	207,804	188,780

Facilities alone are obviously not sufficient for successful development of the automotive industry. The correct industrial development must also be maintained. In this regard, programs to be given greater emphasis during REPELITA IV (1984-1989) are:

- Standardization and normalization of the components to be produced locally
- Reconstruction of fiscal regulation, credit, etc.
- Encouragement of software development and intensification of training programs
- Protection of locally produced components
- Balance of production capacities against demand
- Renewal of land transport operational systems
- Energy conservation programs.

Table 5 shows projected demand for various vehicles in Indonesia for 1985 and 1990, while Figure 1 depicts the correlation between investment, employment, and production for Indonesia's automotive industry.

MOTORCYCLE INDUSTRY

Indonesian motorcycle industries are currently manufacturing six different makes: Vespa (Italy), Bajaj (India), Honda (Japan), Yamaha (Japan), Suzuki (Japan), and Binter/Kawasaki (Japan). The present

TABLE 3 Automotive Engines to be Produced in Indonesia

Make	Type	Fuel	Engine Displacement (cm^3)	No. of Cylinders	Horse-power	Category Appli-cation
Toyota	4 K	Gasoline	1,290	4	60	V
	L	Diesel	2,188	4	66	I
	B	Diesel	2,977	4	80	II, IV
Daihatsu	CB	Gasoline	933	3	65	Sedan Class A (1,000 cm^3), I
	DG	Diesel	2,765	4	84	II
Mitsubishi	4G33	Gasoline	1,439	4	86	Sedan Class B (1,300 cm^3), I
	4G32	Gasoline	1,597	4	100	Sedan Class C (1,600 cm^3), II
	4D30	Diesel	3,298	4	90	II
	6D14	Diesel	6,557	4	160	III
Mercedes	OM 314	Diesel	3,784	4	85	II
	OM 352	Diesel	5,675	6	130	III
Isuzu	C 190	Diesel	1,951	4	85	I
	4 BC2	Diesel	3,268	4	100	II
	C 240	Diesel	2,369	4	65	IV
	6BDI	Diesel	5,785	6	160	III
Hino	KH 700	Diesel	6,443	6	165	III

TABLE 4 Projected Utilization Schedule for Components of Commercial Vehicles

Component	Schedule	Vehicle Category I	II	III	IV	V
Wheel rim	January 1, 1984	-	-	X	X	-
Cabin/chassis frame	January 1, 1984	-	-	X	X	-
Axle/propeller shaft	July 1, 1984	X	-	-	-	X
	January 1, 1985	-	X	X	X	-
Engine	January 1, 1985	X	X	X	X	X
Brake system	January 1, 1985	X	X	X	X	X
Transmission	January 1, 1986	X	X	X	X	X
Steering system	January 1, 1986	X	X	X	X	X
Clutch system	January 1, 1986	X	X	X	X	X

Note: Vehicle categories are as follows:

I = Commercial vehicle (0.75-1 ton)
II = Commercial vehicle (2-2.5 tons)
III = Commercial vehicle (3-5 tons)
IV = General-purpose vehicle
V = Basic utility vehicle

TABLE 5 Projected Demand by Vehicle Category, 1985 and 1990

Vehicle Category	1980	1985	1990
Passenger car	19,500	70,000	190,000
Pickup	42,000	70,000	120,000
Mini-pickup	13,500	20,000	24,000
General-purpose	15,000	30,000	40,000
Basic transporter	14,000	22,000	30,000
Minibus and combi	10,000	16,000	25,000
Delivery van	900	1,000	1,000
2-ton truck	11,000	20,000	40,000
3-ton truck	16,000	34,000	65,000
5-ton truck	1,600	4,000	10,000
Over 5-ton truck	4,000	3,000	15,000
Bus and bus chassis	2,500	5,000	5,000

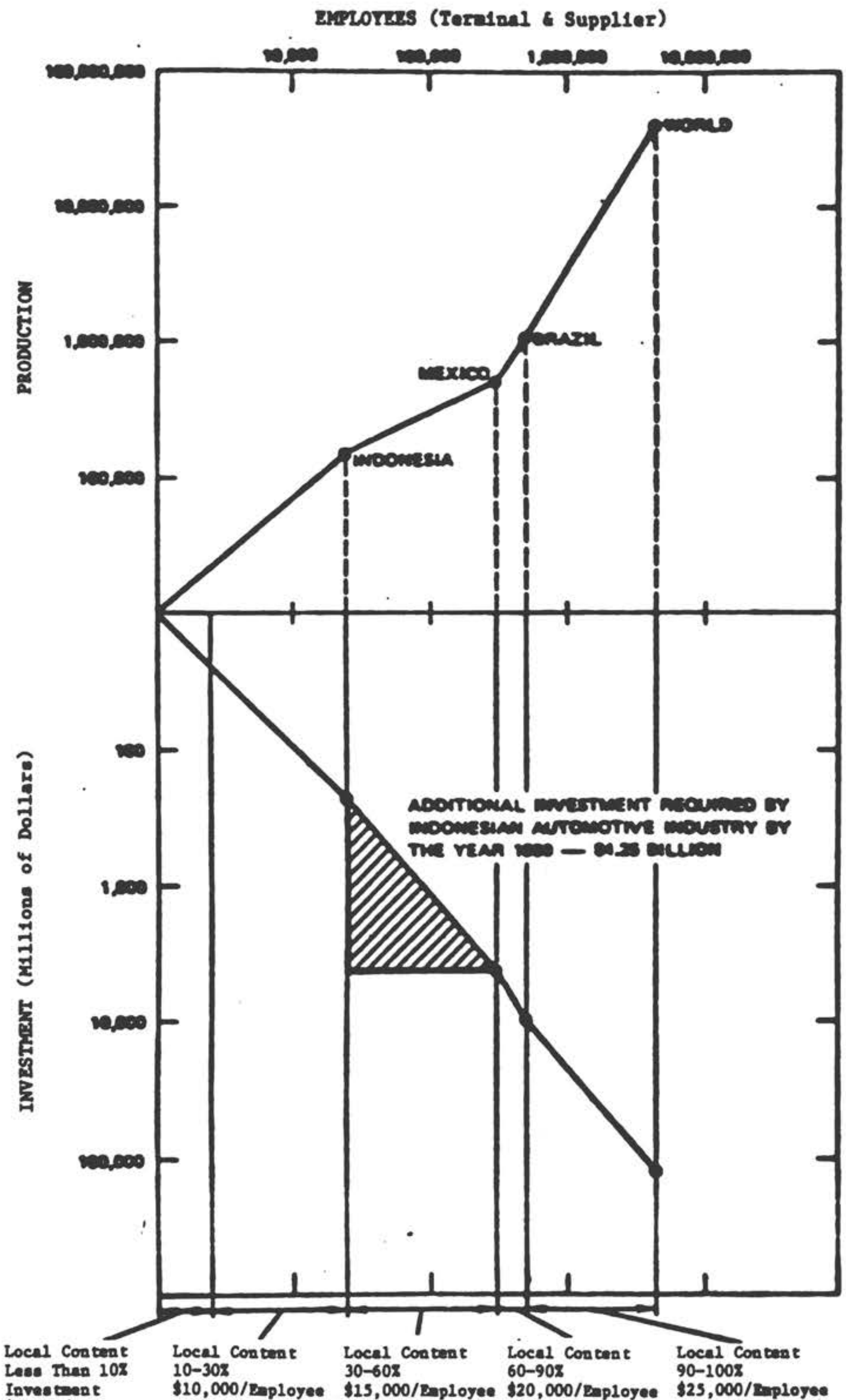

FIGURE 1 Correlation between investment, employment, and production for the Indonesian automotive industry.

TABLE 6 Two-Wheeled Vehicle/Engine Manufacturing Program

Make	Investor	Approval Status	Engine Production Installed Capacity Until 1989	Estimated Investment (US$)
Honda	PMA	SPS	480,000	130,000
Yamaha	PMA	SPS	360,000	100,000
Suzuki	PMA	SPS	240,000	90,000
Vespa	PMA	SPS	110,000	50,000
Binter/ Kawasaki	PMA	LI	175,000	110,000
TOTAL			1,365,000	480,000

SPS = Provisional letter of approval
PMA = Foreign capital investment
LI = Letter of intent

installed production capacity is about 750,000 units per year (see Table 6), and the real output per year has been: 1977, 250,106 units; 1978, 275,406 units; 1979, 221,572 units; 1980, 374,883 units; 1981, 503,522 units.

The motorcycle industry is almost in the same developmental phase as Indonesia's automotive industry. It started from the semi-knocked down (SKD) and completely knocked down (CKD) phases and has progressed to the complete manufacturing phase. A full manufacturing program was declared by the Department of Industry with its issuance of Regulation No. 8 in 1977 and Regulation No. 651 in 1981. Those regulations have had a substantial effect on local manufacture of motorcycle components. By the end of REPELITA III in 1984, local manufacture will have reached 72 percent, and during REPELITA IV it should reach 100 percent.

The number of motorcycles in operation in Indonesia has increased every year: 1979, 1,563,135; 1980, 2,677,799; 1981, 3,198,281; and 1982, 3,764,442. Because motorcycles are becoming more and more popular, a demand will exist for years to come, making the motorcycle industry one of Indonesia's most promising.

INDONESIAN RAILWAY AND ROLLING STOCK INDUSTRY

Indonesian Railways

The Indonesian railway was started under Dutch colonial rule and was operated by several private companies. After Indonesia's independence, these companies were gradually nationalized and merged into a single Indonesian State Railways (ISR).

Rail Track

Of the 13,000 Indonesian islands, rail track is only found in Java, Madura, and Sumatra, totaling 4,076 km of main line. Within the framework of Indonesia's 5-year development plans, the main line track has been rehabilitated since 1966, using 85 m of welded track. The average speed on the newly rehabilitated 1,628-km main line is 80-100 km/h. The main line in Java can withstand an 18-ton axle load, while the branch line can withstand 13 tons.

Signaling and Telecommunications System

Most stations along the main line have been equipped with electromechanical signaling systems from Siemens (Germany) and Halske (Sweden). Others are still using a mechanical signaling system. Modernization, using a N-X system, has been started in selected stations such as Bandung and Solo. Train dispatch via a radio-telephone system has also been introduced on several main lines.

Motive Power and Rolling Stock Fleet

In 1980, locomotives and railcars numbered: 125 diesel electrics, 280 diesel hydraulics, 277 steam-powered locomotives, 10 electric railcars, and 60 diesel railcars. There were also 1,936 passenger cars and 14,500 freight cars in 1980.

Maintenance Facilities

The overhaul, repair, and maintenance of locomotives and rolling stock are carried out in seven mechanical workshops in Java and Sumatra. A workshop in Bandung that manufactures steel bridges has the capacity to produce 1,000 tons of steel per year. With replacements of certain equipment, up to 2,000 tons per year can be produced. This workshop is also responsible for some maintenance and repair of the signaling and telecommunications systems.

Development Program

To fulfill the demand for railway transportation, an Accelerated Program REPELITA III has been launched. This program, designed to meet the forecasted demand of passengers and freight for ISR services, will rehabilitate or procure facilities and infrastructure (see Table 7).

The Indonesian State Railways, in fact, play a vital role in the transport of passengers and goods. For several national development projects, ISR has the crucial task of transporting raw materials, etc. Five examples of these projects follow.

TABLE 7 Rehabilitation and Procurement Program of ISR (REPELITA III)

Item	Unit
Locomotives	
New diesel locomotives	117
Locomotive engines (mid-life)	76
Workshop facilities	2 lots
Spare parts	
Locomotive	277
Passenger car	671
Freight car	1,000
Passenger cars	
New cars	317 + 65
Mid-life component	51
Freight cars	1,829 + 225
Infrastructure	
Rail, fastening	397 km
Crossing	149
Profile machines	83
Steel bridges	1,050 tons
Telecommunications	872
Cables	114 km
Diesel railcars	60 sets

1. The Jakarta Metropolitan Railway Project. This project results from the rapid urbanization and growth of the Indonesian capital, which currently has a population of more than 6 million. The Jabotabek System, a mass rail transit system, will be introduced into the area in the future.
2. The PN Leces and PT Pusri New Project in East Java. Through this project, ISR will play an important role in the transport of raw materials.
3. The South Sumatra Coal Project and the Baturaja Cement Plant. To meet the rising demand for coal transport, the ISR must take drastic steps in rehabilitating its track and rolling stock. This is also the case with the Baturaja cement factory for which the train serves as the chief mode of transport.
4. The Padang Cement Factory. Appropriate transport must be selected for this factory because of its rising production. The ISR will play an important role in the bulk supply of either raw materials or cement.

5. The North Sumatra Transportation Project. Because North Sumatra has many plantations, ISR must transport palm oil, tea, coffee, etc., to selected distribution points.

To guarantee the availability of dependable railway transportation in the future, ISR has prepared a long-term guideline entitled "PJKA/ISR in the Year 2000."

International Relations and Cooperation

International relations and cooperation are very important to the ISR. The attendance of ISR at international railway meetings such as the Pan America Railways Congress, the International Railway Congress, the meeting of the Economic and Social Commission for Asia and the Pacific (ESCAP), and the regional meeting of ASEAN (Association of South East Asian Nations) Railways is very useful for the development and modernization of the ISR.

In the ASEAN region, the ISR always arouses strong interest. ISR has opened discussions with members of the Technology Transfer Institute of Japan and Japan National Railways. Contact has also been made with Dutch Railways for cooperation in the field of management systems.

Indonesian Rolling Stock Industry

Historical Background

Of the ISR workshops in Java and Sumatra that support the railway service, one workshop, located in Madiun, was dedicated to the maintenance and repair of the steam locomotive. This completely equipped facility with a large number of employees was no longer needed as such when the steam locomotive operations were phased out. Meanwhile, ISR began to contemplate manufacturing its own freight and passenger cars. After a comprehensive study, the government decided to set up an Indonesian rolling stock industry and split off the Madiun workshop from ISR. On May 18, 1981, the Madiun workshop became PT INKA, the state-owned Indonesian rolling stock industry.

PT INKA at Present

Being a state-owned industry, PT INKA has a close relationship with ISR and must meet its needs. On the other hand, ISR must provide PT INKA with jobs. With such cooperation, the government believes that both organizations will benefit while creating job opportunities and saving foreign currency that will surely produce a positive impact on national development.

PT INKA began its activities by producing 250 palm oil cars and 150 coal cars. To complete this ISR order, PT INKA entered into a technical cooperation agreement with the Japanese producer, Nippon Sharyo, and with a number of Indonesian subcontractors such as tank builders and ISR workshops, where the last assembling step takes place. Car production in PT INKA followed the so-called Progressive Manufacturing Plan on a SKD, CKD, and CM (completely manufactured) basis. With this plan, the car/wagon manufacturing transfer was guaranteed.

