FACTORS ENHANCING THE PARTICIPATORY ROLE OF RESEARCH INSTITUTES IN THEIR NATION'S INDUSTRIALIZATION

A FOUR COUNTRY SABBATICAL STUDY

DENVER RESEARCH INSTITUTE
UNIVERSITY OF DENVER

FACTORS ENHANCING THE PARTICIPATORY ROLE OF RESEARCH INSTITUTES IN THE R NATION'S INDUSTRIALIZATION

A FOUR COUNTRY SABBATICAL STUDY

REPUBLIC OF KOREA
THAILAND
JORDAN
TRINIDAD and TOBAGO
(Plus Selected Information on INDIA)

FINAL REPORT

Submitted To: USAID/STI

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INTRODUCTION

This sabbatical study investigated factors affecting the participatory role of research institutes in the planning and implementation process of their nation's industrial development programs as well as identified specific governmental incentives programs having beneficial influence on these institute interactions with industry.

This sabbatical study was conducted during the period 14 May 1977 to 7 September 1977. The author spent approximately three weeks in each of the four nations as the guest of the President of their country's principal research institute, and is deeply indebted to them for their extensive efforts in arranging personal discussions with officials in government agencies, industries, and universities.

These four host institutions were:

Korea Institute of Science and Technology (KIST)
Host: Dr. Hahn, San Joon, President

Applied Scientific Research Corporation of Thailand (ASRCT)
Host: Dr. Wadanya Nathalang, Governor

Royal Scientific Society of Jordan (RSS)
Host: Dr. Albert Butros, Director General

Caribbean Industrial Research Institute (CARIRI)
Host: Mr. Hollis Charles, Director

A total of approximately 65 different personal meetings were conducted varying in length from one-half hour to one and one-half hours. See Appendix A for a complete listing of all the officials who participated.

In addition, the author spent some time in India talking to officials in the National Research Development Corporation of India (NDRC) and the Council of Scientific and industrial Research (CSIR).

These discussions, aided by additional reading of reports and material supplied during the interviews, served as the basis for the report which follows.

The views and opinions expressed in this report, unless identified as to source, are solely those of the author and imply no concurrence or endorsement by anyone. It should be noted in particular that the investigator had no opportunity to discuss his concept of the Venture Technology Corporation, see Part Two, Section III, with anyone in Trinidad, for the idea did not mature until his return to Denver.

PREFACE

In February 1977, CARIRI hosted a UNIDO sponsored meeting attended by administrators from five research institutes from three continents, and a comprehensive report was published entitled "Utilization of National Technological Institutions in the Developing Countries for Industrialization."

Because the subject matter under deliberation at this UNIDO meeting is quite relevant to the main thrust of the investigator's sabbatical study and particularly pertinent and timely to a number of issues confronting key leaders in the industrialization of developing nations, it seems appropriate to abstract a number of direct quotations from the report and use them as subject introductions for each of the eight sections of this report. In addition, several score of other direct quotations are presented in Appendix B under subject groupings entitled:

A. Research Institutes - A National Resource

B. Research Institutes' Potential Contribution to the Industrial Development Process

C. Impediments to the Process

D. Policy Issues Confronting a Nation

PART ONE

AN ASSESSMENT OF CURRENT PRACTICES AND/OR POLICIES

I. RESEARCH INSTITUTE PARTICIPATION IN THE GOVERNMENTAL PLANNING PROCESS FOR INDUSTRIAL DEVELOPMENT

> Governments of most developing countries depend largely on foreign expertise for the technological inputs required for industrial planning and programming. National technological institutions should participate in national industrial planning by helping to, within the scope of their expertise, provide the technological inputs needed by Governments for establishing the country's industrial development strategy, policy and planning.[1]

This four-nation study finds a wide variation in the degree of research institute participation in their nation's planning process, as well as a variation in the level of economic development of the countries in which these institutes reside. In general, it was found that there appeared to be a direct correlation between the country's economic development and the institute's participation in that development process. In two of the four nations, government regulations stipulate that research institute officials serve on the governing board of the agency having the planning responsibility and, thus, ensure that interaction and communication take place. While there is no policy in any of the four countries which automatically assigns responsibility to their research institute for the actual development of any portion of the planning document, these research organizations do on a regular ad hoc basis contribute input to this process.

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[1] UNIDO-CARIRI Report, "Utilization of National Technological Institutions in the Developing Countries For Industrialization," 9 March 1977.

The importance which the South Korean government places on the contribution of their research institutes may be seen from the fact that these institutions are represented on the three most important planning organizations in the nation, one reporting to the President, one to the Prime Minister, and one to the Minister of Science and Technology. In Jordan, the Director General of the Royal Scientific Society serves as a board member of the National Planning Council, a prestigious organization chaired by the Prime Minister and responsible for the preparation of their development plan.

Table 1, following, presents a ranking, on a subjective basis, of certain aspects of the interaction by the four research institutes in the nation's planning process.

TABLE 1. RESEARCH INSTITUTES PARTICIPATION IN THE NATIONAL PLANNING PROCESS

As defined by the process of formalized planning for the identification of potential industrialization opportunities (i.e. either broad industry sectors such as "electronics" or specific sectors such as "vitrified ceramic sanitary fixtures") deemed potentially beneficial to the nation's economic welfare.

A. DEGREE OF PARTICIPATION

	High			Low
KIST	X			
ASRCT			X	
RSS		X		
CARIRI			X	

B. THEIR PARTICIPATORY ROLE

	Formal (Organized)	Informal (Ad hoc)
KIST	X	
ASRCT		X
RSS	X	
CARIRI		X

C. THEIR DESIRE TO INCREASE THIS PARTICIPATION

	High	Low
KIST	X	
ASRCT	X	
RSS	X	
CARIRI	X	

II. RESEARCH INSTITUTE PARTICIPATION IN THEIR NATION'S PROCESS FOR IMPLEMENTING THEIR INDUSTRIAL DEVELOPMENT PLAN

> The involvement of these national (research) institutions in the industrialization process has not been clearly understood and well defined. While a number of them play key roles in some countries, their involvement in most developing countries is still very limited, especially in such areas as industrial and technological planning, programming and forecasting; project identification, preparation and evaluation; and project and program implementation. The full potential of these institutions as an instrument of industrialization has therefore not been fully utilized.[1]

It is quite evident that governments in the nations studied do a fairly reasonable job in utilizing their research institutes in the "planning process" but underuse them, almost to the point of exclusion, in the "implementation process" accompanying their industrial development.

There are too few examples of research institutes being retained to systematically transfer the technology required to undergird the industrial sectors programmed for growth. There are selected examples where this has occurred in Korea, but, even there, it would appear that KIST contributes to the nation's industrial development more effectively as a result of than by any overall government strategy, and these efforts are more in pursuit of randomly occurring technological opportunities rather than by a planned, integrated approach to fill a perceived national requirement.

Instead, it would appear that the four nations implement their industrial development plans by the controlled deployment of venture capital and by favorable tax concessions. When faced

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[1] Ibid.

with technological constraints, they most frequently turn to foreign national "experts," and have little or no concern that their indigenous talents may be lying fallow.

Of secondary significance is the fact that India and Korea have vested important "traffic cop" functions to their research institutes for industries seeking government subsidy in purchasing imported technologies (see Part One, Section III following for more information).

It is interesting to note that many senior investigators in all of the research institutes visited felt a serious compulsion, beyond any stated corporate goal, to be instrumental in developing technologies which would create new industries. However, a number of them feel that many of their efforts have small chance of commercialization because they are more isolated than they wish to be from the venture capitalists, the entrepreneurs, and the industrialists, and without better integration into this commercial sector, they too often have no other recourse than to continue to develop new ways to husk the coconut or to search for drugs from native plants.

Of the countries included in this study, Trinidad and Tobago might well be the country which is most prepared to experiment with new organizational entities, designed to couple their research institute into the implementation process accompanying their industrial development plan.