PT INKA still, however, had to acquire skilled people who would be responsible for receiving the new technology. Today, this company has 824 employees, of which 9 are engineers. Besides skilled labor shortages, PT INKA often faces financial problems, and its working capital needs serious attention. Cooperation on a job order basis with ISR sometimes creates another difficulty, which could hamper the company's progress.

In this developing stage, PT INKA needs a partner to develop its software and hardware capabilities so that one day it can stand on its own power, supplying not only ISR as a single domestic buyer, but also playing an important role in the international market.

Future Prospects

As the sole Indonesian rolling stock industry, PT INKA actively participates in rolling stock production and technical services. The goals of PT INKA are as follows:

- To assemble and manufacture rolling stock products and their related components
- To provide major maintenance and overhauls
- To become active in the rolling stock component and service business, either in the domestic or international market
- To provide consulting and engineering services
- To be a professional rolling stock industry and act as a means of transfer for rolling stock technology
- To lessen Indonesia's dependency on foreign countries for its rolling stock industry.

To accomplish these goals, PT INKA has prepared strategies on technology transfer, quality control, human investment, and marketing, for example, which are very important in setting up short- and long-run programs:

- <u>1982-1983</u>. Production of 400 cars. Existing international technology will be introduced and applied in such a way as to profit from its value-added benefits.
- <u>1984-1989, REPELITA IV</u>. Production of 1,430 freight cars and 126 passenger cars by the end of 1985. The capacity for passenger car production will then be increased from 50 to 60 units per year. Engineering and software capabilities will be adjusted accordingly.

- <u>1989-1993, REPELITA V</u>. In this period, PT INKA will have an annual production capacity of 600 freight cars, 60 passenger cars, 10 sets of diesel railcars, and 5 sets of electric railcars. This capacity will be in accordance with the related software needed for design and technology development.

WORKING GROUP REPORT:
LAND TRANSPORTATION INDUSTRIES

Through the transfer of foreign technology, the Indonesian government is seeking to achieve a number of national objectives. Principal among these are the establishment of new jobs and the creation of new products, not only for Indonesia's large domestic market but also for export, joining its present exports of raw materials--principally crude petroleum, liquid natural gas, copper, nickel, aluminum, and forest products. In seeking these objectives, Indonesia aims to establish a manufacturing capability to produce goods under license from foreign producers and to develop a design and engineering capability. Ultimately, Indonesia seeks an indigenous research and development capability that draws on the graduates of its technical schools and universities.

Accordingly, foreign suppliers of science and technology face a number of government regulations designed to accomplish these broad national objectives when they seek to collaborate in this process. Nowhere is this more evident than in the land transportation industries. This working group explored such collaboration with various U.S. interests in two areas: the railroad rolling stock industry and the automotive industry.

RAILWAY ROLLING STOCK INDUSTRY

In the Indonesian government's "frame of reference" for industrial development, the railway rolling stock industry is considered strategic. Thus the government owns and operates the manufacturing plant (PT INKA), and it is not seeking foreign investment. Rather, it is seeking licenses to manufacture with interim technical assistance until it develops its own design and engineering capability. Agreements have been made with Japanese and Canadian interests. No U.S. firms are participating.

The railroad industry in the United States is in a state of revival, both economically and from the standpoint of technological advance. The trend is toward larger cars and car loadings and unit trains--long trains, heavily loaded, usually committed to a particular origin and destination on a fast turnaround. Unit trains carrying coal and grain provide efficient, high-volume, long-haul transportation at low cost. The boxcar is being replaced by trailer-on-flat-car (TOFC) and container-on-flat-car (COFC) services, transported increasingly in unit trains. This is the fastest growing traffic in the railroad industry today. While Indonesian car and axle loadings are lower than on most U.S. railways, some of the U.S. technology would perhaps be applicable to Indonesia.

Rail freight services in the United States are provided entirely by the private sector without government ownership. The management of these railroads has shown little interest in exporting their operating techniques. They limit their foreign activities (aside from Canada and Mexico where some operate) to sales offices that solicit U.S. domestic traffic for their railways.

Rail passenger service in the United States is provided: (1) to commuters in several of the larger cities, (2) long-haul between cities, and (3) in what are called "high-density corridors." Virtually all rail passenger service is subsidized by government--local, state, or federal, or a combination of the three. Some commuter services are owned and operated by local and state agencies. Regular intercity rail service is provided by AMTRAK, a semi-public corporation, heavily subsidized by federal funds.

The federal government has made a major investment of $2 billion to upgrade rail service in the northeast corridor between Washington, D.C. and Boston, Massachusetts, via Philadelphia, Pennsylvania, and New York City. The program is administered by the Federal Railroad Administration (FRA), within the U.S. Department of Transportation. The latest and most modern welded steel track-laying equipment is being used, and more than 1.1 million concrete ties have been put down. Passenger train speeds exceed 200 km/h.

FRA has a simulator of rail train operations which could be of use to the Indonesian government in planning railroad operations and in developing the new rail lines that are planned. In addition, the Association of American Railroads (AAR) operates a full-scale materials test facility at Pueblo, Arizona, which could be used by the Indonesian government to test components, both U.S. and other, for the Indonesian rolling stock industry (PT INKA) at Madiun. The Indonesian government has indicated that they are seeking a new car braking system, among other components. As a first step, the Railway Progress Institute--the trade association for suppliers to the railroad industry--could check with its members to determine their interest in participating in such a program.

AUTOMOTIVE INDUSTRY

In earlier 5-year development plans (REPELITAs), the Indonesian government has sought to develop a domestic automobile manufacturing industry to produce "commercial vehicles" (0.75-ton to 5-ton pickup trucks). This has been carried out with a minimum of government investment by licensing a relatively large number of assemblers and foreign manufacturers in Indonesia, subject to regulations that require that local content, component by component, be increased year by year.

These activities have recently been organized into eight groups to provide better management and control.

The goal of this endeavor is to establish an annual production rate of 200,000 locally manufactured vehicles by 1985, and 550,000 by 1990. The program is heavily oriented toward diesel engines, and the vehicles produced are readily converted locally into minibuses to provide transportation in rural areas. No attempt has yet been made to manufacture passenger automobiles or vehicles of the highest technology in Indonesia.

General Motors (GM) has participated in this program with the manufacture of diesel engines through its Japanese affiliate, Isuzu, one of six manufacturers licensed to assemble the diesel engine component. For the past 18 months, GM has studied the feasibility of providing the steering system components, to be manufactured by an Indonesian affiliate of their company, using U.S. technology. In addition to all the problems one might expect in upgrading the technology of Indonesian firms participating as local suppliers as required by regulation, GM, or any U.S. firm planning to participate in the market, must manufacture components to Japanese specifications as Japanese models dominate the Indonesian automobile industry at the present time.

The Indonesian government is also seeking firms for license to produce the clutches, braking systems, and transmissions for their commercial vehicle manufacturing industry. Foreign firms have been attracted to this program because of the large potential domestic market, long-term opportunities for export, and the availability of a stable, low-cost labor force. Further collaboration by U.S. firms will require that additional U.S. component manufacturers be identified and made aware of opportunities for technical agreements or manufacturing in Indonesia. An appropriate organization for this is the Motor Vehicle Manufacturers Association, with its headquarters in Washington, D.C.

CONTACTS

Institutions that may be able to provide appropriate information or contacts include:

Association of American Railroads
1920 L Street, N.W.
Washington, D.C. 20036
Telephone: 202/835-9100
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Federal Railroad Administration
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Motor Vehicle Manufacturers Association
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ENERGY INDUSTRIES

DEVELOPMENT OF ENERGY INDUSTRIES

Achmad Az
Deputy for Development and Promotion,
Indonesian Investment Board

INTRODUCTION

The industrial transformation of a technologically underdeveloped country into a technologically advanced society involves the transfer, application, and development of science and technology. This in turn requires adhering to five principles:

1. A program must be implemented that provides education and training in various disciplines and technologies needed by a country, either in the country itself or by sending people abroad.
2. A clear and realistic concept must be developed and later implemented in a consistent manner.
3. It must be shown that the transfer, application, and development of science and technology can solve in a satisfactory manner actual problems faced by the country.
4. Development of a technologically advanced nation must be based on a firm resolve to try to solve one's own problems through one's own efforts, since no country should ever become a net importer of technology.
5. A technologically underdeveloped country must protect its national capabilities in science and technology until such time that it can compete internationally.

The industrial transformation that is the aim of these principles should be carried out in four stages of implementation as follows.

In the first stage, available technologies that add value to goods available in the market are used in production activities (the so-called added-value stage). Since this added-value process utilizes available technologies and no increase in technological levels occurs with increasing investments, a short-cut for this stage would be the transfer of technology through the licensing route. Activities connected with this stage will enhance the development of more advanced techniques and production methods, production skills, organizational skills, and production management skills. In addition, work discipline, application of quality standards, and work standards should also increase.

In the second stage, utilization of existing technologies is combined with the design and production of completely new products, thus injecting a creative element. The resulting development of design skills and skills in integrating components into a new system will in turn enhance the capabilities of choosing an optimal new component design for a particular new product.

In the third stage, the particular technology or technologies themselves are developed in anticipation of designing and producing products in the near future. Thus innovations are incorporated.

The fourth stage involves large-scale basic research and development activities to develop the science and technology required to transform a developing nation's technological base and its industries. For this very fundamental stage, investments should be sought from developed countries, but the results of the basic R&D activities should be made available to the developing countries through cooperation in the respective science and technology disciplines.

The transfer and development of technology can only be achieved through a well-prepared, properly directed program that will trigger and expedite the transformation process of technology and industry.* Arguments for selecting energy industries as one vehicle for Indonesia's industrial transformation include such supporting factors as:

- Indonesia's coal, oil, natural gas, geothermal, hydro, and nuclear power resources are estimated to be substantial.
- Indonesia's still relatively low energy consumption ensures that its potential for increase is large in connection with increased technological and industrial capabilities.
- Indonesia's population, currently estimated at 154 million and estimated to increase to 200 million by the year 2000, provides a large number of recipients for technological and industrial products.
- Indonesia's relatively large energy resources offer vast potential for developing energy industries and technologies. Their development will mean technological and industrial benefits for other sectors such as the agriculture/estate sector, the metal and machine industry sector, and the transportation sector.

Energy industries include all activities concerned with the development of energy resources--exploration, exploitation, processing, electric power generation, transport of energy materials and electric

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*This thinking was put forward by Professor B. J. Habibie in an address delivered to the Deutsche Gesellschaft für Luft- und Raumfahrt meeting in Bonn, June 11, 1983 (see Appendix E). In his address, Professor Habibie stated that the industrial transformation of Indonesia would be undertaken through the following industries: automotive, rolling stock, aircraft, manufacturing, maritime and shipyard, energy, electronics and telecommunications, plant machine and equipment, agricultural equipment, and defense.

power to their final consumers, and all the machine and equipment manufacturing industries that support it, including its design and engineering.

In applying science and technology to Indonesia's real problems, the same obstacles experienced by other developing countries will be faced, namely, inadequate capital to sustain energy development activities; development of supporting manufacturing industries and design and engineering services; application of appropriate technologies; and expertise and skill development.

NATIONAL POLICY IN THE ENERGY AND MACHINE SECTORS

Energy Sector

The People's Consultative Assembly Decree No. II/MPR/1983, or the Guideline for State Policy, stipulates that the general pattern of the fourth 5-year plan with regard to energy will be as follows:

- Development and utilization of energy will be based on a coordinated, integrated policy that takes into account growth of demand, for exports as well as domestic consumption, and the long-term strategic ability to supply energy.
- Oil is the main source of supply for domestic energy requirements. Because the demand for this limited resource will continue to increase, energy conservation measures for oil will be continued and even enhanced, while development and utilization of other energy sources such as coal, hydropower, wind, nuclear, solar, and biomass will be encouraged.
- Other policies supporting the energy policy will continue to be geared toward attaining the greatest possible results with existing capabilities, by means of hiring experts, conducting research and development, and applying technology.
- Electric power development will be geared toward increasing the welfare of urban as well as rural communities and encouraging economic activities. For that purpose, the availability, utilization, and management of electric power should be increased so that it is available in sufficient quantity, with adequate service, and at a price affordable to the community at large.
- Rural electrification will be increased to stimulate rural social and economic activities. Thus locally available energy sources such as micro-hydro, wind, and biogas should be developed within the context of oil savings and simultaneously decreased environmental damage.

THE POTENTIAL ENERGY RESOURCES OF INDONESIA

<u>Coal</u> Coal deposits that could be commercially processed are estimated at 10 billion tons, and these are mostly found in South Sumatra. Only

about 300 million tons have been mined to date, making almost no dent in the available deposits. Because PN Batubara is the sole company currently mining coal, expansion is possible while reserves are still abundant. If the added demand for coal was 15 million tons annually, about 60 years would be required to process all the reserves.

Oil Based on the latest investigations, oil reserves in Indonesia are estimated to be about 50 billion barrels. Oil exploration began in 1885, but production to date has only been about 10 billion barrels. If the current production rates of about 1.5 million barrels per day are maintained, sufficient reserves will be available for exploitation well into the future.

Natural Gas Gas reserves are estimated to be around 34 trillion cubic feet, while current production capacities amount to 1.13×10^{12} standard cubic feet (SCF), providing ample quantities for a long time to come.

Hydropower Indonesia's total hydropower potential is estimated at 31,000 MW of electric power spread over all of Indonesia. As of 1977, about 450 MW had been utilized, and another estimated 1,100 MW are expected to come on line in 1984. Exploitation of hydropower is undertaken by the state-owned electric company PLN, the Ministry of Public Works, and the Ministry of Mines and Energy.

Geothermal The geothermal power potential of Indonesia is estimated at 1,510 MW. This figure includes 9 main thermal regions that could produce about 1,450 MW and 10 regions, each of which could provide about 5 MW.

The application of geothermal resources for power generation and its direct utilization in industry have not been fully researched. The Vulcanology Bureau of the Ministry of Mines and Energy has undertaken several studies on the potential, development, and possible application of geothermal power.

Uranium Uranium deposits have been reported in Sumatra, Kalimantan, Irian Jaya, and Maluku Island. Past and present surveys indicate various possibilities for exploiting these energy resources. The government agency authorized to deal with nuclear energy is BATAN, assisted by the three atomic reactor centers in Jakarta, Bandung, and Yogyakarta.

Solar Energy Because the sun shines 360 days a year in Indonesia, eight institutes in this country are involved in solar energy research.