Table 2, following, presents several aspects of factors relevant to this subject.

TABLE 2. RESEARCH INSTITUTES AND THE NATIONAL INDUSTRIAL DEVELOPMENT IMPLEMENTATION PROCESS

A. DEGREE OF PARTICIPATION (Relative to one another)

	High				Low
KIST			X		
ASRCT				X	
RSS				X	
CARIRI				X	

B. THEIR PARTICIPATORY ROLE

	Formal (Organized)		Informal (Ad hoc)		Non-Existent
KIST	X	———	X		
ASRCT			X	———	X
RSS			X	———	X
CARIRI			X	———	X

C. THEIR DESIRE TO INCREASE THIS PARTICIPATION

	High				Low
KIST			X		
ASRCT		X			
RSS		X			
CARIRI			X		

D. THEIR TECHNICAL CAPABILITY TO PARTICIPATE MORE ACTIVELY

	High				Low
KIST	X				
ASRCT				X	
RSS	X				
CARIRI			X		

I.I. GOVERNMENTAL INCENTIVES FOR THE ENCOURAGEMENT OF INDUSTRIAL RESEARCH AND DEVELOPMENT

> Each developing country should, where appropriate, establish a national policy and create machinery for the commercialization of R&D results.[1]

In three of the five countries visited, Thailand, Jordan, and Trinidad, there were no laws which were identified which provided governmental incentives for the encouragement of industrial research and development. It was surprising to note that the negative responses to this question occurred, in general, without the respondent having to search his memory.

In the countries which have not enacted incentive legislation, there is a concensus that their nations must first establish policy issues dealing with industrial development and technology before they are prepared to implement incentive programs. This subject is treated in greater depth in Section II of Part Two. Table 3, following, presents a subjective four-country, relative ranking of such laws and policies.

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[1] Ibid.

TABLE 3. GOVERNMENTAL LAWS AND POLICIES

A. GOVERNMENTAL INCENTIVES FOR THE ENCOURAGEMENT OF INDUSTRIAL RESEARCH AND DEVELOPMENT

	Extensive	Nonexistent
KOREA	X	
THAILAND		X
INDIA	X	
JORDAN		X
TRINIDAD		X

B. EXTENT TO WHICH GOVERNMENT HAS ARTICULATED POLICY FOR SCIENCE AND TECHNOLOGY

	Extensive	Fragmentary
KOREA	X	
THAILAND		X
JORDAN	X	
TRINIDAD	X	

C. EXTENT TO WHICH GOVERNMENT HAS ARTICULATED POLICY FOR INDUSTRIAL DEVELOPMENT

	Extensive	Fragmentary
KOREA	X	
THAILAND		X
JORDAN		X
TRINIDAD		X

In total, there were three laws that were identified in this incentive category, two of them enacted in Korea and one in India and are noted below. In addition, there were a half-a-dozen loosely structured policies and practices which were intended to encourage greater interaction between industry and research institutes.

A. Incentive Laws

1. On 28 December 1972, Korea enacted the "Technological Development Promotion Law, No. 2399."

   Purpose: To promote development of industrial technology, as well as to assist in the transfer of imported technology.

   Method: Industry may, with the permission of the Ministry of Science and Technology (MOST), set aside up to 10 percent of its profits, before taxes; and, with MOST permission, can invest these funds in research and development, either in-house or contracted to a research institute.

   Progress to date: From both industrial and governmental reports, Korean industry is taking ever increasing advantage of this law. At the latest count 135 firms of differing size have set aside approximately 15 billion won ($30 million US). It is also encouraging to note that the Minister of Science and Technology estimates that 50 percent of the new industrial business which is coming to KIST is as a result of this law.

2. Another law, passed in Korea in 1977, permits an industry building a research laboratory to take credit for such capital expenditures with a reduction in taxes of up to 10 percent, and to carry the credit forward as long as five years, to obtain full write-off, if possible.

3. India has an incentive law where industry can write off 100 percent of its expenditures on "Approved National Research Development Corporation (NRDC) Projects," as well as write off 35 percent of its capital expenditures on such NRDC projects. In addition, industry contracting with a recognized research institute can claim one and one-third times its actual research expenditures for tax computation.

B. POLICIES WHICH ENCOURAGE INTERACTIONS BETWEEN INDUSTRY AND RESEARCH INSTITUTES

1. India has instituted an attractive incentive system which flows back to the inventor 40 percent of the royalties received by its venture development corporation, NRDC, as well as a flow back to the inventor's research laboratory of another 30 percent.

2. India's venture capital corporation, NRDC, has been recently authorized to collaborate with industry to finance development projects on a fifty-fifty basis, and under certain circumstances the loans are forgiveable. NRDC can also take an equity position.

3. In September of 1974 KIST formed a wholly-owned subsidiary called Korea Technology Advancement Corporation (K-TAC), with initial capitalization of $1 million (US) to commercially exploit concepts developed in KIST or by cooperating industry. K-TAC can flow its profits back to KIST, either as cash dividends or by the purchase of contract research. The hope was expressed that in ten years the revenue produced by K-TAC would support 50 percent of KIST's budget.

4. In February 1976 KIST formed a Technology Transfer Center with the primary function to, under contract, acquire, evaluate, accumulate, and make prompt recommendations to domestic firms on overseas technological information.

5. India's Council of Scientific and Industrial Research (CSIR), a 12,000 man organization, initiated a new policy several years ago designed to encourage its professional staff to spin off and establish new industrial organizations, by granting three-year leaves of absence and rather permissive use of CSIR facilities. Twenty employees have opted for such leaves, and, to date, four have established operating companies.

6. India's Minister of Finance has recently announced his intentions of pushing for a new law for a "Research Cess" or tax.

7. Although the investigator did not pursue the subject, in retrospect it would appear that some of the governments, by curtailing funding are pressuring their research institutes to increase their contract income from industry.

IV. LEVEL OF INPUT INTO GOVERNMENT PROCESS BY TECHNOLOGISTS

> In most developing countries, local technological institutions, where they exist, are generally not called upon nor do they actively seek to play an important role in national planning. The level of achievement of national industrial goals would generally be enhanced if national indigenous technical capabilities, especially technological institutions, were intimately involved at all points of the industrialization process, especially at the planning stage.[1]

There appears to be a rather direct correlation between the level at which the nation's champions of technology have input into the government process and the government's formulation of policy issues linking their research institutes with their industrial development program. Table 4 below, presents a subjective ranking of one element of this factor for the four countries visited.

TABLE 4. THE LEVEL OF INPUT INTO THE GOVERNMENT PROCESS BY TECHNOLOGY PROPONENTS

	Prime Minister	Minister	Sub-Minister
KOREA	X		
THAILAND	X	(?)	X
JORDAN	X[2]		X
TRINIDAD	X		

Korea is well recognized for its progressive policies in linking its research institutes with its industrial development program (see Part Two, Section II for additional information). This has been

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1 Ibid.

2 The Crown Prince

attributed in no small measure to the fact that the first president of KIST, appointed in 1966, was then elevated to the post of Minister of Science and Technology. In Thailand there is strong feeling by some senior governmental and industrial officials that their nation should establish a new ministry embracing industry, science and technology, but their efforts are meeting with a fair degree of opposition. Unfortunately, the National Research Council (NRC), established in 1956 under Thailand's Prime Minister, is not perceived as a vehicle which can mount a strong voice for technology since the organization represents a multiplicity of interests ranging afar afield as law, medicine and sociology. In Jordan, the research institute, RSS, functions under a Board chaired by the Crown Prince, but this does not insure that their inputs are requested at the ministerial level.

There is strong activity in Trinidad and Tobago to elevate the science and technology leaders into the highest governmental council. The National Council for Technology in Development, established in 1976, reports to the Prime Minister through an inter-ministerial group. Also, there is considerable interest in Trinidad in having their research institute take an increased leadership role on technological issues.