Wood Wood as a source of energy should not be underestimated, since about 80 percent of Indonesia's population lives in 57,000 villages, of which only 15 percent receive electricity. Wood and charcoal are still the main sources of energy for rural communities. Forests cover an estimated 120 million ha in Indonesia, of which 40 million ha are production forests and 24 million ha could be permanently exploited. In addition, 6.71 million ha of estates could possibly provide local communities with wood and charcoal as sideline production activities.

THE CURRENT ENERGY SITUATION

Oil currently fulfills 78.5 percent of all commercial energy requirements, while the remaining 21.5 percent is divided among coal (0.4 percent), LPG (18.7 percent), and hydropower (2.4 percent).

Indonesia's energy consumption pattern for 1981-1982 is shown in Table 1. The household, transportation, and industrial sectors are the so-called end users of energy, while the electric power sector converts energy material into electric power. Since the latter sector has a far-reaching impact on industrialization and the application of science and technology, this sector will be discussed in more detail.

Consumption of generated power in Indonesia is low compared to that of its neighboring ASEAN (Association of South East Asian Nations) countries (Table 2), and even more so when compared to that of developed countries (Table 3). In 1979, for example, electric power consumption for Indonesia was only 74.5 kWh per capita compared to 693 kWh per capita for Malaysia and 3,394 kWh per capita for Singapore.

Electric power production in Indonesia is undertaken partly by the state-owned PLN and partly by the private sector for its own use. Installed power in Indonesia, both PLN and non-PLN, amounts to 3.18 million kW and 2.74 million kVA, respectively. This does not, however, include electric power centers owned by PT Krakatau Steel, INCO, and ASAHAN (see Table 4).

Although Indonesia's electric power consumption is still very low, its supply of electric power has grown rapidly. It has not, however, caught up with demand. This is evident from the relatively large number of autogeneration (private) facilities in existence. Table 5 shows the growth of installed capacity for PLN production and autogeneration for the period 1973-1974 up to and including 1981-1982.

ENERGY REQUIREMENTS IN THE FUTURE

A long-range planning study of PLN's power-generating system indicates that in the year 2003-2004 it will consume 2.05 billion BOE (barrels of oil equivalent) consisting of oil, 17 percent; coal, 38 percent; geothermal, 4 percent; hydro, 11 percent; and nuclear, 30 percent. Compared to PLN's energy consumption in 1981-1982 when 19 percent was obtained from hydropower and 81 percent from oil, a shift will occur in the use of other energy sources, which is in line with PLN's diversification policy.

TABLE 1 Indonesia's Energy Consumption Pattern According to Energy Source and Sector, 1981-1982

Sector	Unit	Oil	Coal	LPG	Hydro-power	Geo-thermal	Total
Household	10^6 BOE	52.6	--	0.4	--	--	53.0
	%	26.4	--	0.2	--	--	26.6
Transpor-tation	10^6 BOE	52.5	0.1	--	--	--	52.6
	%	26.3	0.1	--	--	--	26.4
Electric Power	10^6 BOE	14.9	--	--	2.1	4.8	21.8
	%	7.5	--	1.1	1.4	--	11.0
Industry	10^6 BOE	36.4	0.7	34.7	--	--	71.8
	%	18.3	0.3	17.4	--	--	36.8
TOTAL	10^6 BOE	156.4	0.8	37.2	4.8	--	199.2
	%	78.5	0.4	18.7	2.4	--	100.0

BOE = barrels of oil equivalent.

SOURCE: World Bank. 1980, 1981. World Development Report. World Bank, Washington, D.C, USA.

TABLE 2 Per Capita Electric Power Consumption of ASEAN Countries

	1977		1978		1979	
Country	kWh/ Capita	GNP/Capita (US$)	kWh/ Capita	GNP/Capita (US$)	kWh/ Capita	GNP/Capita (US$)
Indonesia	61.8[a]	300	68.6	360	74.5	370
	25.6[b]		30.4		37.1	
Thailand	205.1	430	250.9	490	313.0	590
Malaysia	500.2	930	551.6	1,090	693.0	1,370
Singapore	1,952.4	2,880	2,212.2	3,290	3,394.0	3,830
Philippines	300.2	450	310.8	510	364.0	600

[a]PLN = other.
[b]PLN only.

SOURCES: Electric Power in Asia and the Pacific, 1977, 1978; United Nations. 1980. U.N. Statistical Year Book 1979/1980. United Nations, New York, New York, USA.

TABLE 3 Commercial Energy Consumption of Selected Developing and Developed Countries (Kilograms of Coal Equivalent per Capita)

	Year	
Country	1978	1979
El Salvador	256	351
Indonesia	278	237
Thailand	327	376
Philippines	339	356
Egypt	463	565
Iraq	633	992
Colombia	700	938
Malaysia	716	767
Singapore	2,461	6,211
Japan	3,825	4,260
France	4,368	4,995
USSR	5,500	6,122
Federal Republic of Germany	6,015	6,627
Kuwait	6,771	6,348
United States	11,374	12,350

TABLE 4 Installed Capacity, PLN and Non-PLN, 1981-1982

Region		PLN (kW)	Non-PLN (kVA)[a]
I.	Aceh Special Region	27,642	203,243.90
II.	North Sumatra	176,904	131,377.30
III.	West Sumatra	68,067	324,097.35
IV.	South Sumatra	122,912	204,551.70
V.	West Kalimantan	25,603	45,334.65
VI.	Central, South, East Kalimantan	107,822	117,594.55
VII.	North Central Sulawesi	61,075	21,799.50
VIII.	South and South East Sulawesi	81,876	93,352.00
IX.	Maluku	12,572	9,725.15
X.	Irian Jaya	22,882	11,848.05
XI.	East Tunas	66,780	22,802.40
	East Java Distribution	652,428	433,267.10
	Central Java Distribution	241,532	298,223.90
	West Java and DKI[b] Distribution	1,364,387	831,733.85
	SUBTOTAL	3,032,492	2,748,991.40
	Jatiluhur[c]	150,000	
	TOTAL	3,182,492	2,748,991.40

[a]Does not include the electric power centers owned by INCO, ASAHAN, and PT Krakatau Steel.
[b]Daerah Khusus Ibukota (National Capital District).
[c]Hydropower plant.

TABLE 5 Growth of Installed Capacity for PLN Production and Autogeneration, 1973-1974 to 1981-1982

Year	Installed Power: PLN (MW)	Installed Power: Autogeneration (MVA)[a]	GWh Production: PLN[b]	GWh Production: Autogeneration
1973-1974	776	1,252	2,932	2,504
1974-1975	921	1,626	3,345	3,252
1975-1976	1,129	1,921	3,770	3,842
1976-1977	1,376	2,130	4,127	4,260
1977-1978	1,863	2,245	4,740	4,490
1978-1979	2,288	2,396	5,723	4,792
1979-1980	2,536	2,525	7,004	5,050
1980-1981	2,554	2,516	8,420	5,032
1981-1982	3,032	2,703	10,137	5,406

[a]Estimated figures are based on a power factor of 0.80.
[b]Estimated figures are based on an assumption of 2,500 working hours per year.

Oil In 1989, toward the end of the fourth 5-year development plan, oil will remain the principal energy source for PLN's steam, gas, or diesel power plants. Large-scale construction of oil-fueled power plants has been undertaken in the past to meet the increased demand for electric power that has occurred since the first 5-year development plan.

Natural Gas Estimates of Indonesia's natural gas reserves have been set at 139.45 tons of coal equivalent (TCE) by the Directorate General of Oil and Gas, Ministry of Mines and Energy. This vast natural gas potential could well become an alternative source of energy for existing steam and gas power plants as well as those that must be built in the future to produce the estimated 3,332 MW needed by the year 2003 to sustain peak loads.

In 1987, a steam power plant, equipped with a dual-firing system and an installed capacity of 260 MW and exploitation of 5,000 hours annually, will consume 35-40 million standard cubic feet per day (SCFD) of natural gas, or about 2,500 barrels of oil per day. By the year 2003, a gas power plant of 3,332-MW capacity and exploitation of 1,000 hours annually (on an average basis) will require 130 million SCFD of natural gas.

The pricing policy for natural gas will determine, however, its competitiveness against other energy sources. With the currently agreed price of US$3 per thousand SCFD for Java, coupled with an adequate supply mechanism, natural gas is expected to play a relatively large role in efforts to diversify fuel supplies for electric power generation in Java.

Hydropower According to a study undertaken by PLN, the theoretical hydropower potential of Indonesia is 77,863 MW spread over the whole of Indonesia, with the following major breakdowns: Sumatra, 15,803 MW; Java, 4,422 MW; Kalimantan, 23,053 MW; Sulawesi, 11,396 MW; Irian Jaya, 22,157 MW; Bali/Nusa Tenggara, 620 MW; and Maluku, 412 MW. As of April 1982, installed capacity of existing hydropower plants was 548.23 MW, including the Jatiluhur hydropower plant. Non-PLN hydropower plants are owned by ASAHAN, 603 MW, and Larona, 165 MW.

Fully realizing the potentials of hydropower as an energy source, the PLN's long-range planning study envisions that hydropower plants built by the year 2003-2004 will have a capacity of 5,738 MW, leaving an attractive reserve of about 72,000 MW. Upon completion of a more detailed study of Indonesia's hydropower potential, it is likely that this energy resource will be utilized increasingly in the future and will partially replace coal and nuclear energy as a source for energy-generating systems in Indonesia.

Geothermal Power The PLN's development of geothermal power is in line with the Indonesian government's policy of giving priority to the development of nonexportable renewable energy resources. According to the PLN's long-range plans, the installed capacity of geothermal power plants will be increased from only 30 MW at the end of the third 5-year plan to about 1,405 MW.

Coal Upon completion of the Surabaya Unit I and II steam power plants in 1985, each of which produce 400 MW, PLN's electric power generation system will diversify into non-oil resources, especially in Java. It is envisioned that coal-fired steam power plants with an installed capacity of 18,295 MW will be developed by the year 2003. The demand for coal is estimated to be 2.2 million tons in 1985, increasing to 55 million tons in 2003. These demands will, it is hoped, be supplied from South Sumatra and, at a later time, East Kalimantan.

To optimize coal mining operations, it is desirable to know the minimum production level required so that a relatively inexpensive price of coal per unit weight can be achieved. Capabilities in providing coal and its price level will determine how extensively coal-fired steam power plants must be developed to fulfill Java's demand for electricity.

Nuclear Power In 1996, Java's peak load is estimated to be 15,000 MW, and it is likely that this demand will be met by various power plants such as hydropower. After 1997, utilization of nuclear energy could well become attractive. The large-scale economies of a 1,000-MW nuclear power station, which is relatively capital intensive but uses relatively cheap fuel, will become viable.

Coal use in Java will create side effects and problems such as pollution, transportation, and coal mining capacity if it must be used to meet a demand of about 55 million tons annually. Yet premature construction of nuclear power stations will use funds that could be earmarked for construction of geothermal and coal-fired steam power plants. Early application of nuclear power would also decrease the market for coal, which, in turn, would increase its price because of low-volume production, thereby stunting the coal industry's growth. Finally, because careful preparation, substantial financing, suitable technology, experts, and the uranium itself are required to establish nuclear power stations, premature construction would increase Indonesia's dependency upon outside financing, technology, and experts.

In view of these potential problems, an optimization study should be undertaken before decisions are made about nuclear power to determine whether power stations such as hydro, coal-fired, and geothermal can compete with nuclear power stations. This is in line with PLN's system of annually reviewing its long-range planning, given the long construction period and vast amount of financing involved. National capabilities such as economic resources, absorption and participation of domestic industries, and availability of trained manpower for the construction of nuclear power stations should also be taken into account.

As the technologies and procedures for constructing nuclear power stations become more established, the apprehension about and opposition to nuclear power stations should diminish.

Demand for Electric Power

The demand for electric power for the coming 20-year period is estimated at 50,000 MW. A long-range plan for installed electric power generation up to year 2000 has been established and is shown in Table 6. The demand for fuels, by type, from 1984 to 1987 is shown in Table 7. According to this table, oil is still the dominant fuel for electric power generation, followed by hydro, coal, and geothermal sources.

The types of machinery and technology needed to sustain this program can be forecasted. Table 8 shows for 1984-1989 the projected demand for various kinds of distribution and transmission equipment, and the rural electrification program that must also be prepared. The demand for transmission cables will not be less than 10,000 km and that for main transformer stations less than 10,000 units, for example.

DOMESTIC MACHINE MANUFACTURING INDUSTRIES TO SUPPORT THE ENERGY INDUSTRY SECTOR

Various domestic industries have been recruited to support the development of all phases of the energy industries, from energy application

TABLE 6 Long-Range Estimates of the Installed Capacity of PLN Power-Generating Plants

Kind of Power Plant Unit		Last Year of 5-Year Development Plan: I, 1973-1974	II, 1978-1979	III 1983-1984	IV 1988-1989	V 1993-1994	VI 1998-1999	VII 2003-2004
Hydropower	MW	279.0	351.0	471.0	2,693.0	4,458.0	5,338.0	5,733.0
	%	35.1	15.3	10.1	24.6	21.4	15.5	11.1
Diesel	MW	230.0	499.0	1,465.0	2,327.0	2,756.0	3,069.0	3,320.0
	%	28.9	21.8	31.5	21.2	13.2	9.0	6.4
Gas	MW	62.0	882.0	1,132.0	1,132.0	1,432.0	2,532.0	2,532.0
	%	7.8	38.5	24.3	10.3	6.9	7.4	7.4
Nuclear	MW	—	—	—	—	—	4,000.0	15,000.0
	%	—	—	—	—	—	11.6	2.9
Thermal	MW	—	—	30.0	390.0	1,405.0	1,490.0	1,490.0
	%	—	—	0.6	3.6	6.7	4.3	2.9
Oil-fired steam	MW	225.0	556.0	1,556.0	2,441.0	2,916.0	3,916.0	4,516.0
	%	28.5	24.4	33.5	22.2	14.0	11.4	8.7
Coal-fired steam	MW	—	—	—	1,980.0	7,895.0	14,095.0	18,292.0
	%	—	—	—	18.1	37.8	40.8	35.5
TOTAL	MW	796.0	2,288.0	4,654.0	10,963.0	20,862.0	34,440.0	51,691.0
	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 7 Breakdown of PLN Fuel Requirements According to Energy Type, 1984-1987

Type of Energy Source	1984-1985		1985-1986		1986-1987	
	10^6 kWh	10^6 BOE	10^6 kWh	10^6 BOE	10^6 kWh	10^6 BOE
Coal	--	--	3,971	7,082	5,946	10,524
Hydro	2,709	5,406	4,453	8,832	5,707	11,389
Thermal	171	341	171	341	171	341
Subtotal non-oil	2,880	5,747	8,595	16,255	11,824	22,254
Oil	14,842	26,269	13,345	13,619	14,224	25,175
TOTAL	17,722	32,016	21,940	29,874	26,048	47,429

BOE = barrels of oil equivalent.

and consumption to domestic capabilities for support of exploration activities, exploitation, further processing, and transportation of ready-for-use energy materials.