V. COMMUNICATION LEVELS AND ATTITUDES

> Technological institutions....must develop a rapport with industry and must convince industry that the results of their actions will be to its benefit. At the same time, they must also develop close working relationships with the decision-making and implementing bodies of government.[1]

A. Government Viewpoint of Their Research Institute

There were marked differences between the four countries in the general viewpoint of officials in various ministries towards their research institutes. A subjective evaluation is presented in Table 5, following.

B. The Governing Boards of the Research Institutes

The governing boards of the research institutes visited were of a rather uniformly high caliber. In Korea, KIST has a nine-man board of Trustees, including a Vice Economic Planning Minister, a Vice Commerce and Industry Minister, a Vice Science and Technology Minister, and representatives from industry and universities. In Trinidad, CARIRI is governed by a Board of Management consisting of twelve members appointed by the Minister of Finance, and includes a representative of government to serve as chairman, a representative of the Industrial Development Corporation, four from the University of the West Indies, and three from the industrial commercial sector.

These boards have considerable influence in high government circles and when properly motivated can contribute much to the growing success of these research institutes. Table 6, following, presents a subjective evaluation of some aspects of the functioning of these boards.

[1] Ibid.

TABLE 5. GOVERNMENT VIEWPOINT OF THEIR RESEARCH INSTITUTE

(A subjective evaluation, integrating inputs from a number of government officials)

A. SIGNIFICANCE OF CURRENT PROGRAM

	Important			Unimportant
KIST	X			
ASRCT			X	
RSS				X
CARIRI		X		

B. POTENTIAL FOR INCREASED CONTRIBUTION TO THE NATION'S PLANNING PROCESS

	High			Low
KIST	X			
ASRCT			X	
RSS		X		
CARIRI	X			

C. POTENTIAL FOR INCREASED CONTRIBUTION TO THE NATION'S INDUSTRIAL DEVELOPMENT PROCESS

	High			Low
KIST	X			
ASRCT			X	
RSS		X		
CARIRI			X	

TABLE 6. GOVERNING BOARDS OF RESEARCH INSTITUTES

A. THEIR DEGREE OF EFFECTIVE COMMUNICATION WITH GOVERNMENT

	High			Low
KIST	X			
ASRCT			X	
RSS				X
CARIRI	X			

B. THEIR DEGREE OF EFFECTIVE COMMUNICATION WITH INDUSTRY

	High			Low
KIST		X		
ASRCT			X	
RSS				X
CARIRI		X		

PART TWO
DESIGNING FOR CHANGE

I. ELEVATION OF TECHNOLOGY CHAMPIONS INTO HIGHEST GOVERNMENT POLICY LEVEL

> There is general recognition that the rate of economic growth in general and of industrial development in particular is greatly enhanced by the level of technology in the country.
>
> ....technological institution(s)...are focal points, in terms of the existing and future development of indigenous capability.[1]

It was a uniformly held opinion that a key factor affecting the development of a strongly articulated national policy for industrial development, as well as a positive climate for favorable growth of their nation's industrial research institute(s) was the ability of their technology leaders to serve in a formal policy role at a level reporting to the prime minister, or even better, to have an entire ministry dedicated to the development of a sound and vigorous industrial and technological infrastructure.

There seems to be a universal syndrome that scientists are more prestigious than engineers, and it is the author's opinion that all too frequently government officials place more emphasis on the opinion of academic scientists on technological issues than they do on the opinion of the engineer technologist. As a result, scientists frequently serve in important capacities in their nation's industrial development programs, sometimes to the exclusion of the participation by technologists.

It is the investigator's considered opinion that LDC's should seriously consider establishing ministries of industry, science, and technology, with a greater emphasis on technology than on science.

[1] Ibid

II. ESTABLISHING NEW GOVERNMENTAL POLICY

> There also needs to be a clear technology policy that will determine: the degree of technology development needed; the extent of involvement of various institutions; the mechanism and mode of transferring technology; and the extent of utilization of foreign versus local sources of expertise.[1]

It was underscored repeatedly during this investigation that developing nations committed to an industrialization development program must first establish, at as early a date as possible, an overall policy which clearly establishes the government's position in support of selected industrial development programs, and guarantees continuity and consistency of all the economic elements contributing to the financial success of these new industrial operations.

Once such policies are established, then, the nation is better prepared to articulate a subset of policies designed to provide incentives for the encouragement and growth of its scientific and technological infrastructure, including a positive, well defined role for its research institutes in the nation's industrial development process.

The Republic of Korea has actively addressed this problem, and the policy which they established in 1975 should be brought to the attention of other nations who have yet to formalize such policy. Because of the potential value of this document, entitled "Main Korean Science and Technology Development Policies in 1970's" and issued by the Ministry of Science and Technology, the Table of Contents and Chapters III through V are reproduced in their entirety in Appendix D.

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[1] Ibid.

III. A NEW ORGANIZATIONAL APPROACH

> An important approach to the development of the national industrial capacity is to involve indigenous technical personnel in the entire industrialization process. A national system and machinery must be developed to ensure the proper coordination and effective use of local technical expertise in industrial development. An important aspect of such a national system and machinery is the establishment of technological institutions to cater for the technological inputs at each point of the industrialization process.[1]

There was rather universal interest in most of the nations visited in the concept of a "National Research and Development Corporation," or venture capital, high technology organization, even though each nation has some form of an industrial finance corporation, investing large sums of money in industrial endeavors, often of a highly technological nature. It appears that this interest is occasioned because the boards and staff of these existing financial organizations have no technological component and are almost entirely bankers and economists. In Thailand, their Industrial Finance Corporatio , an excellent organization, invested in 11 projects in 1976 totalling $25 million (US) and over a 17-year period has invested a total of $175 million in 376 projects.

In the same type of operation, the Trinidad and Tobago Development and Finance Company, in the six-year period of 1970 to 1976, invested in 148 projects totalling $17.3 million (US), and their annual report indicates that this investment has created 3,285 jobs in Trinidad. This sabbatical study indicates that the technological input by research institutes into the decision processes that lead to these loans was almost nil, and it is not surprising that some technologists raise the question about

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1 Ibid.

organizational vehicles which can put the technologists at the same table as the investment banker in this phase of the industrial development process of the nation.

Even the banking institutions raise similar questions. The Chairman of the Board of Trinidad's Development Finance Company said, "...there is need for institutional mechanisms to coordinate research and to develop and package bankable projects that could provide some avenues for investment for the private sector and the existing financial institutions. Unless some positive attempt is made to develop projects, the banking system will continue to remain short of good investment avenues."

In Korea, KIST formed in 1974 a wholly-owned subsidiary called Korea Technology Advancement Corporation (K-TAC) with initial capitalization of $1 million (US) to commercially exploit concepts developed in KIST or by cooperating industry (see Part Three for additional information). K-TAC can flow its profits back to KIST, either as cash dividends or by the purchase of contract research. The hope was expressed that in ten years the revenue produced by K-TAC would support 50 percent of KIST's operating budget. Korea's Ministry of Science and Technology is also giving consideration to the establishment of a quasi-government venture capital corporation.

In 1953, India established the National Research Development Corporation of India to exploit processes developed in government laboratories. It is controlled by a board with representation from the Prime Minister's office, the Ministry of Industry, the Planning Commission, and the director of their leading research institute, CSIR. In 1977, NRDC is budgeted to receive royalty payments of approximately $750,000 (US) of which NRDC will distribute 70 percent to the government laboratory developing the process and retain 30 percent for its own operational expenses. NRDC receives these royalties from 350 licensees whose production of goods in 1976 amounted to about $30 million (US).

Because of the high degree of interest evidenced by government officials and other Trinidad leaders in exploring new concepts in organizational mechanisms designed to enhance the transfer and commercialization of new technologies, the investigator, upon return to the United States, drafted a position paper, which he reviewed with his Trinidad host, CARIRI of a concept for a new type of venture capital, high technology corporation. For purposes of this report it will be called the VENTURE TECHNOLOGY CORPORATION and its general goals and functioning would be as follows:

VENTURE TECHNOLOGY CORPORATION

This Corporation could be incorporated as a quasi-government, for profit organization. It could be initially capitalized at a level of $4 to $6 million (US).

At first glance, VTC might appear to resemble a banking institution, or perhaps a "National Research and Development Corporation," but in fact there would be major differences. The general philosophy pervading VTC would be quite similar to that expressed by General Georges F. Doriot, President, American Research and Development Corporation (ARDC), when he said, "....we are not financiers, nor are we bankers. We are builders."[1]

The dominant role of VTC would be to exert an aggressive entrepreneurial role in the creation and financing of new industrial enterprises using the most appropriate technologies of the world.

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[1] 1969 Annual Report, the American Research and Development Corporation, January 30, 1970.

A. Corporate Goals

The corporate goals of VTC would be to systematically identify and assess those technologies of the world which could be introduced into the nation's economy; to serve as an entrepreneurial broker to transfer selected technologies to existing industries or to be the catalytic agent in the creation of new industries; and to provide venture capital, largely on an equity basis, for such development. A prime responsibility of the Corporation would be to gain financial self-sufficiency within the first five years by generating income from its investments in excess of its operating budget, while continuing to gradually divest its older equity holdings to obtain the new capital required to roll-forward its portfolio to new investments. Implicit in the pursuit of these goals is the establishment of strong cross-linkage between the commercial, technological, and governmental sectors as well as the initiation of monetary reward mechanisms to motivate the key performers.

B. Corporate Ownership and Organization

VTC would be incorporated as a nongovernment organization with its shares equally divided between three organizations--the nation's Industrial Development Corporation, the nation's leading development bank, and the nation's leading industrial research institute.

VTC would operate for profit, and dividends would only be distributed to the above shareholders. The Board of Directors of VTC would be selected equally from these three organizations and an equal number representing both government and industry.

C. Corporate Objectives

1. Commercial Activities

- Provide venture funding either as interest-bearing loans or on an equity basis to cooperating industry for the development and capital costs incurred in the commercialization of technology-based products and processes.

- Form new companies, if required, either jointly with participating organizations or as wholly owned VTC subsidiaries.

- Establish joint venture activities with conventional, national and international banking institutions, and venture capital firms.

- Function as brokers, when VTC has no interest in participating as a principal, to introduce individual innovators or small companies to larger organizations having the capability to commercially develop their concepts.

- Sell outright or license patents, trade secrets, licensing agreements, and know-how owned by the Corporation to both national and international industrial organizations.

- Assign patent equity positions to university and research institute staff for royalties accruing under VTC sponsorship.

- Develop incentive mechanisms to adequately compensate university faculties for their energies expended on VTC corporate activities.

- Finance, at least on an incentive basis, new university programs in engineering innovation designed to develop the engineer entrepreneur.

2. Technology Assessment

- Identify and assess existing and emerging technologies on a worldwide basis for products and processes which have reasonable potential for commercial development in their nation.

- Classify specific products and processes which appear to have acceptable levels of technological risk, and identify technological capabilities required for development.

- o Inventory innovative and entrepreneurially motivated scientists and engineers of the nation's universities and research institutes having potential capabilities to contribute to technology acquisition transfer.

3. Economic Assessment

- o Conduct market studies to determine the potential sales, both domestic and export, of specific new products and processes which appear technologically promising.

- o Conduct economic studies of the pricing structure of new technologically promising products and processes versus imported products and processes.

- o Establish VTC priorities for the acquisition and application of new technologies having acceptable levels of economic risks.

- o Remain informed on the policies and fiscal terms of national and international financial institutions.

- o Catalog both developed and undeveloped natural resources of the nation.

- o Monitor the indexes of both raw material and finished goods affecting the import-export balance of trade of the nation.

4. Technology Acquisition

- o Acquire on the world market licensing agreements for selected products, processes, trade secrets and know-how.

- o Acquire title to patents on selected products and processes.

- o Subsidize, while granting equity participation in royalty income, university and research institute investigators for work on promising concepts having commercial development potential.

- o Acquire existing companies having technological growth potential for integration into a cooperating industry or for operation as a wholly owned subsidiary of VTC.

5. Technology Transfer

- o Actively solicit selected industrial corporations to engage in joint ventures to exploit new technology.

- Retain expert national and international consultants as required to assist in the commercial introduction of new technologies.

- Assign VTC executives to boards of directors of cooperating industries to transfer management expertise.

- Specify under terms of their loans, if appropriate, that participating industries appoint university/research institute entrepreneurial technologists to their boards of directors.

- Finance mission-oriented university and research institute R&D required to translate specifically needed technological concepts into products and processes that are programmed for commercial development.

- Develop incentive mechanisms for university and research institutes to initiate new interations with industry.

PART THREE

UPDATES ON FOUR RESEARCH INSTITUTES

Korea Institute of Science & Technology

Applied Scientific Research Corporation of Thailand

The Royal Scientific Society (Jordan)

The Caribbean Industrial Research Institute

PART THREE
UPDATES ON FOUR RESEARCH INSTITUTES

During this study, conducted in four different countries, the investigator spent approximately three weeks in residence at the principal research institute in each nation. Officials of these institutes provided assistance in arranging the meetings with government, industry, and university leaders.

Table 7, following, presents the 1976 annual operating budgets of these institutes as well as the current size of staff and their degree holdings. Table 8, following, presents the nation's population, the GNP, and the per-capita income; Columns D and E represent some of the information contained in Table 7. The simple ratio of a research institute budget to the nation's GNP results is presented in an index in Column F. The index given in Column G shows the ratio of the staff size of the institute to the total population of the nation. The absolute value of these indices has no meaning, but the relative size of the index of one country compared to other countries does give some insight. As an example, RSS's percentage consumption of Jordan's GNP is 20 times higher than Thailand's, whereas Trinidad's and Korea's are somewhere closer to Thailand's. The author interprets this as confirmation of an observation in Jordan that there is an uneasiness with certain Jordanian government officials that the RSS's impact on the nation's industrialization is not commensurate with the size of their budget. Also, the low index for Thailand may indicate that the Thai government should increase their financial support of ASRCT. There would also appear to be a correlation between the index and the level of the countries' economic development, with the exception of the Jordan index.

The index presented in Column G of the ratio of the staff size of the research institute to the population of their nation again indicates similar trends.

In the several pages which follow is an update of certain data points concerning the operations of the four institutes included in this study. Other miscellaneous information on these research institutes as well as other organizations they interact with is presented in Appendix C.

TABLE 7. DATA ON THE RESEARCH INSTITUTES

A. ANNUAL EXPENDITURE ON OPERATING BUDGETS FOR 1977
($ in thousands, US)

	Govt. Funding	Other Income	Total
KIST	$3,093	$9,377	$12,470
ASRCT	1,570	251	1,821
RSS	1,149	2,883	4,032
CARIRI	850[1]	240	1,090

B. STAFF NUMBERS AND DISTRIBUTION

	Ph.D.	M.S.	B.S.	Others	Total
KIST	81	160	275	529	1,045
ASRCT	9	58	105	272	444
RSS	23	16	137	195	371
CARIRI	4	9	19	98	130

[1] Income exceeded expenditure by $190,000 (US) and thus the total contribution from government funds was $1,040,000.

TABLE 8. CORRELATION OF INSTITUTE BUDGETS AND STAFF WITH NATIONAL INDICES

(1977 Data Unless Otherwise Indicated)

	A	B	C	D	E	F	G
	Population	GNP	Per Capita	Research Institute Budget	Research Institute	Index #1 D/B	Index #2 E/A
	x 10^{-6}	x 10^{-9}	Income	x 10^{-6}	Staff Size	x 10^{4}	x 10^{5}
Korea	36.0[1]	$31.5[1]	$864	$12.5	1,045	4	3
Thailand	44.0	18.5	420	1.8	444	1	1
Jordan (East Bank Data Only)	2.1	2.0	941	4.0	371	20	18
Trinidad	1.0[2]	0.8[2]	1300[2]	1.1	130	14	13

[1] 1978 data

[2] 1976 data

KOREA INSTITUTE OF SCIENCE AND TECHNOLOGY (KIST)
REPUBLIC OF KOREA

KIST was incorporated in 1966 as an autonomous not-for-profit institute, in reality, a quasi-government organization. It is governed by a board of trustees numbering twelve, including three vice ministers, and three industrialists.