Some existing machine manufacturing industries that currently support the application of energy include:

- Electrical household appliances: current annual production, 1.9 million units; estimated production in 1989, 2.3 million units.
- Power transformers: current annual installed capacity, 20 units; estimated installed capacity in 1989, 170 units.
- Distribution transformers: current annual installed capacity, 20 units; estimated installed capacity in 1989, 15,000 units.
- Medium- and low-voltage panels: current annual installed capacity, 30,000 units; estimated installed capacity in 1989, 50,000 units.
- Kilowatt-hour meters: current annual installed capacity, 800,000 units; estimated installed capacity in 1989, 1.4 million units.
- Electric motors and welding generators: current annual installed capacity, 15,000 units.
- Electric power-generating equipment: annual installed capacity of generators up to and including 15 KVA, 60,000 units; estimated installed capacity in 1989, 100,000 units. In addition, a generator manufacturing industry capable of producing up to 1,000-KVA units with an installed capacity of 875 units annually is expected to come on-stream in 1984, the beginning of the fourth 5-year development plan.

TABLE 8 Construction Plan for Electrical Projects by PLN During the Fourth 5-Year Development Plan

Description	Unit	1984-1985	1985-1986	1986-1987	1987-1988	1988-1989	Total
Construction of electric power stations:							
Hydro	MW	68.0	700.0	217.0	246.0	935.0	2,166.0
Diesel	MW	110.3	82.0	143.3	82.0	200.5	618.1
Geothermal	MW	--	--	110.0	--	250.0	360.0
Steam (coal)	MW	--	800.0	230.0	400.0	550.0	1,980.0
Steam (oil)	MW	130.0	300.0	330.0	--	125.0	885.0
TOTAL	MW	308.3	1,882.0	1,030.3	728.0	2,060.5	6,009.1
Construction of transmission and main transformer station:							
Transmission	km	3,107	1,730	1,910	1,132	2,634	10,513
Main transformer station	pc/MVA	134/5,050	36/810	46/1,941	29/592	70/1,866	315/10,259
Distribution:							
Medium-voltage network	km	4,476	6,451	6,049	6,827	7,647	31,450
Low-voltage network	km	8,952	12,901	12,097	13,654	15,295	62,899
Distribution station	MVA	689	992	931	1,050	1,177	4,839
Total connections		688,646	992,402	930,548	1,050,295	1,176,506	4,838,397
Rural electrification:							
Diesel	MW	--	42	50	56	62	244
Oil	MW	200	13	1	11,934	28,050	55,764
Medium-voltage network	km	9,121		10,876	11,811	12,603	54,381
Low-voltage network	km	6,000	6,600	7,200	7,800	8,400	36,000
Transformer/distribution station	MVA	169	225	281	326	371	1,372
Total connections		320,000	420,000	510,000	590,000	660,000	2,500,000
Total electrification	village	2,000	2,200	2,400	2,600	2,800	12,000

Two diesel engine manufacturing industries in Indonesia are producing engines in the 30-500 horsepower (HP) range, both licensed from West Germany. Another industry, licensed from Japan with the Kubota, Yanmar, and Mitsubishi brands, is producing engines with a power range of up to 35 HP.

The cable manufacturing industries are capable of producing medium- and low-voltage cables, including watertight cables, ground cables, and automotive cables. Likewise, the land and sea transportation manufacturing industries are capable of producing tankers and energy material transport vehicles (rail, trucks, or ships).

Three pressure vessel and heat exchange equipment factories could, with offshore licenses, produce pressure vessels that have a capacity of up to 100 tons of steam per hour. A government-owned heat exchanger equipment business recently obtained a license from Combustion Engineering to produce such equipment with an annual capacity of 5,000 tons.

The existing specially welded pipe and spiral-welded pipe manufacturing industries can produce pipes in accordance with API (American Petroleum Institute) technical standards and can thus support transmission of energy materials.

Domestic manufacturing capabilities to support energy exploration and exploitation are still scarce, especially those for manufacturing equipment. General and platform construction works could, however, be undertaken. The few existing domestic capabilities that can support exploration and exploitation include seismic data processing, seismic data acquisition, geological interpretation, mud drilling, wireline logging and reservoir engineering, and other repair and maintenance services. General design and engineering services have been established that cater to the energy industries as well as other manufacturing industries.

PROBLEMS IMPEDING THE APPLICATION OF SCIENCE AND TECHNOLOGY

Several problems are impeding the application of science and technology to energy industries in Indonesia:

- Scarce capital for developing energy resources, thus preventing realization of available potential
- Scarce capital for developing the machine manufacturing industries needed to support the energy industries
- Lack of design and engineering capabilities, which in turn results in an incapacity to design new components and equipment for the machine manufacturing and energy industries.

All of these factors necessitate the importation of technology and skills from offshore sources, which in turn involves a large outlay for developing energy industries. These skills pertain to operation of equipment as well as production management. The search for potential energy resources also involves the acquisition of adequate equipment for surveying purposes, for example. In addition, an infrastructure must be further developed to facilitate the arrival of all production equipment at the site in a timely fashion.

CHOOSING AND APPLYING TECHNOLOGIES

Achieving the dual objective of developing energy resources for domestic consumption as well as export, and developing the supporting machine manufacturing industries, requires the careful selection, transfer, and application of science and technology and the utilization of domestically available software and production facilities.

The application of science and technology to the energy sector can be divided into two parts. The first, more specific in nature, entails applying science and technology in a particular sector such as developing energy resources, exploration, exploitation, mining and utilization of existing energy resources, energy transportation, and process design and engineering. The second, more general in nature, is science and technology based upon mechanics, statics, dynamics, and kinematics.

This presentation focuses only on the first part and on all the steps required to convert energy material into ready-for-use energy: exploration, exploitation, and further processing. For these steps, the relevant science and technology must be applied to, for example, determining data on existing resources and available reserves, exploration techniques, exploitation/mining, transportation, and further processing to obtain ready-for-use energy.

The exploration up to the further processing stages require high-pressure and high-temperature technologies, heat transfer, a transportation system, and a valve and purification system. The conversion of energy material into ready-for-use energy involves construction and manufacturing process technologies, as well as boilers, steam turbines, water turbines, gas turbines, diesel engines, and generators. Finally, distribution and use of the ready-to-use energy involve technologies pertaining to construction, the manufacturing process, distribution systems, and transmission with all its inherent technical specifications. Transmission technology is closely related to heat transfer technology, as well as pressure and temperature. In the context of energy conservation, this technology prevents heat losses along the transmission path as much as possible.

The choice and application of a technology should meet certain conditions:

- The technology in question should solve a real problem and enhance the welfare of the people.
- The technology should preserve the environment.
- The technology should utilize existing and potential human as well as industrial resources.
- The technology eventually should be economically feasible and profitable for someone to introduce it.

Forms of Transfer of Technology

Technology transfer to accelerate industrial transformation is a mutually beneficial cooperative arrangement between a technologically advanced country and a country requiring a particular technology produced by the former.

Technical cooperation can take the form of the education and training offered in technologically advanced countries, so that the knowledge can be applied later in the home country. Another form of cooperation is the use of experts from developed countries in technologically developing countries to provide guidance on production technologies, production management, and utilization of existing potentials.

In line with the policy of Indonesia's Investment Coordinating Board, investments from technologically advanced countries are invited for energy industry fields designated for such investments. It is hoped that the transfer of technology under such arrangements takes place in a direct manner. In view of Indonesia's large potential domestic market, this would be a viable proposition.

Options for Cooperative Efforts

In the industrial transformation process, particularly in the transfer of science and technology for the energy industries, each stage should be expressed in concrete, comprehensive programs that cover both technical cooperation and investments. Technical cooperation includes technical assistance, project aid, investments, and other forms that are mutually beneficial.

In this regard, two cooperative programs are suggested here.

Developing the Oil and Gas Industry

A cooperative program designed to enhance Indonesia's oil and gas industry should include the following facets:

- Geological services: logging, perforating, cementing wireline, etc.
- Technical services for oil and gas drilling, onshore as well as offshore
- Maintenance and repair of drilling installations
- Technical services, maintenance, and repair for oil and gas processing installations
- Technical services and testing of offshore oil and gas equipment and installations
- Coating pipes for the oil and gas industry
- Leasing equipment for the oil and gas industry
- Increasing capabilities and investments in other energy resources.

Developing the Metal and Engineering Industries

In line with the Indonesian government's policy of encouraging increased use of domestically produced materials, equipment, and machinery, a cooperative effort designed to develop the metal and engineering industries--either technical cooperation on the basis of a licensing agreement or investments in the relevant manufacturing industries--should cover the following:

- Steel industries, including steel alloys, cast steel, forged steel
- Seamless pipe manufacturing
- Nonferrous metal industries, including aluminum alloys, aluminum rods, aluminum slabs, and copper cathodes
- Diesel engines with a 500-HP or greater rating, water turbines, gas turbines, steam turbines
- Machinery for metal working, machine tools, industrial tools
- Machinery and equipment for factories, including boilers and their components, heat exchangers, high-pressure vessels, and high-temperature equipment
- Machinery and equipment components for oil refineries
- Machinery and equipment for oil mining
- Handling equipment such as cranes, blowers, etc.
- Large transformers and generators
- Instrumentation
- Precision valves, high-pressure pumps, energy transmission equipment
- Mechanical power transmission
- Shipyards for building new ships larger than 5,000 GRT
- Machinery for electric power generation, electrical production apparatus such as industrial electric motors, control and safety equipment, starters, high-voltage fuses.

Cooperation in design and engineering is also very important to support development of the energy industries as well as other manufacturing industries.

WORKING GROUP REPORT: ENERGY INDUSTRIES

To set the stage for this working group's deliberations, Dr. Rahardi Ramelan, deputy chairman for industrial development, Agency for the Assessment and Application of Technology, described the strategic energy planning program carried out by the Indonesian government several years ago in cooperation with the Bechtel Corporation. He also emphasized Indonesia's need to export oil; to develop hydroelectric and geothermal resources, high-voltage transmission, rural electrification, solar energy (photovoltaic), biomass, and wood gasifiers; and to replace subsidized kerosene and diesel fuel. Plans are also being made to carry on work on ocean thermal gradient systems (OTEC).

In exploring possibilities for U.S.-Indonesian collaboration on energy systems, this working group examined the following energy sources: fossil fuels (coal and oil, but primarily coal), electric utility technology, and renewable energy (primarily solar and biomass technologies with an emphasis on solar).

Discussion of collaboration with U.S. governmental organizations largely centered around the U.S. Department of Energy (DOE) which is engaged in six general areas of endeavor:

1. Studies of materials used in the manufacture of energy systems
2. Fuel chemistry and combustion efficiency studies
3. Engineering mathematics
4. Geological sciences
5. Biological energy research, including waste conversion studies, photosynthesis studies, anaerobic digestion, fermentation, etc.
6. Advanced energy projects.

ENERGY SOURCES

Fossil Fuels

The U.S. Department of Energy is primarily concerned with basic research, applied research, and proof-of-concept studies in the area of fossil fuels. The follow-up steps of process development and commercial utilization are, by government policy, left to others, largely private industries or in some cases organizations such as the Synthetic Fuels Corporation.

DOE is currently carrying on a number of cooperative programs with other countries, including a project with Venezuela on enhanced oil recovery, a project with Brazil on oil shale slag utilization and disposal, and a third with India on coal utilization.

This working group reviewed the problems of designing coal-burning systems--from bituminous through sub-bituminous to lignite and peat--and the need to tailor designs specifically to the special characteristics of the coal to be burned. Good coal analysis prior to the design of burner and boiler systems is necessary, as well as well-trained, highly skilled plant operators if high plant availability and performance are expected.

The experimental cooperative efforts of Bechtel Corporation, the Electric Power Research Institute (EPRI), Southern California Edison, Texaco, General Electric, Toseco (Japan), and others in fluidized bed combustion of gasified fuel were also described. Coal, as well as many other fuels, could serve as the fuel to be gasified and then all used in the same combustion reactor.*

Coal gasification experiments will be undertaken shortly in Indonesia using the well-known German Lurgi process developed in the 1930s. Two coal plants are now under construction on Java using Sumatran brown coal.

Electric Utility Technology

EPRI's programs relating to the utility industry include those that deal with:

1. Phosphoric acid fuel cells
2. Effective utilization of energy (finding ways to help a customer get more use from a kilowatt-hour of energy)
3. Solving the environmental problems sometimes associated with electrical generation plants such as desulfurization of flue gas, acid rain, fly ash disposal, etc.
4. Transmission and distribution technology.

All of these programs are, of course, directed toward EPRI's primary mission of minimizing future capital and revenue requirements; assuring fuel availability; meeting health, safety, and environmental requirements; and increasing conservation, productivity, and flexibility in the utility industry.

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*For further specific information, contact individuals from the respective oganizations who made presentations as listed in Appendix D. In addition, EPRI--the R&D arm of the Synthetic Fuels Corporation--has a program on fluidized bed combustion of oil and wood wastes with the Northern States Power Company and one using low-grade coal with the Tennessee Valley Authority. Addresses are listed at the end of the working group report.

Advances in transmission technology include trends toward higher voltage transmission. The ultimate limitation in high-voltage technology will be less technical and economic than sociological and political. For AC transmissions of power, more power can be transmitted for a given conductor size by (1) increasing the voltage; (2) rectifying to DC, transmitting, and inverting back to AC on the load end; and (3) increasing the number of phases and the number of different conductors (one conductor must be added for each additional phase).

The participant from Power Technologies stated that the United States is approaching the limit of solution to item (1) above, but for social and political rather than technical and economic reasons. Item (2) has not been fully exploited, but it is currently being extensively exploited worldwide and tends to lead to still higher voltage. The United States has not fully exploited item (3)--that is, for higher phase numbers.

There are also alternatives to higher and higher voltage 3-phase transmission, such as higher phase order transmission line systems. Essentially, these techniques allow significantly reduced voltages and line spacings for given levels of power transmission.

If one opts to use higher phase numbers for any given amount of power transmission, one can (1) build smaller towers, (2) have closer conductor spacing and lower voltages, and (3) have fewer stray electric and magnetic fields. It is convenient to use multiples of 3 because a 3-phase (standard worldwide) can be transformed to 6 or 9 very easily and then reverted back to 3 at the load after transmission.

DC transmission in the electric utility industry--for closing otherwise unstable loops and for super long-range transmission--was also discussed by working group participants.