The staff numbers approximately 1,000, and its funding for 1977 is $12,470,000 (US). Twenty-five percent of KIST funding comes from the federal government, about 40 percent of that resulting from specific programs and 60 percent from packaged programs that are evaluated by the Ministry of Science and Technology and the Economic Planning Board.

KIST organized a subsidiary corporation in September 1974 called Korea Technology Advancement Corporation (K-TAC) with initial funding of $1 million (US). K-TAC has great flexibility as a venture capital organization and can pursue KIST ideas to commercial fruition or team with industry on their ideas. K-TAC retains an equity position, and it will flow its profits back to KIST either as cash dividends or by the purchase of contract research. It is hoped that in ten years K-TAC revenue will support 50 percent of KIST. As of June 1977, K-TAC has ventured on five projects.

KIST has a staff currently (1978) numbering 1,045 with the following terminal degrees:

Ph.D.	81
Masters	160
Bachelors	275
Other	529
TOTAL	1,045

APPLIED SCIENTIFIC RESEARCH CORPORATION OF THAILAND - ASRCT

KINGDOM OF THAILAND

The Applied Scientific Research Corporation of Thailand became operational in 1964. It is a main center for applied scientific research in Thailand. It has semi-autonomous structure, operating outside of the Thai civil service, and although receiving governmental financial subsidy, it has an almost unique capability of being in a position to coordinate research programs involving governmental departments, foreign and international agencies as well as to carry out research projects, on contract basis, for private industry.

ASRCT has recently been reorganized, as shown in Figure 1. At present, it has a staff of 444 persons, including 154 professionals. The distribution of staff within various departments is given in Table 9, and the educational background of the professional staff is given in Table 10.

Its budget for fiscal year 1977 is approximately $1.8 million (US).

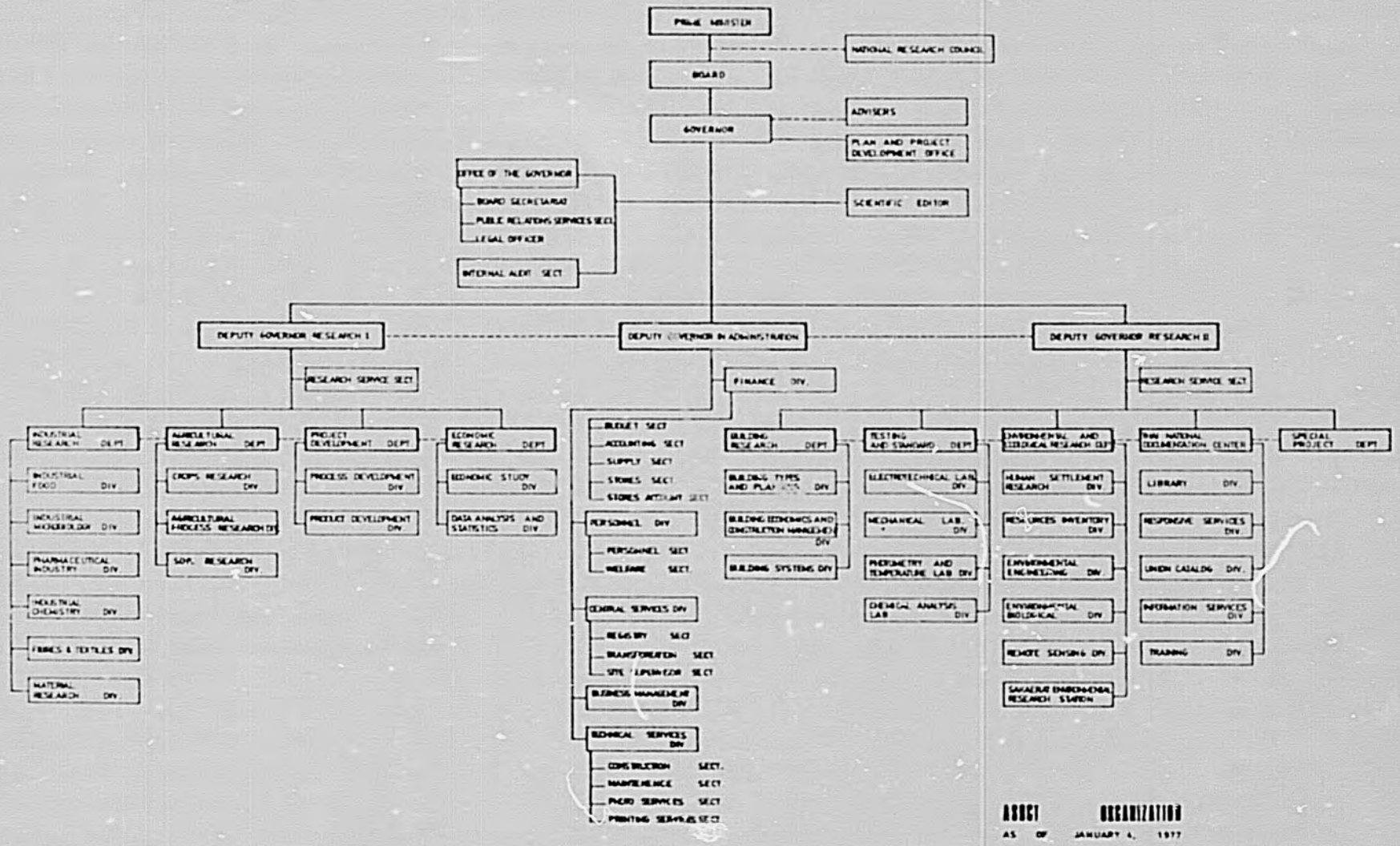

PRIME MINISTER
NATIONAL RESEARCH COUNCIL
BOARD
ADVISERS
GOVERNOR
PLAN AND PROJECT DEVELOPMENT OFFICE
OFFICE OF THE GOVERNOR
BOARD SECRETARIAT
PUBLIC RELATIONS SERVICES SECT.
LEGAL OFFICER
INTERNAL AUDIT SECT
SCIENTIFIC EDITOR
DEPUTY GOVERNOR RESEARCH I
DEPUTY GOVERNOR IN ADMINISTRATION
DEPUTY GOVERNOR RESEARCH II
RESEARCH SERVICE SECT
FINANCE DIV.
RESEARCH SERVICE SECT
INDUSTRIAL RESEARCH DEPT.
INDUSTRIAL FOOD DIV.
INDUSTRIAL MICROBIOLOGY DIV.
PHARMACEUTICAL INDUSTRY DIV.
INDUSTRIAL CHEMISTRY DIV.
FIBRES & TEXTILES DIV.
MATERIAL RESEARCH DIV.
AGRICULTURAL RESEARCH DEPT.
CROPS RESEARCH DIV.
AGRICULTURAL PROCESS RESEARCH DIV.
SOIL RESEARCH DIV.
PROJECT DEVELOPMENT DEPT.
PROCESS DEVELOPMENT DIV.
PRODUCT DEVELOPMENT DIV.
ECONOMIC RESEARCH DEPT.
ECONOMIC STUDY DIV.
DATA ANALYSIS AND STATISTICS DIV.
BUDGET SECT.
ACCOUNTING SECT.
SUPPLY SECT.
STORES SECT.
STORES AUDIT SECT.
PERSONNEL DIV.
PERSONNEL SECT.
WELFARE SECT.
GENERAL SERVICES DIV.
REGISTRY SECT.
TRANSPORTATION SECT.
SITE SUPERVISOR SECT.
BUSINESS MANAGEMENT DIV.
TECHNICAL SERVICES DIV.
CONSTRUCTION SECT.
MAINTENANCE SECT.
PHOTO SERVICES SECT.
PRINTING SERVICES SECT.
BUILDING RESEARCH DEPT.
BUILDING TYPES AND PLANNING DIV.
BUILDING ECONOMICS AND CONSTRUCTION MANAGEMENT DIV.
BUILDING SYSTEMS DIV.
TESTING AND STANDARD DEPT.
ELECTROTECHNICAL LAB DIV.
MECHANICAL LAB DIV.
PHOTOMETRY AND TEMPERATURE LAB DIV.
CHEMICAL ANALYSIS LAB DIV.
ENVIRONMENTAL AND TECHNICAL RESEARCH DEPT.
HUMAN SETTLEMENT RESEARCH DIV.
RESOURCES INVENTORY DIV.
ENVIRONMENTAL ENGINEERING DIV.
ENVIRONMENTAL BIOLOGICAL DIV.
REMOTE SENSING DIV.
SAVANNAH ENVIRONMENTAL RESEARCH STATION
NRM NATIONAL DOCUMENTATION CENTER
LIBRARY DIV.
RESPONSE SERVICES DIV.
UNION CATALOG DIV.
INFORMATION SERVICES DIV.
TRAINING DIV.
SPECIAL PROJECT DEPT.
ASSET ORGANIZATION
AS OF JANUARY 4, 1977