Solar Energy Technology

Work being carried out in the United States on solar technology for electrical generation, using both thermal and photovoltaic techniques, was described for the working group as well as the types of government policies toward renewable energy technology that either enhance or hinder their growth and growth of the associated industries.

Essentially all major nongovernment-sponsored projects in the United States, whether solar, geothermal, photovoltaic, or wind, are located in California where the political and tax climates are quite favorable. The leadership of Southern California Edison also has a positive attitude toward such projects. California's climate itself, with its specular (rather than diffuse) sunlight, is ideal for most renewable energy projects. In this regard, a 10-MW power tower has been installed in Barstow, California, and a 1-MW photovoltaic system has been engineered and installed by the Arco Corporation.

An analysis of projected cost reductions in photovoltaic systems and a prediction of the cost levels at which they would become directly competitive with standard generation systems were made available to group members. Significant cost reductions are being projected for solar thermal collectors. A test cooperative program between Brookhaven

National Laboratory and India is evaluating this new style of collector, which utilizes polymers, laminates, and new fabrication techniques, all of which make the collector cheaper and easier to use.

For photovoltaic systems, it has been determined that a figure of $4 per peak watt for the total system must be reached to penetrate Indonesian and other markets. This figure appears to be near the take-off point for a very large market to develop. The photovoltaic industry believes that a market of about 100 MW per year would be adequate to bring production costs down and allow sales of complete systems at roughly the figure mentioned. It is generally thought that this could almost be achieved with the present first-generation (single-crystal) technology. Use of second-generation (ribbon) technology and third-generation (amorphous silicon) technology could reduce the ultimate peak watt costs to well below the $4 figure. In that case, the balance-of-system costs would become the dominant factor rather than direct photovoltaic costs. These second- and third-generation technologies are not yet, however, technically feasible for commercial production.

A number of photovoltaic experiments are now being conducted in Indonesia at the village level. These experiments are joint ventures of the Indonesian government, which furnished land, buildings, and local facilities, and the Germans and Japanese, who furnished the equipment.

CONTACTS

In addition to organizations that were represented at the meeting (see Appendix D), the following institutions may be able to provide information:

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Tennessee Valley Authority
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APPENDIXES

APPENDIX A

OPENING ADDRESS

His Excellency A. Hasnan Habib
Indonesian Ambassador to the United States

I am very pleased and honored to be among this learned and distinguished gathering today. I am particularly delighted to have the privilege of addressing this august assembly at the request of the Minister of State for Research and Technology of the Republic of Indonesia, Professor B. J. Habibie. I believe it is a matter of regret to him that he is unable to participate in this symposium, knowing his very keen interest in scientific and intellectual exchanges.

The timing of this meeting is most appropriate as it takes place on the eve of President Reagan's planned trip to East Asia, which includes a visit to Indonesia. This is an indication of the continued interest of the United States in the stability and prosperity of our subregion, Southeast Asia. We are indeed gratified that cooperation in science and technology between the United States and Indonesia, in addition to other important issues related to the prosperity and stability of this region, is expected to be on the agenda of the discussions between President Reagan and President Suharto. It is also timely because it is held at a time when we are nearing the completion of REPELITA III and approaching REPELITA IV which will commence on April 1, 1984, and will cover the 5-year period 1984-1989. This is a most crucial and critical period in our long-term national development, which started some 15 years ago (1969-1974) and will span 25-30 years. For one thing, the whole period of this long-term development, to use Professor Rostow's growth theory, belongs to the second stage, namely, the preconditions for take-off. This is the most vulnerable stage of the five stages of growth, since a society in this stage is in the process of transition from a traditional to a modern society. Major changes take place not only in the economic life, but also in the entire scope of national life--politically, culturally, and socially--which leads to changes in value systems.

The fourth REPELITA, in particular, is most crucial for two reasons. First, it is midway in the long-term development period and its economic development strategy will continue to increase agricultural production and intensify industrialization to move the national economy toward a more balanced structure and the broader base of the agricultural and industrial sectors. Second, this midway point happens to coincide with a world economic situation characterized by uncertainties after experiencing the longest and deepest recession since World War II.

The main target of our long-term national development is the attainment of a high degree of national resilience that can cope with hostile external as well as internal situations and give the nation a firm foundation for growing on its own strength, moving toward prosperity and security. Thus our development is not just the pursuit of material gains or nonmaterial satisfaction, but a harmonious balance between these two needs. Basically, our development is the total development of the Indonesian man and the Indonesian society.

Through national development we wish to create a better existence for the whole Indonesian nation. Development is a process of growth through structural changes. Structural deficiencies and disparities that existed before must be alleviated and rectified. These deficiencies and disparities were the main causes of the low standard of living. There is, for instance, a structural disparity in the endowment of resources. Indonesia has an abundance of natural and human resources (still too many unskilled), but it lacks capital, technology, and managerial skills or know-how. There is also a disparity in the sectoral allocation of resources. This then causes Indonesia to remain a primary producing and exporting country today, very much subjected to fluctuations of its export markets.

This condition makes it imperative to establish priority scales for the allocation of resources in the implementation of the development programs, inevitably leading to unequal rates of development among the various sectors. If we are not alert and only focus our attention on the pure economic aspects of the problem, we may aggravate another structural disparity, a disparity in wealth and income among social groups connected to the chains of production and distribution in the economic process. And, of course, there are deficiencies in social institutions and habits viewed from the requirements of a modern society.

All these disparities and deficiencies are interrelated, and their mutual interactions with and reactions to the outside influences that come with development--as, for example, with the introduction of science and modern technology--can impede and act counterproductively to development itself, thus inhibiting growth. It would be most unfortunate indeed if this were to happen, since the alternative to no growth for a developing nation in this vulnerable stage can only be decay and chaos. Only when these resistances to growth are finally overcome and the forces that make for growth can expand and are accepted by the majority of the society, will we have achieved the next stage, that of take-off. Growth will have become its normal condition.

Thus the strategy and pattern of growth of technology transfer are very important to minimize the shocks and frustrations of and resistance to change. The process of development as structural change means more than just economic growth conceived in terms of productivity and income. Nevertheless, raising the income of society is a must without which all other development programs cannot be carried out, hence the emphasis on economic development.

Indonesia is currently in a stage of transition, and as I mentioned earlier, this is a vulnerable stage. This is even truer, given the present world economic situation, which although showing signs of a recovery, especially in the United States, still raises questions as to its scope, rate, and durability.

A great majority of our people are still engaged in the traditional agricultural sector which consists mostly of small farmers. On the other hand, the development of the nontraditional sectors such as the extractive industries--in particular, oil and gas--has also taken place, and industrialization is growing. Some of these sectors, like oil and gas, have even become the leading growth sectors. These nontraditional sectors are capital intensive, dependent on modern technology, and not very labor absorptive, at least not in their present stage of development. Thus at present we have the so-called "technological dualism" of the traditional sector of agriculture, where most of the population still makes its livelihood and which still relies on labor-intensive technology, and the nontraditional sectors that require modern, capital-intensive technology. This dualism creates social tensions that can lead to serious frictions if it is not tackled by appropriate policies.

The success of our development since it started in 1969, and, in particular, during the second part of REPELITA II and the first part of REPELITA III, have raised the expectations of our people and with it the demands for a better existence. It is in finding the proper response to these rising demands that science and technology can play a crucial role, even a decisive role, because our future development depends on our own ability to make the best possible use of our abundant natural resources for the benefit of the greatest number of people. This can only be possible by raising the quality of our also abundant human resources. In trying to determine the proper role of science and technology, one should be guided by the principle to "serve society and humanity," and not "science for science" or "technology for technology." This means that those who are engaged in this difficult but noble task should learn as much as possible about the social and individual human needs of the Indonesian man and the Indonesian society, and fit technological responses accordingly. Science and technology must also be firmly rooted in our own cultural values and not just a blind imitation of outside higher technology and "transplanted" through so-called technology transfer.

Transfer of technology to our society, which is in transition, should not just serve the modern sectors, which need high technology but which are less labor absorptive. We do not need growth for the sake of growth but growth with equity. This means that we must also develop labor-intensive industries that will relieve underemployment pressures and absorb the 2 million annual new entrants into the labor force. This requires capable scientists and technicians who must also be innovative and creative. They must be able to come up with people-related technology projects such as for village water supply, village energy generation, and projects to enable the villagers to build their own homes at low cost.

I do not mean to say that high technology is not relevant or important for us. We must also try to master the latest scientific strides and try to relate them to the needs of our society and development. Advances in biotechnology which offer promise of increasing agricultural yields without high-priced energy inputs, and computer science and technology and information processing which are crucial to progress in other areas, are some examples. This means meshing high technology, which is knowledge intensive, with people-oriented technology. Finding the proper "high-low mix" again requires ingenuity and innovative and creative thinking.

The United States, as we all know, is the storehouse of science and technology and, I believe, it is willing to share its knowledge and experience with its friends. This very symposium testifies to that, where American scholars sit face to face with their Indonesian colleagues, discussing topics of interest and importance to Indonesia. This is, of course, a great opportunity for my compatriots, who, I believe, will try to get the most out of this meeting for the best of our national development.

APPENDIX B

SCIENCE AND TECHNOLOGY IN INDONESIAN NATIONAL DEVELOPMENT

Sukadji Ranuwihardjo
Assistant Minister for Policy Coordination,
Ministry of State for Research and Technology

INTRODUCTION

Indonesia is the world's largest archipelago, extending between the continents of Asia and Australia. Its location across important trade routes has long influenced its political and economic development. Indonesia has a land area of 1,175,000 km^2, and its 13,677 islands stretch 5,120 km from east to west--roughly the distance from Moscow to London--and 1,770 km from north to south.

The main islands are Sumatra, Java, Kalimantan (the major part of Borneo), Sulawesi, and Irian Jaya--the western part of New Guinea. Java is the most densely populated island, containing about two-thirds of the total population of Indonesia. Jakarta, the capital of Indonesia, is located on its northwestern coast.

The total population of Indonesia is estimated to be 154 million, making it the fifth most populous country in the world. It is exceeded only by China, India, the Soviet Union, and the United States. Indonesia is divided into approximately 300 ethnic groups that speak 365 languages and dialects.

NATIONAL DEVELOPMENT PLANS

Much progress has been made the past 15 years during the first three 5-year national development plans (REPELITAs I-III). Despite a rapid population growth rate of 2.34 percent annually, Indonesia moved in 1982 from the status of a low-income to a middle-income country. In addition, achievements in economic sectors have enabled Indonesia to deal with the sociopolitical and cultural problems inherent to a modern, progressive society.

Implementation of the next two 5-year plans (1984-1993) is expected to accelerate national development so that by the sixth 5-year plan (1994-1999) Indonesia will have achieved self-sufficiency and equitable social development toward a just and prosperous society according to our national ideology of Pancasila.

The basic objectives of the fourth 5-year plan (REPELITA IV, 1984-1989) are to continue agricultural development and to accelerate industrialization and emphasize improvements in infrastructure, social services, and development of human resources.

THE ROLE OF SCIENCE AND TECHNOLOGY

The role of science and technology in national development is deemed increasingly important to the successful achievement of these national goals. National development strategies must seriously consider Indonesia's human and natural resources and how they might best be used in the international marketplace.

Recent international monetary crises and the lengthy world recession have had a negative impact on the ability of Indonesia to implement its national development plan. Many large development projects have had to be rescheduled, and priorities have had to be rearranged based on these resource constraints. Economic institutional reforms have been implemented to help place Indonesia in a better position to continue its domestic economic revival. It also actively pursues the establishment of the New International Economic Order.

Within the new resource constraints, Indonesia has to further develop its national capabilities in science and technology in both national efforts and international cooperative ventures. Indonesia must be more efficient in the deployment of its limited resources--financial and human--in its development efforts. With increased national capabilities in science and technology, Indonesia will be better able to both solve its national problems and engage more competently in international economic relations. At the same time, Indonesia continues to welcome capital investments by international private interests in the country's natural resources so that they may be developed for the benefit of the national welfare and the world economy.

In 1978, the Minister of State for Research and Technology officiated at the establishment of a Team for the Formulation and Evaluation of National Major Programmes on Research and Technology (PEPUNAS-RISTEK). This team serves as an advisory body to the minister, and its members are scientists from universities, national research institutes, and R&D agencies within technical ministries. The team will soon be strengthened and reorganized into a National Research Council. As one of its tasks, the team has developed a matrix of national research that covers five major fields:

1. Basic human needs
2. Natural resources and energy
3. Industrialization
4. Security and defense
5. Social, economic, cultural, and legal problems.

The national research matrix has functioned as a frame of reference in the development of a research agenda for the national research institutes and the R&D agencies within the technical ministries, assuring a unified approach to national development. The next step will be to develop criteria for coordination and setting of priorities, and for . planning, implementation, and evaluation of research activities in Indonesia.

Research in science and technology will be successful if and only if it is backed by a large pool of skilled scientists and technical personnel. Indonesia still has a long way to go in developing its scientific and technical manpower; it is one of a group of countries with a very low ratio of scientists/engineers to population. The lack of such personnel is further aggravated by inefficient deployment of these very scarce human resources.

International cooperation in scientific manpower development for Indonesia is very highly valued because it is a long-run strategic step for national progress. It will enable the Indonesians to solve their own development problems and to enter into mutually beneficial international cooperative ventures.

THE ROLE OF THIS SYMPOSIUM

As part of the science and technology agreement between the government of Indonesia and the United States, three seminars have been held in Jakarta under the joint sponsorship of the Indonesian government and the U.S. National Research Council. These seminars have made very important contributions to the Indonesian government's decision-making process related to its programs to enhance national capabilities in science and technology. Topics of these seminars have included:

- Improving village productivity
- Science and technology planning and forecasting for Indonesia, with special emphasis on manpower development
- Planning and execution of science and technology activities in Indonesia.

This symposium is a continuation of the seminars conducted in Jakarta. It is intended to be a forum for the exchange of information and for discussion between Indonesian scientists and their U.S. counterparts and with other participants, including government officials and representatives of private interests. Discussions will focus on the plans and prospects of Indonesian national development in various fields and the opportunities for possible collaborative ventures and assistance. While papers submitted to this symposium are not official concepts of the Indonesian government, they do reflect the salient issues of Indonesian development problems.

During the fourth 5-year plan which begins in 1984, industrial development will be the important component. Presentations at this symposium focus on the industries selected to receive greatest attention during the next 5 years, including:

- Energy industry
- Engineering industry
- Electronics and telecommunications
- Land transportation
- Agricultural machinery.

These industries have been chosen because they are the most dynamic in the present as well as future industrial development. It is neither practical nor possible to shed light on all industrial programs in the coming 5 years. For example, the steel, aircraft, and shipbuilding industries, while important, will not be discussed at this symposium.

The government has played an important role in Indonesia's industrial development. It guides the planning and policymaking for future development and also provides protection from foreign competition. In the case of electronics and communications, the government is the major market for this new and rapidly developing industry.

Research and development in technology are known to be expensive. At the present stage of development, the Indonesian industries that comprise mostly small- or medium-sized firms spend much too little on research and development. In many cases, the government spends money for research and development that will benefit private industries, yet the private sector plays the major role in the Indonesian economy.

Almost 80 percent of all Indonesians live in rural areas, with agriculture as their main source of livelihood. Although the contributions of agriculture to the gross domestic product decreased from 49.3 percent in 1969 to a low 24.5 percent in 1981 due to the rapid development of other sectors of the economy, agriculture is still a very important sector. The productivity of food crops, especially rice, and livestock has increased very quickly in the last 10 years. Rice production doubled in that period, from 12 million tons in 1970 to 23 million tons in 1982, yet postharvest losses and waste are still high. In the case of rice, losses are estimated to be as high as 20 percent. Thus in 1981, Indonesia lost 4.5 million tons of rice after harvest—an amount that is much larger than the total amount of rice imported that year. This situation is apparently also true for other crops. For this reason, postharvest technology is very important for Indonesia, especially since the losses directly affect such a large portion of its population. The government is, therefore, promoting private capital investment in agribusiness to improve quality control, storage, processing, and marketing of agricultural products.

Biotechnology, like agricultural technology, is a fast-developing scientific field. It opens new opportunities and sometimes shortcuts in agriculture, health, and industrial products. Indonesia is also interested in developing expertise in this area. Applications of biotechnology to agriculture will be discussed in the presentation on agricultural technology.

Last but not least, Indonesia is a maritime nation. The Indonesian archipelago consists of more than 13,000 islands with about 81,000 km of coastline, and water covers two-thirds of its territory. Although the marine sciences in Indonesia have lagged behind somewhat as a result of long-time neglect, today there appears to be renewed interest that covers a broad range of scientific fields and disciplines. There are many opportunities for scientific endeavors in this area, including education, surveys, and joint research and technological development activities. Indonesia will make the best use of these opportunities through international collaboration as well as through bilateral arrangements.

These are the highlights of the coming discussion in this seminar.

APPENDIX C

SYMPOSIUM AGENDA

MONDAY, October 3

9:00 a.m.	Plenary session
Welcome	Dr. Frank Press President, National Academy of Sciences
	Professor Walter A. Rosenblith Foreign Secretary, National Academy of Sciences
Opening Address	His Excellency A. Hasnan Habib Indonesian Ambassador to the United States
	Science and Technology in Indonesian National Development Professor Sukadji Ranuwihardjo Assistant Minister for Policy Coordination, Ministry of State for Research and Technology
10:00 a.m.	Coffee break

PRESENTATIONS BY INDONESIAN PANELISTS:

10:30 a.m.	Marine Sciences in Indonesia: Problems and Prospects for National Development Dr. Aprilani Soegiarto Director, National Institute of Oceanology, Indonesian Institute of Sciences (LIPI)
11:30 a.m.	Problems and Prospects of Postharvest Technology in Indonesia Dr. F. G. Winarno Head, Food Technology Development Center, Bogor Agricultural University

12:15 p.m.	Farm Mechanization and Development of the Agro-industry Ir. Hidayat Nataatmadja Head, Documentation Department, Agency for Agricultural Research and Development, Ministry of Agriculture
1:00 p.m.	Lunch, NAS Refectory
2:00 p.m.	Development of Energy Industries Ir. Achmad Az Deputy for Development and Promotion, Indonesian Investment Board
3:00 p.m.	Prospects for the Electronics and Telecommunications Industries in Indonesia Dr. Sumaryato Kayatmo Director, National Electronics Institute, Indonesian Institute of Sciences (LIPI)
3:30 p.m.	Coffee break
4:00 p.m.	Land Transportation Industries Dr. Rahardi Ramelan Deputy Chairman for Industrial Development Agency for the Assessment and Application of Technology
4:30 p.m.	Design and Engineering and the Plant Machine and Equipment Industry Ir. Eman Yogasara Director General of Basic Metal and Machinery Industries, Ministry of Industry

COMMENTS ON BALANCE OF PROGRAM

5:00 p.m.	Professor Walter A. Rosenblith, U.S. Chairman
5:15 p.m.	Reception, Great Hall

TUESDAY, October 4

9:00 a.m. Participants were divided into the following topical working groups:

Marine Sciences
Chairperson: Dr. Dirk Frankenberg
Director, Institute of Marine Sciences,
University of North Carolina

9:00 a.m. Mini-Plenary on Industrial Development in Indonesia
Dr. Rahardi Ramelan

10:00 a.m. Postharvest Technology, Farm Mechanization and Agro-industry
Chairperson: Dr. Ernest J. Briskey
Dean, School of Agriculture,
Oregon State University

Land Transportation Industries*
Chairperson: Mr. Samuel E. Eastman
President, Economic Sciences Corporation,
Washington, D.C.

Telecommunications and Electronics
Chairperson: Mr. William A. W. Krebs
Vice-President,
Arthur D. Little, Inc.

Engineering and Machine Tool Industries
Chairperson: Mr. Robert Huber
Editor and Publisher,
Production Magazine

Energy Industries*
Chairperson: Dr. William Hughes
Director, Engineering Energy Laboratory,
Oklahoma State University

4:30 p.m. Working groups adjourn

Evening Free

*Land Transportation Industries and Energy Industries met jointly.

WEDNESDAY, October 5

9:00 a.m.	Plenary session: findings of six working groups
10:30 a.m.	Coffee break
11:00 a.m.	Continue reports; formal closing
12:00 noon	Symposium adjourns

APPENDIX D

SYMPOSIUM PARTICIPANTS

Dr. M. Robert Aaron Head, Digital Techniques Department Bell Laboratories, 3C225 Holmdel, New Jersey 07733	Telecommunications and Electronics
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Dr. Ardjuno Brodjonegoro Director of Physics Institute Indonesian Institute of Sciences Indonesia	

Ir. Achmad Az Deputy for Development and Promotion Indonesian Investment Board Indonesia	Plenary
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Dr. Nyle C. Brady AA/S&T Room 4942, New State U.S. Agency for International Development Washington, D.C. 20523	Plenary
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Ms. Rosanna Ciupek NOAA/NESDIS International Affairs	Marine Sciences

Mr. John Clark National Park Service International Branch Washington, D.C. 20240	Marine Sciences
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Mr. Donald Ferguson Bureau of Oceans and International Environmental and Scientific Affairs Department of State Washington, D.C. 20520	Energy Industries

Mr. Walter L. Flinn Director, U.S. Operations Resources Management International, Inc. 2000 L Street, N.W., Suite 200 Washington, D.C. 20036	Plenary
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Dr. Dirk Frankenberg Marine Sciences Program University of North Carolina 12-5 Venable Hall 045A Chapel Hill, North Carolina 27514	Panel Chairman, Marine Sciences
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Mr. Burton J. Gleason Head, Office of Information Ames Laboratory Energy & Mineral Resources Research Institute Iowa State University Ames, Iowa 50011	Land Transportation Industries Energy Industries
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Mr. Joseph Goldberg Deputy Division Chief Telecommunications, Electronics & New Technology Division, Industry Department World Bank 1818 H Street, N.W., Room D651 Washington, D.C. 20433	Telecommunications and Electronics

Dr. Miles Greenbaum U.S. Department of Energy FE-14, Germantown Washington, D.C. 20545	Energy Industries
Dr. Michael Greene Associate Director/Research Grants BOSTID, National Research Council	Plenary
Dr. M. Grant Gross Director, Division of Ocean Sciences National Science Foundation Washington, D.C. 20550	Marine Sciences
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APPENDIX E

SOME THOUGHTS CONCERNING A STRATEGY FOR THE INDUSTRIAL TRANSFORMATION OF A DEVELOPING COUNTRY

Professor B. J. Habibie
Minister of State for Research and Technology
Chairman,
Agency for the Assessment and Application of Technology

Your Excellencies,
Mr. Chairman,
Distinguished Members of the Society,
Ladies and Gentlemen,

I wish to preface my remarks today by expressing my personal and my country's deep appreciation for the honor given to me by having been elected Honorary Member of this distinguished Society as of February 22 this year. I have accepted this appointment with grave humility and with a profound awareness of the serious responsibility the appointment brings with it and deeply hope that the Good Lord will permit me to fulfill it with the same distinction as that of the other eminent Honorary Members of this Society.

The topic I wish to address today is the theme of the process of industrial transformation in a technologically less-developed country by the systematic transfer, application, and development of science and technology by using Indonesia, my own country, as an example. In using the term "technologically less-developed country" I trust I do not need to stress that the term does not in any way imply that countries like Indonesia are not highly developed in the arts, culture, philosophy, and other important aspects of life.

Distinguished Members of the Society,

The process of industrial transformation in technologically less-developed countries can be conceived of as being part of a larger and much more complex process of nation-building which, as I have said on another occasion,* I understand to be the course through which a

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*See: B. J. Habibie, "Science, Technology and Nation-Building," Address delivered at the International Symposium on Energy and International Cooperation: Options for the 21st Century, Tokyo, Japan, March 1982.

This address was delivered to the Deutsche Gesellschaft für Luft- und Raumfahrt, Bonn, Federal Republic of Germany, June 14, 1983.

people in a particular state develop their common identity and philosophy of life, evolve their own characteristic way of living and working together, and realize their economic, cultural, and political potential as a distinct national entity. Nationhood in this sense involves much more than the possession of the formal requirements of political independence. It is characterized by a people's capability to stand on their own economically, their ability to maintain their cultural identity, and their power to maintain their political integrity. Economically, it involves the ability to produce the goods and services it needs for its own consumption and those demanded on the world market to trade for the goods and services the country needs but cannot produce. For all this, the capability to acquire and develop technology is crucial. For without it, the possession of even vast reserves of natural resources will not be a controllable asset, while with science and technology the lack of natural resources will not be an insurmountable obstacle.

It seems to me that there are certain principles which ought to be practiced in the application of science and technology for nation-building. Being a mixture of factual as well as value statements, they may be regarded as representing my basic philosophy on this issue. Allow me to present these briefly before commencing with a discussion of a possible strategy of applying science and technology for technological and industrial transformation in the course of nation-building.

BASIC PRINCIPLES

First, education and training in the various sciences and technologies relevant to the nation-building needs of the country must be undertaken. This involves both in-country as well as education and training abroad. This is an essential step. It is, however, by itself, not sufficient.

In addition, a clear, realistic, and consistently applied concept of the nature of the society to be developed and the technologies needed for the realization of this future society must also be evolved. These technologies need not necessarily be the most primitive. They may indeed in many cases be the most advanced in the world. The only criterion for the appropriateness of technologies for any particular country, including technologically less-developed countries, is their utility in solving actual problems in that particular country.

Third and perhaps most important, technologies can only be transferred, adapted, and further developed through their being applied to concrete problems. By their very nature, technologies cannot be learned, let alone be developed, in the abstract. To develop rice production technology it is, of course, very important to study rice agriculture and the various rice production technologies available in the world today. Yet most important, one must actually try to produce more rice under given soil, climatic, economic, social, and cultural conditions. Only through working on concrete production problems is the actual working of particular technologies comprehended. And only when thus comprehended is their future development possible.

Fourth, and as a corollary to the previous principle, for a country to develop itself technologically it is vital that it solves its own problems by itself. To develop its technology, no country can continue to be a net technological importer indefinitely. At some point it must be able to develop its own technologies.

Fifth, in the very first stages of transforming itself into a technologically advanced nation, every country must protect the growth of its national technological capabilities until its international competitiveness has been established. I quickly add that one must plan to achieve such international competitiveness as soon as possible.

These, then, are some of the principles that must be observed in the execution of a strategy for the application of science and technology for the technological and industrial transformation of a developing country. Many strategies are possible. Allow me now to invite your attention to one of these.

Mr. Chairman,
Distinguished Members of the Society,

Conceptually, there are two elements of this strategy. The first element comprises the phases of the strategy; the second, the vehicles of its implementation.

PHASES OF TRANSFORMATION

The process of the transformation of a society into a technologically and industrially developed nation may be conceived as consisting of four overlapping phases. Three of these are of relevance to presently less-developed countries, while the fourth is vital to the preservation of technological prominence.

The first, most basic, phase is the use of already existing technologies for added-value processes in the assembly and manufacture of products already on the market. This includes both the domestic as well as the international market. In this phase, manufacturing and management technologies are used to transform raw materials and intermediate goods into higher-value finished products. In doing this, one could, of course, utilize the technologies already existing in the country. This, however, would not automatically lead to technological advance. To improve existing technologies one could make investments in additional research and development. In many cases, however, this would lead to costly and time-consuming "reinventions of the wheel" in many areas. The logical shortcut to take would therefore be to import technologies from abroad and produce under license. Progressive manufacturing programs will be needed to help ensure the systematic transfer of licensed technologies by relating the progression of transfer to the number of items produced rather than by setting time targets. Through this step capability is obtained in the understanding of more advanced designs and manufacturing processes developed abroad. Better manufacturing skills as well as organization and management capabilities are developed. Work discipline is inculcated. Quality standards are enforced. The maintenance of work and quality standards becomes habitual.

The second phase is the integration of already existing technologies into the design and manufacture of completely new products. In this second phase, technologies are used and developed to create blueprints and designs, thus adding the element of creativity to the first phase. In addition to design capability, other skills are gained. These are skills in integration and optimization of components into new systems and based on these, the ability to select, from all the possible designs for components of the new system, those that will be the most optimal. Essentially, any product can be seen as a system consisting of various components, each of which requires a particular technology to manufacture. In this system, each component derives its value on the market from its function within the total product in the same way that the total product derives its market value from its function in the market. No matter how well designed, no undercarriage system, no propeller will have any value on the market unless it can be integrated into an existing or future railway wagon or airplane. Tires, engines, avionics, and other components will enter the market only through their being integrated into an airplane. Components will enter markets only through fulfilling their function in products which, in turn, fulfill their own particular missions in society. The development of design and integration skills, therefore, quite naturally brings with it the opportunity to select, from all the available technologies existing in the world, including the most advanced, those most suitable for the new product to be designed and manufactured. And these opportunities will be generated automatically by the market without cost to firms in this phase of development because manufacturers of components will strive to offer their designs and products to firms in the process of designing new manufactures.

Quite suddenly, driven by the force of the market, the flow of technological information to the country increases, including information on the latest developments. Since the new product has to be tested on the market and in the laboratory, testing capability is therefore also being developed at this stage as are marketing and new management skills. The role of research and development is much more pronounced in this phase rather than in the previous phase requiring the improvement of, among others, facilities for design, for testing, and for simulation.