FIGURE 1

TABLE 9. ASRCT STAFF NUMBERS AND DISTRIBUTION

Departments	No. of Staff
Industrial Research	76
Agricultural Research	34
Engineering	68
Economic	13
Building Research	18
Testing and Standards	18
Environmental & Ecological	55
Thai National Documentation Center	20
Administrative Services	90
	392 (1977 Data)
	(444 in 1978)

TABLE 10. EDUCATION OF ASRCT'S STAFF
(1978 Data)

	No. of Staff
Ph.D. Level	9
Masters Level	58
Bachelors Level	105
Others	272
TOTAL	444

THE ROYAL SCIENTIFIC SOCIETY
HASHIMITE KINGDOM OF JORDAN

The Royal Scientific Society (RSS) was founded in 1970 by Royal Charter. During the intervening seven years it has gone through the customary growing pains as well as being penalized by an unfortunate turnover of seven Director Generals in five years. The present Director General has by all reports, given new leadership to the organization, established realistic goals, assembled an exceptionally well qualified middle management, and has generated confidence with government and industrial officials in the productive future of the RSS. In summary, the RSS is coming into maturity probably at a faster rate than the rest of the nation and its future today is brighter than it has been in sometime; however, it will be increasingly accountable for its contributions to the nation's industrial development.

It is the investigator's personal opinion that in several years the RSS will have an assemblage of talents which will be greatly in excess of the capability of Jordanian industry to utilize and that this important natural resource of Jordan, technological manpower, could be profitably directed toward exercising entrepreneurial and technological leadership in the identification and formation of technologically based industry.

The RSS has a staff currently numbering 371 with the following academic degrees.

Ph.D.	23
Masters	16
Bachelor	137
High School	119
Other	76
TOTAL	371

Currently the RSS property covers an area of approximately 55 acres, with about 180,000 square feet of modern laboratories and offices.

There are essentially eleven departments as follows:

1. Computer Systems
2. Mechanical Engineering
3. Electronics Engineering
4. Economic Research
5. Industrial Chemistry
6. Education
7. Housing
8. Library
9. Printing Press
10. Public Relations
11. Administration

The 1977 budget[1] for RSS is given as follows:

INCOME

Department Revenues	161,878 JD
Domestic Financial Assistance	369,660
Accounts Receivable & Cash	279,112
Tech. Assistance & Loans	710,965
Deficit	658,392
Total	$2,179,947 JD ($6.5 million US)

EXPENDITURE

Recurring Expenditures	778,925
Ordinary Capital	114,250
Investment Project Expenditures	86,966
Education	448,241
Expenditures on Equipment Training & Housing	710,965[2]
Total	$2,179,947 JD

[1] Update data furnished in August 1978 shows current expenditures at $1,031,958 (US).

[2] Externally financed

THE CARIBBEAN INDUSTRIAL RESEARCH INSTITUTE, CARIRI REPUBLIC OF TRINIDAD AND TOBAGO

CARIRI was founded by an act of Parliament in 1970, with the assistance of UNDP UNIDO, to provide testing, consulting, and technological services to industry in the Caribbean. For several reasons, CARIRI has never functioned as a regional organization for Caribbean nations and is truly an agency of the Republic of Trinidad and Tobago. The duration of UNDP assistance was originally for five years, but this has been extended for an additional three years.

Over the seven intervening years, it has achieved a steady growth, accompanied by an ever maturing rationale of its mission.

CARIRI has a staff currently numbering 130, with the following terminal degrees:

Ph.D.	-	4
Masters	-	9
Bachelors	-	19
Others	-	98
		130

There are six operating research divisions:

Food and Chemistry
Engineering
Materials Technology
Technical Information Services
Economics and Systems Research
Electronics Instrumentation

CARIRI has an acute space shortage problem and is overflowing the two modern air-conditioned buildings of about 20,000 ft.^{2} located on the campus of the University of the West Indies. As yet, the institute does not have title to these buildings.

CARIRI has acquired laboratory equipment valued at $1.1 million TT ($460,000 US).

The 1976 budget for CARIRI was:

INCOME

Contribution by Government	$2,425,000 TT
Net Project Income	576,198
Interest Income	80,249
Total Income -	$3,081,447 TT
	($1,280,000 US)

EXPENSE

Salaries & Fringe Benefits	
Professionals	901,130 TT
Others	691,826
Depreciation	147,958
Rent	38,633
Purchase of Fixed Assets	525,317
Miscellaneous	308,485
	$2,613,349 TT
	($1,090,000 US)

Excess of Income Over Expenditures - $468,098 TT

The total number of project and service requests increased from 515 in 1975 to 628 in 1976. The dollar volume increased by 42 percent to $1,543,000 TT ($640,000 US) with a breakdown as follows:

Category	Number	Dollar Volume (TT)
Preparatory	9	13,000
Internal	9	71,000
External-Private	15	242,000
External-T & T Gov't	4	537,000
External - CARICOM	1	5,000
External - International	2	595,000
Service (Testing and Information	588	80,000
Total	628	$1,543,000 TT
		($ 643,000 US)

The institute has built up a reserve from income from contract activities for discretionary use by the Board. As of the beginning of 1977, this reserve fund amounted to $1.3 million TT

($580,000 US) but, commencing next year, this income will not be accrued.

CARIRI is governed by a twelve-man Board of Management appointed by the Minister of Finance and includes a representative of the Industrial Development Corporation, four from the University of the West Indies, three from the industrial commercial sector, and the UNDP regional representative.