The third phase is the stage of the development of technology. Existing technologies are improved and new ones developed in the effort to design and manufacture the products of the future. If in the second phase one can avail oneself of existing technologies, at this stage there is a need for the creation of completely new ones.

This is, of course, the scenario that is familiar to scientists and technologists in technologically developed countries and that is becoming established in the so-called "newly industrializing countries" today. Firms and countries neglecting to make investments in new technologies will in a very short time lose their competitive edge. The third phase, therefore, will be the phase of innovations, of the creation of the technologies for components to be integrated into products which in their time will be the most advanced in their respective markets. This phase is a necessary stage for every firm and every country wishing to maintain their position in the market. And however far this stage may seem to many less-developed countries today, it would be wise for these countries to plan on eventually embarking on this stage of their technological and industrial development lest they lose the advances they will be making in the first and second stages.

Firms and countries in the third phase of development will very often find that in many cases there exist gaps in theory which need investment in basic research. This may be called the fourth stage in the development of science and technology for technological and industrial transformation. New developments in information technology, in control, and in computer technology are already at this moment ushering in new ways of life and work in industrially developed nations.

While some developing countries do make investments in basic research, many find that their scarce financial, material, and human resources are better spent in more urgent tasks. The great bulk of basic research is therefore undertaken in developed countries with developing countries maintaining access to this research and its results through cooperative agreements in science and technology. While not completely irrelevant to less-developed countries, this fourth phase of development is not as central to their transformation as are the first three phases.

In all of these phases the principle of active involvement in the manufacturing and production processes already referred to is absolutely vital.

It is, of course, possible to gain some understanding of production technologies through observation and participation in workshops or seminars. It is also possible to learn production technologies by learning to manufacture one or two items. No lasting manufacturing skills and know-how, however, can be gained through these means. Technological knowledge is lastingly gained and improved only when applied. Workshops and seminar papers and presentations and briefings are indeed useful media for transferring industrial knowledge. Yet for the successful and lasting transfer of manufacturing and other technologies relevant to industrial development, consistently executed programs of designing and manufacturing technologically viable and economically feasible products are better media.

Having discussed the phases of technological transformation, let me now turn to what I call the "vehicles" of industrial transformation.

VEHICLES OF INDUSTRIAL TRANSFORMATION

Only through a program is the transfer and development of technology possible. Therefore, programs for the design and manufacture of concrete products are conditio sine qua non for any effort to achieve technological advancement. Not all programs, however, are equally appropriate for a country's industrial transformation. Allow me a few moments to elaborate a bit further on this point.

In principle, any program involving production technologies for the manufacture of any product in any sector can be chosen as a medium for the transfer and further development of technology through the three phases as I have suggested. But for programs to be able to launch a developing country into a sustained process of transformation into a technologically and industrially developed nation they must satisfy two critical requirements.

The first and necessary condition is that the program must be made amenable to the design and implementation of progressive manufacturing plans. This means that it must be possible to decompose the programs into steps permitting a progressively deeper penetration of the technology used. In this context, penetration of technology is measured by the proportion of domestic added-value in the total product manufactured while progress is measured in terms of numbers of units produced. Progressively deeper penetration therefore signifies that the amount of domestic added-value must increase with the number of items produced. It is true, of course, that the degree of decomposition of manufacturing programs in each case depends on the degree of human and capital investment required in relation to what is feasible in terms of engineering capability at a given time and place. The aim of progressive manufacturing plans is to improve the technological capability of the producing firm into a stage in which it is able to manufacture the same percentage of added-value as is normally produced by comparable firms in any industrially developed country. For airplane manufacturers, for example, the percentage of value added by the firm is typically around 40-60 percent of the value of the total product, since it is more economical to purchase many parts and components from other, more specialized companies as vendor items.

The second and sufficient condition for a program to perform the function of a vehicle for technological and industrial transformation is that their products must fulfill the requirements of the market. In developing countries with a limited domestic market for the products or product groups chosen, programs must meet the conditions necessary to make the products competitive on the world market. In developing countries with a large domestic market for the products chosen, the technologies must make the products competitive on the domestic market.

For developing countries with a limited domestic market for aircraft, for instance, programs for the production of propellers, or undercarriages, or aircraft engines would not be appropriate ways to launch viable technological and industrial progress. They could, of course, transfer even the most sophisticated technology for this purpose so that in time, these countries would be producing excellent propellers, undercarriages, and airplane engines. At such a time, however, the firms manufacturing these products would have to face enormous marketing problems. Since there would be no demand for these products in their own domestic market, the firms would have to enter the world market and counter the competition of other companies with years of sales experience, international contacts, and vast financial and managerial strength. Even with excellent products, it would be very difficult for these firms to compete. Programs like these, therefore, are not the proper vehicles for their countries' transformation into a technologically and industrially developed nation, not because the technologies involved are primitive but because of the lack of a direct link between the program and the requirements of the domestic market. Given a large and controllable domestic market, it would be unwise for Indonesian companies to implement manufacturing programs without any relation to this market. Unlike countries such as Singapore and Hong Kong which have no other course but to enter the world market directly, countries like Brazil and Indonesia can and should orient themselves to the demands of their own domestic markets in defining and implementing the most appropriate programs for their transformation.

I shall call products and product groups which fulfill these two conditions the "vehicles" for technological and industrial transformation.

Mr. Chairman,
Distinguished Members,
Ladies and Gentlemen,

There is a further point to which I would like to invite your attention. Several requirements must be fulfilled for products to be offered on the market at competitive prices. First, the scale of production must approach the optimum. Second, the quality of the products and the after-sales service must be reliable. In order to achieve these conditions it will in many cases be necessary for firms to be given temporary protection. Optimum scale of production cannot be obtained if sales are limited to very small numbers of production because markets are overcrowded. Manufacturing and servicing skills do not develop overnight after having produced a few items. Therefore, although we all agree that in the final event producers must be able to compete in the free market, it is in order to enable firms to achieve competitiveness in the long run they must in many cases be given protection in the short run. For obvious reasons, this protection can be provided only in domestic markets. It is for these reasons that in the effort to nurture certain products or product groups to fulfill their role as vehicles for industrial transformation they are given temporary protection.

When scale is achieved and the required skills are established, protection is released and the vehicles are launched to compete on their own strength in the domestic as well as the world market.

Honorable Members of the Society,
Ladies and Gentlemen,

Several questions may at this point arise: If the ideas in the foregoing appear valid, how would their application be in concrete cases? What would be the vehicles and what programs would be undertaken?

In answer to these questions, allow me now to progress from the general and the abstract to the specific and the concrete and use Indonesia, where these ideas are currently being implemented, as an example.

PHASES AND VEHICLES FOR TRANSFORMATION: THE CASE OF INDONESIA

What products or product groups constitute the proper vehicles for each particular country and what phases of development should be undertaken in each product group depend on the particular circumstances in each case.

In Indonesia, the product groups selected were chosen on the basis of factors such as geographical size, strategic location, present and future size of its domestic market, and our perception of the political scenario in the Southeast Asian area today and in the time to come. With 13,000 islands stretching over an area from west to east as far as San Francisco to New York or from Ireland to Moscow, with a present population of 156 million people, a strategic location on main shipping routes between the Indian and the Pacific Oceans, and in the long run growing per capita income, the following industries appear to be the natural vehicles for Indonesia's transformation.

Given Indonesia's size and composition and the need to strengthen political integrity and to develop a unified economy, the whole transportation equipment sector is an obvious choice: the aircraft industry, the maritime and shipbuilding industries as well as automotive and rolling stock manufacturers. These industries plus electronics and telecommunications are the most logical vehicles in which to transfer and develop, in 20 years' time, all the necessary technologies through the third and perhaps the fourth stage as well. Through their development employment will be created. Incomes will rise and markets will grow. Indonesia's human potential for economic growth will be developed. And given the fact that energy consumption rises with income, the whole energy industry is another promising vehicle; this includes the manufacture of turbines, boilers, generators, heat exchangers, etc. as well as energy transport and transmission equipment. With growing needs for facilities for the processing of Indonesia's agricultural products and mineral and energy resources--sugar, palm oil, petrochemicals, cement, etc.--the engineering industry also appears to be an appropriate vehicle for Indonesia's industrial transformation. A seventh vehicle is the agricultural equipment industry. With land on Java increasingly scarce, agriculture on poorer soils and more limited labor on islands outside Java must be increasingly developed. This requires increased mechanization of agriculture, both preharvest as well as postharvest. Last, after having invested large amounts of capital in these industries and thereby given rise to increasing wealth, given Indonesia's strategic location and her vast reserves of natural resources, there is greater need for a domestic defense industrial capability. At the same time, the development of the aircraft, shipbuilding, and land transportation equipment industries implies the development of weapons and weapon systems platforms. They have, therefore, made the development of the defense industry more feasible.

With the growth of these industries, other sectors of Indonesia's economy will also expand through many backward and forward linkages: road construction, housing, food production, agro-industry, pharmaceuticals, and all kinds of services, including health services.

Moreover, industries which at first would not be appropriate vehicles such as the production of engines, propellers, undercarriages, hydraulic systems, and bodies for railway cars would become economically feasible because of the creation of their markets. All these industries together can be regarded as the "invisible" ninth vehicle.

In the improvement of our technological capabilities in these sectors, most of the first- and second-phase development programs are undertaken by industry while third- and even fourth-phase programs are undertaken by PUSPIPTEK--the Center for the Development of Research, Science, and Technology in Serpong near Jakarta—and other research and development centers. When fully completed, PUSPIPTEK's facilities will include a construction testing laboratory; an aerodynamics, gas dynamics, and vibrations laboratory; a thermodynamics and propulsion laboratory; a process technology laboratory; a physics laboratory; an electronics laboratory; a chemistry laboratory; a calibration and instrumentation laboratory; an energy laboratory; a metallurgical laboratory; and a multipurpose research reactor with its supporting laboratories.

The development of all these industries and the creation of these laboratories point to a scenario for Indonesia's transformation from a predominantly agricultural country today into a technologically and industrially developed nation in the future. Additional employment and wealth would be brought into being. In addition to her vast natural wealth, Indonesia would be endowed with immense reserves of renewable human resources.

Mr. Chairman,
Distinguished Members of the Society,
Ladies and Gentlemen,

A final question may now have arisen about the implementation of these ideas in actual practice. It is to this question that I now would like to turn.

APPLICATIONS IN INDONESIA

Aeronautics and Aerospace

In this industry, the first phase was implemented in 1976 with the manufacture of the NC-212 two-engine, 19-passenger STOL airplane under license from the Spanish firm of Construcciones Aeronauticas SA (CASA) and the NBO-105 helicopter under license from Messerschmitt-Bolkow-Blohm. Today, PT NURTANIO Indonesian Aircraft Industry is the licensee of four helicopters—the BO-105, the 10-passenger MBB-Kawasaki BK-117, the 15-passenger Bell Textron Bell-412, and the 24-passenger SUPER-PUMA from France's Aerospatiale. The progressive manufacturing plan is used in the manufacture of all these crafts. In 1976, PT NURTANIO started operations with an employment of 500. Today, PT NURTANIO employs 8,500 persons. When we began, less than 10 percent of the components were produced domestically; today, it is 90 percent. After 4 years of operations, this product group was declared a vehicle for Indonesia's industrial transformation. Today, we export aircraft to Thailand. Our prices are the same as that of our licensors. The quality of our products is also the same. We are internationally competitive.

The second phase in this industry began 4 years ago with the creation of Aircraft Technologies Corporation (AIRTEC), a joint venture formed by PT NURTANIO and CASA, each having a 50 percent share, to design and manufacture prototypes of the CN-235, a new two-engine, 35-passenger aircraft. The roll-out of the prototypes is planned for September this year with flight-testing for FAA certification beginning the following October.

There is an overlap between the second and the third phase in the development of this industry, for even in the second phase new components are beng integrated into the new aircraft. The prototypes of the airplane will undergo static and dynamic tests at the Construction Testing Laboratory of the PUSPIPTEK Center for the Development of Research, Science, and Technology to which I referred earlier. Other PUSPIPTEK facilities to be involved in the CN-235 program are the aerodynamics, gas dynamics and vibrations laboratory, the electronics laboratory, and the calibration and instrumentation laboratory.

The next phase in the development of the aircraft industry may take the form of the development of new jet aircraft such as larger passenger craft, trainers, and fighters.

These developments demonstrate that in the span of 7 years this industry has proven itself to be a feasible vehicle for Indonesia's transformation into a developed country. Indeed, our experience shows that this vehicle is not only feasible but that it is also economically viable. With accumulated investment costs of approximately 85 million U.S. dollars and a working capital of around 140 million U.S. dollars, PT NURTANIO has since its third year of operations been profitable. By 1982, accumulated net profits were about 9 million U.S. dollars.

Even in the first phase what I have called the ninth vehicle began to emerge. Today, in this industry alone a market has been created and/or widened for 116 domestic companies. One firm which started out with five people now has 200 persons on its payroll. Others are now working together with international partners supplying components to PT NURTANIO.

It is true that this rapid advance has been achieved under the conditions of a protected market, since with the declaration of this industry as a vehicle for transformation in 1980 the import of aircraft of similar classes as those manufactured by PT NURTANIO has been restricted. However, this protection has had the result of creating, for the first time in the market's history, the degree of standardization which has made it possible for the industry to manufacture at scales of production permitting it to be internationally competitive. And because we believe that ultimately, it is the market which is the best arbiter of business performance, in time we will open our market to international competition and enter the international market ourselves for all our products.

Maritime and Shipbuilding

At the present moment, the maritime and shipbuilding industry in Indonesia is dominated by eight shipyards, of which PT PAL, a government-owned company like PT NURTANIO, is by far the largest.

Today, this industry is in its first phase of transformation. PT PAL; PT Pelita Bahari, another government corporation; and PT Intan Sengkunyit, a private company, are producing 3,500-ton tankers for which the designs were purchased from Mitsui Engineering Company. Other programs include the production of 3,000-dwt general cargo vessels by PT PAL also in cooperation with Mitsui. For Indonesia's defense purposes, PT PAL will commence with the manufacture of 400-dwt, 30-knot FPB-57, and 60-dwt, 30-knot FPB-28 patrol boats under license from Friedrich Luerssen Werf in Bremen, and with Boeing Marine Systems, of 50-knot jet-foils, vessels produced with the latest state-of-the-art technology, with differing configurations. In all of these programs, except for the building of the 3,500-dwt tankers which is fully Indonesian, progressive manufacturing plans are in force to ensure the gradual transfer of technology.

In cooperation with Mitsui Engineering Company, PT PAL is also enlarging and improving its dry-docking, maintenance, and overhaul capabilities to serve Indonesia's growing fleet and is developing the capacity to build ships of up to 30,000 dwt.