APPENDIX A

INDIVIDUAL MEETINGS HELD BY DR. S. A. JOHNSON, JR. WITH OFFICIALS AND BUSINESS LEADERS ON THE SUBJECT OF THIS SABBATICAL STUDY

REPUBLIC OF KOREA

Mr. Youn-Hwi Wooh	Secretary General, The President's Economic & Scientific Council.
Dr. Choi, Dong Kyu (and Assistant, Mr. Lieu, Tai H.)	Assistant Minister for Planning and Management, Chairman of the Economic Planning Board of the Office of the Deputy Prime Minister
Dr. Kim, Kwang Suk	Director, First Department of Resources, Korea Development Institute, KDI, of the Office of the Deputy Prime Minister
Dr. Choi, Hyung Sup	Minister of Science & Technology (MOST)
Mr. Kim, Hyung Ki	Director, Bureau of Program Development & Promotion, Ministry of Science & Technology (MOST)
Dr. Choi, Jong Wan	Administrator, Industrial Advancement Administration Ministry of Commerce & Industry
Mr. Kim, Ip Sam (and Assistant, Lee, San Woon)	Executive Vice President, and Federation of Korean Industries, FKI
Mr. Kim, Hyun K.	Managing Director, Korea Chamber of Commerce and Industry

Korea Institute of Science & Technology (KIST)

Dr. Hahn, San Joon	President
Dr. Yang, Jae Hyun	Vice President
Mr. Yun, Yeo Gyeong	President, Korea Technology Advancement Corporation (K-TAC) a wholly owned subsidiary of KIST
Dr. Kwon, T. W.	Vice President for Research I
Dr. Seo, Jinbom	Vice President for Research II
Dr. Ahn, Young Ok	Chief, Polymer Chemistry
Mr. Rhee, Chan Juh	Director for Administration
Dr. Pack, H. W.	Director General, Technology Transfer Center

Korea Advanced Institute of Science, KAIS

Dr. Cho, Soon Tahk	President
Dr. Yoon, Duk N.	Associate Professor
Dr. Lee, Jinjoo	Assistant Professor

Korea Atomic Energy Research Institute

Dr. Yoon, Young Ku	President

Dr. Cha, Jong Kee	Vice President
Mr. Seo, Hyo Joon	Deputy Manager, Project Coordination Department
Mr. Kim, Jin Hyu	Manager, Department of Administration

Seoul National University

Dr. Lee, Chai Sung	Dean of the College of Engineering
Dr. Ko, Myoung Sam	Chairman, Electrical Engineering
Dr. Park Soon Dal	Chairman, Industrial Engineering
Dr. Kim, Chang Hyo	Chairman, Nuclear Engineering
Dr. Lee, Ki-Jun	Associate Professor, Chemical Engineering

JAPAN

Dr. Shinichiro Amanuma	President, Japan Engineering Development Company (JED)
Dr. Isao Gokyu	President, Japan Institute of Metals

KINGDOM OF THAILAND

Mr. Krit Sombatsiri	Secretary-General, Office of the National Economic and Social Development Board.
Dr. Sanga Sabhasri	Secretary-General, National Research Council.
Mr. Decha Boonchoochuay	Deputy Secretary-General, Board of Investment.
Mr. Pairote Gesmankit	Chief, Project Development, Board of Investment.
Dr. Prom Panichpakdi	Secretary-General, Office of the National Environment Board.
Mr. Pravit Ruyabhorn	Secretary-General, National Energy Administration.
Mr. Apilas Osatananda	Deputy Director-General, Department of Technical and Economic Cooperation, Office of the Prime Minister.
Mr. M. C. Piriyadis Diskul	Director, Industrial Economics and Planning Division, Ministry of Industry.
Dr. Praprit Na Nagara	Director-General, Science Division, Ministry of Industry.
Mr. Sivavong Changkasiri	Deputy Director-General, Department of Industrial Promotion, Ministry of Industry.

Mr. Waree Bhongsvej	Director & General Manager, The Industrial Finance Corporation of Thailand.
Dr. Pradisth Cheosakul	Executive Director, Thai Asahi Caustic Soda Company, Ltd.; Past Secretary General, National Research Council.

Applied Scientific Research Corporation of Thailand

Dr. Wadanyu Nathalang	Governor
Dr. Narong Chomchalow	Deputy Governor, Research 1
Dr. Smith Kampermpool	Deputy Governor, Research 2
Dr. Malee Sundhagul	Director, Industrial Research Department
Mr. Nitasna Pichitakul	Director, Project Development Department
Mrs. Chalermvarn Choosup	Director, Thai National Documentation Center
Dr. Pradit Cheuychit	Deputy Governor in Administration
Mr. Richard R. Brown	USAID Mission Office

Chaing Mai University

Dr. Boonyawart Lampaupong	Dean, Faculty of Agriculture
Dr. Narin Tongsiri	Department of Food Science & Technology
Mr. Weerapon Tammacoon	Department of Food Science & Technology

Other Contacts

Mr. Suwat Riebroycharoen	Product Development Engineer, Pressure Container Industry, Ltd.
Mr. Lynn Hewitt	UNDAC, Chiang Mai
Mr. Sanguan Chantalay	USDA-ARS, Chiang Mai
Mr. Inson Klongkarnngarn	Head ASRCT's Essential Oil Station, Chiang Mai
Mr. Panlert Buranasilpin	Owner, Wangnamkan Citrus Grove, Chiang Mai and Past Minister of Agriculture

REPUBLIC OF INDIA

NationalResearch Development Corporation of India

Dr. C. V. S. Ratnam	Managing Director

Dr. R. A. Rao	Chief Engineer (Chemical)
Dr. J. P. Bhargava	Chief Engineer (Electronics and Instrumentation)

Council of Scientific and Industrial Research

Dr. Y. Nayudamma	Secretary to the Government of India and the Director General, CSIR.

HASHIMITE KINGDOM OF JORDAN

Dr. Tayseer Abdel Jaber	Secretary General, National Planning Council
Mr. Tawfiq Batarsi	Head, Department of Industry, Ministry of Industry and Trade
Mr. Ghalib Arafat	Director, Department of Industrial Studies and Encouragement of Investment, Ministry of Industry and Trade
Dr. Jawad Anani	Under secretary, Ministry of Labor
Dr. Hassan Gharaibeh	Director, Department of Agriculture, Research and Extension, Ministry of Agriculture
Mr. Ziyad Annab	Director General, Industrial Development Bank

Mr. Ali T. Dajani	Director, Amman Chamber of Industry
Mr. Mohammed A. Tijani	Director, Amman Chamber of Commerce
Mr. Mosa Shtieh	Manager, Jordan Ceramics Industries Company
Dr. Adnan Badran	President, Yarmook University
Mr. Christopher Russel	USAID Mission, Jordan
Mr. Franz Herder	USAID Mission, Jordan

Royal Scientific Society

Dr. Albert Butros	Director General
Dr. Fakhruddin A. Daghestani	Deputy Director General
Dr. Abdullah Khatib	Director, Planning and Development Department
Dr. Bassam Khalil Al-Saket	Director, Economics Department
Dr. Arafat Altamemi	Director of Industrial Chemistry Department
Dr. Abdulla Jaradat	Director of Mechanical Engineering Department
Mr. Mohammed Qashou	Department of Mechanical Engineering

Dr. Said Alloush	Department of Industrial Chemistry
Mr. Suleiman Abu-Sabha	Chief of Planning and Development Section

REPUBLIC OF TRINIDAD AND TOBAGO

Mr. Richardson Andrews	Director of Planning, Ministry of Finance
Mr. Max Cuffie	Deputy General Manager, Industrial Development Corporation (IDC)
Mr. Earle C. Baccus	Director, Economic Studies and Planning Division, IDC
Mr. J. E. N. Scoon	Managing Director, Trinidad and Tobago Development Finance Company, Ltd., (and member National Advisory Committee and Chairman of the Board, British West Indian Airways)
Dr. Lenny K. Saith	Managing Director, Trintoplan Consultants, Ltd., (and Chairman, Executive Committee, CARIRI and member National Council for Technology in Development)
Mr. Mervyn Assam	General Manager, Central Soya Corporation (and President, Trinidad Manufacturers' Association)

Mr. Thomas Gatcliffe	Managing Director, Angostura Company and Fernandes Distillery (and member of National Advisory Council and former Senator)
Dr. Compton Seaforth	Professor of Chemistry, University of the West Indies (and Executive Committee, CARIRI Board of Managers and member National Council for Technology in Development)
Dr. John Spence	Dean of Faculty of Agriculture, University of the West Indies (and Head, National Council for Technology in Development, member National Advisory Council, and Chairman, CARIRI Board of Management)
Dr. John Cropper	Research Associate in Agro-Economics, University of the West Indies
Ms. B. Lincoln	U.S. Embassy

Caribbean Industrial Research Institute (CARIRI)