In this industry, the second phase of transformation will not be far off, with PT PAL performing the function of taking the lead in developing technology and disseminating the results to the other companies.

Land Transportation

Two subsectors of this industry are of particular interest at this moment: the automotive industry and the rolling stock industry, with both in the first phase of development.

For historical reasons the automobile industry is largely privately owned with six groups of local assemblers, manufacturers, and dealers operating jointly with major European, Japanese, and U.S. firms. Although privately owned, all groups will follow the pattern of transformation I have described. Commencing in 1979, a rationalization of the industry was undertaken, reducing the number of makes from 57 to 30 and the number of types from 140 to 72 by 1980. Priority is given to the assembly of commercial rather than to personal-use vehicles with an overall national ratio of 8:1. Sole agents-assemblers of commercial vehicles are also required to use domestically produced components such as tires, paint, accumulators, shock absorbers, leaf springs, and safety glass, as well as rear bodies, fuel tanks, chassis, and cabins. By 1986, all components used in the manufacture of the products of the automotive industry will be made in Indonesia. The same policies are enforced in the two-wheel vehicle industry in which nine companies are actively assembling, distributing, and manufacturing components for six makes.

In the automotive components industry the government has studied the feasibility of developing the manufacture of petrol and diesel engines, axles and propeller shafts, and steering systems. PT Spicer Indonesia, for instance, has obtained government permission to produce axles and propeller shafts under license from Dana Corporation, a U.S. firm.

The following stock manufacturing industry is controlled by a single government-owned corporation, PT Industri Kereta Api (PT INKA). Major programs of PT INKA today are the manufacture of 150 units of coal cars, another 250 units of tank cars to be completed this year, and up to 2,400 units of freight cars under license from Nippon Sharyo, a corporate member of the Sumitomo group of companies. The production programs for 1985 and 1986 include 126 units of passenger cars, an additional 344 units of coal cars, 200 units of fertilizer freight cars, and a total of 766 units of freight cars for various other purposes. Again, progressive manufacturing plans are implemented in all programs.

Recently, with Nippon Sharyo, PT INKA has submitted a joint bid for the delivery of freight cars to Thailand. This will be the company's first test of its competitiveness in the international market.

With the development of the rolling stock manufacturing industry, the market for its components has correspondingly widened giving rise to the prototype production of casted bogies by PT Barata Indonesia. The progress made by PT INKA has also attracted the interest of foreign companies such as Messerschmitt-Bolkow-Blohm, Linke-Hoffman-Busch and Salzgitter AG from Germany, and Holec from The Netherlands to cooperate with the company.

Telecommunications

Three subsectors are being developed in this industry: the consumer electronics industry which like the automotive industry in Indonesia is largely private; the utility telecommunications industry manufacturing communications satellite ground station equipment, telephone equipment, etc., in which government-owned enterprises play a major role; and the cable and wire industry, also largely privately owned. This sector is also in the first stage of development.

Major programs being implemented include the manufacture by PT INTL, a government corporation, of digital telephone switching systems under license from Siemens. An evaluation is currently being made for the concluding of a second licensing agreement between PT INTI and another company for the same type of equipment. Contenders include among others Phillips, the French CIT ALCATEL, and the U.S.-Belgian Bell Telephone Company. The firm is also cooperating with the Japan Radio Corporation in the manufacture of automobile telephones, and with VIZ of the United States in producing radio wind sondes. The National Electronics Institute, a government research organization, is developing a defense-related communications system as well as short-wave 100-kW and 250-kW radio transmitters, 50-W to 10-kW television transmitters, and satellite television receivers. The privately owned Radio Frequency Company manufactures various types of radio receivers, multiplexers, television transmitters, and translators as well as radar under license from the

Atlas-Krupp company. All three companies--PT INTI, the National Electronics Institute, and Radio Frequency Company--produce components for satellite ground stations under license from International Telephone and Telegraph Company, Nippon Electric Company, and others. PT INTI, for instance, has completed 20 small ground stations for domestic uses and is on contract with Malaysia for the construction of, in the first phase, six small ground stations. Under contract with the International Telecommunications Union, PT INTI will construct a packet satellite data communication network to be operational this year.

Present capacity of the cable manufacturing industry includes duct cables, jelly-filled cables, underground cables, electric wires, automotive wires, and other products.

The Energy Industry

Given Indonesia's projected growth in the demand for tertiary energy, mechanical power, and energy transport, there is vast scope for investment in the energy industry: the manufacture of boilers, turbines, generators, heat exchangers, energy transport equipment, and machinery.

We conservatively estimate that in the coming years the demand will approach 30,000 megawatt electrical which implies a volume of business of up to 45 billion U.S. dollars. We are planning for at least one-third participation of Indonesian firms in this business through licensing.

In the boiler industry, present capability comprises the manufacture of industrial boilers of up to 100 t/h steam-generating capacity, while industrial boilers with larger capacities and utility boilers are still being imported. Firms active in the boiler industry include PT Atmindo, a licensee of Bardet Babcock and Deutsche Babcock; PT Super Andalas Steel, licensed by Takuma Boiler to manufacture boilers of up to 80-t/h capacity; PT Boma Sork, a Brownswerk Utrecht licensee; and PT Barata, a Combustion Engineering-Lummus Company licensee for the manufacture of erection boilers of up to 200 MW. PT Barata Indonesia is also a licensee of CE-Lummus to manufacture heat transfer equipment of 5,000-t/y capacity.

In water turbine manufacture, present Indonesian capability has reached 1,400 BHP.

Two electric generator manufacturers are in operation in Indonesia today: PT Denyo Indonesia, manufacturing generators of up to 50 KVA under license from Denyo of Japan, and PT New Age Engineers Indonesia, producing generators of up to 1,000 KVA in cooperation with the British firm of Stamford.

Electric generator diesel engine manufacturers include PT Boma Bisma Indra producing Deutz and PT Mesindo Agung manufacturing MWM engines, both from West Germany.

As is the case with the other industries also in this vehicle, control of the market does not necessarily mean the predominance or monopoly of government enterprise.

The Engineering Industry

The engineering industry also has large potential in Indonesia, producing components for sugar factories, paper mills, fertilizer plants, etc. In the sugar industry alone, this is a market for 10 factories which, if produced at the rate of one every 2 years, will provide component manufacturers work for 20 years. We are, therefore, preparing PT Barata Indonesia to work together with Kawasaki in a first-phase development program in this field. Barata will also be specializing in manufacturing equipment for the papermill industry. PT Boma Bisma Indra will be geared to serve the petrochemical industry, while other firms will be prepared to specialize in other selected fields. In addition to these government corporations, private firms are also active in this industry.

Many government and private companies are also active in the software business of project management and engineering. Present capacity reaches 210,000 man-hours a month with, for instance, PT Panca Perintis Indonesia working together with Fluor of the United States in the Cilacap Refinery project; PT Purna Bina Indonesia in partnership with Bechtel also from the United States working on the Bontang LNG-project; and PT Barata Indonesia being the main contractor for the Baturaja Sugar Factory.

Because as in the case of shipbuilding there is scope for the participation of a sizable number of firms in this industry, it has appeared more efficient to establish a single separate company, PT Rekayasa Industri, expressly for the purpose of leading the second phase of the development of this industry by undertaking the tasks of designing new products and integrating components into the new product with component manufacture being undertaken by other companies.

Agricultural Equipment

With presently projected rates of growth of the Indonesian economy, agriculture will remain a very important sector in terms of contributions to GDP and employment. The scope for manufacturing both pre- and postharvest agricultural machinery and implements is correspondingly very large.

Except for large tractors, domestic industry has developed sufficient technological capability to manufacture equipment such as hand tractors; mini-tractors; irrigation pumps; sprayers; rice threshers, hullers, polishers, and milling units, etc.; and implements such as plows, levelers, floating wheels, and rotors, both of foreign as well as of domestic design. Most manufacturers, assemblers, and sole sales agents are privately owned.

The Defense Industry

In addition to what has been said with regard to the production of patrol boats by PT PAL and the manufacture of helicopters by

PT NURTANIO, both companies plan to be active in the defense industry with the possible design and manufacture of jet trainers and fighter aircraft by PT NURTANIO in a third-phase development of the aircraft industry, and the future production of 2,100-dwt frigates and minesweepers by PT PAL.

The weapons systems division of PT NURTANIO will also manufacture AEG Telefunken SUT torpedoes and Belgian 2.75-in. FZ rockets.

PT PINDAD, a government company, in a first-phase development program will manufacture FNC rifles firing SS-109 5.56-mm bullets under license from the Belgian firm of FN Herstal. Also with FN Herstal, PINDAD will manufacture various other caliber ammunition and nonguided missiles as well. Other PINDAD programs include mortars and grenades.

PINDAD's technological and manufacturing capability will also be used for nondefense-related production programs such as the manufacture of engine components, transmissions, steering wheels, front axles, and ship components in cooperation with Rheinstahl Technik in forging technology; the production of industrial tool machinery with the DIAG Group; and the production of various tools and jigs.

The Role of the Agency for the Assessment and Application of Technology

In the evaluation of sectors of industry for their potential as vehicles for Indonesia's transformation into a technologically and industrially developed nation; in the definition and monitoring of first-, second-, and third-phase development programs; in the selection of potential partners for Indonesian firms; and in the selection, preparation, and supervision of Indonesian companies engaged in the various phases of transformation of their industries the Agency for the Assessment and Application of Technology plays a crucial role.

It is this agency which guides and monitors the implementation in Indonesia of the concept of technological and industrial transformation that I have described, and which assesses the interconnections between technology, industry, and other areas of Indonesia's national life.

Established in 1978 by Presidential Decree Number 25 and recently reorganized by Presidential Decree Number 31 of 1982, the agency has the tasks of advising the president in matters of national policy with respect to the development and application of technology for national development; of coordinating the implementation of technology development and application programs; of providing advisory and consulting services to government agencies and to the private sector; and of implementing technology development programs.

Governed by a chairman who is concurrently Minister of State for Research and Technology and a vice-chairman, the agency has 20 directorates and 4 bureaus reporting to 6 deputy chairmen. These are:

- The directorates of basic sciences, life sciences, engineering sciences, and marine sciences reporting to the Deputy Chairman for Basic and Applied Sciences

- The directorates of human settlement and environmental technology, industrial process technology, energy conservation and conversion technology, electronics and informatics, and physical facilities and laboratories reporting to the Deputy Chairman for Technology Devélopment
- The directorates of machine and electrotechnical industries, processing and engineering industries, defense and strategic industries, and industrial infrastructure reporting to the Deputy Chairman for Industrial Analyses
- The directorates of natural resources inventory, mineral resources, and nonmineral resources reporting to the Deputy Chairman for Natural Wealth
- The directorates of operations research and management, systems analyses, technological regulation, and simulations and modeling reporting to the Deputy Chairman for Systems Analyses
- The personnel, education, and training bureau; the finance bureau; the bureau for legal affairs and public relations; and the bureau for supervision and control reporting to the Deputy Chairman for Administration.

In addition, the agency has the following technical operations units: the Construction Testing Laboratory; the Aerodynamics, Gas Dynamics, and Vibrations Laboratory; the Thermodynamics and Propulsion Laboratory; the Energy Laboratory; the Processing Technology Unit; the Ethanol, Single-Cell Protein, and Sugar Unit; the Hydro-Electrical Unit; the Coal Processing Unit; the Transportation Systems Unit; the Defense Industries Unit; and the Social Sciences Unit.

As can be seen, the agency's technical operating units include those facilities of the PUSPIPTEK Center for the Development of Research, Science, and Technology which have been completed. And as has been said earlier, while most of the first- and second-phase development programs are undertaken by industry, the agency itself implements many third-phase developments and prepares the execution of most fourth-phase programs. Many of these are being executed jointly with research and development organizations both in Indonesia as well as abroad.

Mr. Chairman,
Distinguished Members,
Ladies and Gentlemen,

After having shown you that the concepts I have presented do have practical utility, I would now like to conclude with the following closing remarks.

SUMMARY AND CONCLUSIONS

In the context of nation-building which I regard essentially as the effort to develop a people's human potential to produce goods and services of benefit to themselves and to the world, to protect their political integrity, and to advance their cultural endowments, the transformation of a society into one that is technologically and industrially sophisticated is a vital process. For this transformation the improvement of scientific and technological skills is central.

I have approached the problem of achieving this transformation from the point of view that while education is very important, it cannot be sufficient. For science and technology is only mastered through work. Lasting technological skills are only transferred and further improved through concrete programs of producing goods and services.

One can conceive of the process of technology transfer and development as consisting of three overlapping phases: the use of existing technology for added-value processes; the integration of existing technologies for the design and manufacture of new products; and the development of new technologies. A fourth phase can also be identified. This phase, crucial for the maintenance of scientific and technological prominence and of particular relevance to developed industrial countries, is the phase of basic research in order to advance scientific knowledge itself.

In theory, any program can function to transfer and and develop technology. Not all programs, however, are the proper vehicles for the technological and industrial transformation of developing countries. To become vehicles they must fulfill certain criteria. The first and necessary condition is that progressive manufacturing plans can be designed and implemented permitting a step-by-step penetration of the technology. The second and sufficient condition is that the products or product groups must have a demand on the controlled domestic market.

The products or product groups appropriate to qualify as vehicles for the transformation of a particular country are determined by its geography, its factor endowment, the growth of its economy, the size of its domestic market, and other factors. For Indonesia, the following eight industries have emerged as the vehicles for the transformation of the Indonesian people into a nation masterful in technology and proficient in industry. These are: aeronautics and aerospace, shipbuilding, land transportation, electronics and telecommunications, energy, engineering, agricultural mechanization equipment, and the defense industry. The very growth of these eight vehicles have through many forward and backward linkages, engendered the growth of what I have called the ninth vehicle: all kinds of service industries, including health services, housing, construction, food, agro-industry, pharmaceuticals, component manufacture, etc.

Finally, by describing the developments in the industries defined as Indonesia's vehicles, I have attempted to demonstrate that the ideas I have presented are being implemented in the guiding and controlling of a country's technological and industrial transformation.

Mr. Chairman,
Honorable Members of the Society,
Ladies and Gentlemen,

The fact that technological and industrial development in Indonesia is subject to guidance, supervision, and control does not mean that private initiative is stifled. Indeed, as I have shown, in all the vehicles for our transformation there is vast scope for private enterprise. For Indonesia does believe in the efficacy of the market economy. As is also evidenced by our conclusion of agreements of cooperation in science and technology with the United States in 1978, with the Federal Republic of Germany and with France in 1979, and with Japan in 1981, we highly value our close economic, political, and cultural relations with any country and any party willing to be our partners on the basis of mutual respect and interest based on the philosophy and the concepts I have presented to you today.