Mr. Hollis Charles	Director
Mr. Lennox Lewis	Assistant Director (Administration)
Mr. Saied Mohammed	Secretary/Comptroller
Dr. Winthrop W. Wiltshire	Head, Technical Information Services

Professor G. S. Ramaswamy	U.N. Chief Technical Advisor
Mr. Edwin Skinner	Head, Economics Division
Miss Waveney Henry	Research Chemist
Dr. Desmond A. Ali	Head, Food and Chemistry Division
Mr. Sidney Thomas	Economics Division
Mr. Gary Voss	Head, Engineering Division

APPENDIX B

"UTILIZATION OF NATIONAL TECHNOLOGICAL INSTITUTIONS IN THE DEVELOPING COUNTRIES FOR INDUSTRIALIZATION," A UNIDO/CARIRI REPORT

A UNIDO/CARIRI MEETING

In February, 1977, CARIRI hosted a UNIDO sponsored meeting in Port O' Spain, attended by administrators from five research institutes: KIST (Korea), NRDC (India), CSIR (India), FIIR (Nigeria) and CARIRI. A comprehensive report entitled "Utilization of National Technological Institutions in the Developing Countries for Industrialization" was issued on 9 March 1977.

Because the subject matter under deliberation at this UNIDO meeting is relevant to the main thrust of the investigator's sabbatical study, it seems appropriate to abstract a number of direct quotations from the report. The grouping into topical areas was done by this author for greater emphasis in this report.

A. RESEARCH INSTITUTES - A NATIONAL RESOURCE

"There is general recognition that the rate of economic growth in general and of industrial development in particular is greatly enhanced by the level of technology in the country and the rate at which technological research results and 'know-how' are applied."

"....technological institution(s)...are focal points, in terms of the existing and future development of indigenous capability."

"An important function of technological institutions in most developing countries is to collect and analyse production, economic and technological information. In addition, these activities provide the institutions with a basis for interpreting the technological implications of the national plans and assisting those concerned with planning and forecasting."

"Governments of most developing countries depend largely on foreign expertise for the technological inputs required for industrial planning and programming. National technological institutions should participate in national industrial planning by helping to, within the scope of their expertise, provide the technological inputs needed by Governments for establishing the country's industrial development strategy, policy and planning."

"One of the critical problems of the industrialization process is the lack of organized technical and planning data and the talent to analyse and interpret the data in terms of project, sectoral and national needs. Technological institutions are ideal organizations to carry out such functions."

"Technological institutions should endeavour to act as the honest broker with no axes to grind. Their findings and recommendations must be honest and objective in attempting to find reasonable solutions to problems. They must develop a rapport with industry and must convince industry that the results of their actions will be to its benefit. At the same time, they must also develop close working relationships with the decision-making and implementing bodies of government. Thus they must develop the confidence of both industry and the government."

B. RESEARCH INSTITUTES' POTENTIAL CONTRIBUTION TO THE INDUSTRIAL DEVELOPMENT PROCESS

"Planners in any developing country could conceive of literally thousands of projects that the country might undertake. However, the possibility of undertaking them may not exist. Thus it is essential to determine objectively whether a particular project is feasible under the conditions prevailing in the particular country."

"The project initiation phase, from preliminary idea to decision-to-invest provides a great scope for contributors from technological institutions...."

"During the technological feasibility phase, inputs could be handled by local technological institutes, with the assistance of foreign firms as necessary. Successful performance in such an arrangement could enhance the credibility of the technological institutions of a developing country."

"As far as commercialization is concerned, technological institutions can either concentrate on research and development, and thus play a limited role, or they can be involved in the full cycle of a project, including not only R and D but also pilot plant development, marketing studies, economic surveys and other activities such as technical consultancy required for project implementation."

"In furthering national industrial development capabilities, developing countries in general and technological institutions in particular should pay attention to developing skills in collecting, analysing, interpreting and providing technological information and industrial statistical data required for application at all stages of industrialization."

"For the technological institutions to make a more effective contribution to industrial development, they should act in the dual capacity of catalysts and performers in industrial development."

"Technological institutions can help in initiating industrial projects and programmes by identifying, collecting, and preparing sectoral industrial surveys and technology plans. To do this effectively, special staff need to be trained and a national network or system established to ensure a smooth and constant flow of information to the planners."

"Another important role of technological institutions is to approve and monitor licensing of foreign technology. Monitoring will not only help to ensure that the technology imported shall be in the best interests of the country concerned but will also provide important inputs to the technological institutions that they can use in their work in support of industry."

C. IMPEDIMENTS TO THE PROCESS

"Technological institutions in most developing countries tend to respond only when asked to participate in national planning. They usually provide ad hoc services upon request. They tend to shy away from participating in the identification of industrial projects that could have real national impact."

"The implementation of industrial projects by nationals becomes extremely difficult when the local technological institutions are not involved in the planning and formulation stages of such projects."

"The involvement of these national (research) institutions in the industrialization process has not been clearly understood and well defined. While a number of them play key roles in some countries, their involvement in most developing countries is still very limited, especially in such areas as industrial and technological planning, programming and forecasting; project identification, preparation and evaluation; and project and programme implementation. The full potential of these institutions as an instrument of industrialization has therefore not been fully utilized."

"One of the problems national technological institutions constantly face in initiating and implementing industrial projects, especially in preparing feasibility studies, is that the Government and local and foreign financial institutions lack confidence in them."

D. POLICY ISSUES CONFRONTING A DEVELOPING NATION

"An important approach to the development of the national industrial capacity is to involve indigenous technical personnel in the entire industrialization process. A national system and machinery must be developed to ensure the proper co-ordination and effective use of local technical expertise in industrial

development. An important aspect of such a national system and machinery is the establishment of technological institutions to cater for the technological inputs at each point of the industrialization process."

"There also needs to be a clear technology policy that will determine: the degree of technology development needed; the extent of involvement of various institutions; the mechanism and mode of transferring technology; and the extent of utilization of foreign versus local sources of expertise."

"In most developing countries, local technological institutions, where they exist, are generally not called upon nor do they actively seek to play an important role in national planning. The level of achievement of national industrial goals would generally be enhanced if national indigenous technical capabilities, especially technological institutions, were intimately involved at all points of the industrialization process, especially at the planning stage."

"Each developing country should, where appropriate, establish a national policy and create machinery for the commercialization of R and D results."

"Each developing country should establish national machinery, where this does not exist, for the effective development, interaction, and utilization of national indigenous capabilities with resources and management for planning, programming, implementing, monitoring and evaluating in its industrial development plans and programmes."

"Governments of developing countries should not only be concerned with the success of industrial projects in the short term, but also endeavor to develop a sound local basis for long-term industrial development by creating national indigenous technological capacities to develop and apply indigenous technologies, where appropriate, and to absorb and adapt foreign technology."

"For technological institutions to be effective, the policy under which they operate must be clearly defined and adequate financial and human resources and physical facilities provided."

"Each developing country should establish a national system and appropriate institution for the acquisitions of technology. Its terms of reference should allow it to work closely with the national technological institutions but as an independent entity, negotiate with the private sector the terms of acquiring technology, both locally developed and imported."

"...technological institutions should endeavor to involve themselves, to the maximum extent possible, at all stages of the industrialization process, from planning through production."

APPENDIX C

MISCELLANEOUS INFORMATION ON THE NATIONS

VISITED DURING THIS STUDY

(The material in this Appendix, as well as some selected sections presented in the main body of this final report, were presented previously in four earlier progress reports.)

REPUBLIC OF KOREA

I. RESEARCH INSTITUTES' INTERACTIONS IN KOREA'S NATIONAL PLANNING PROCESS

Both at the Prime Minister level and the Ministries of Science & Technology and Commerce & Industry, there is acute awareness that Korea is going from a labor intensive to a capital/high technology intensive economy, and that this makes it increasingly necessary for KIST, as well as other technological institutes, to take an increasingly active role in the national process.

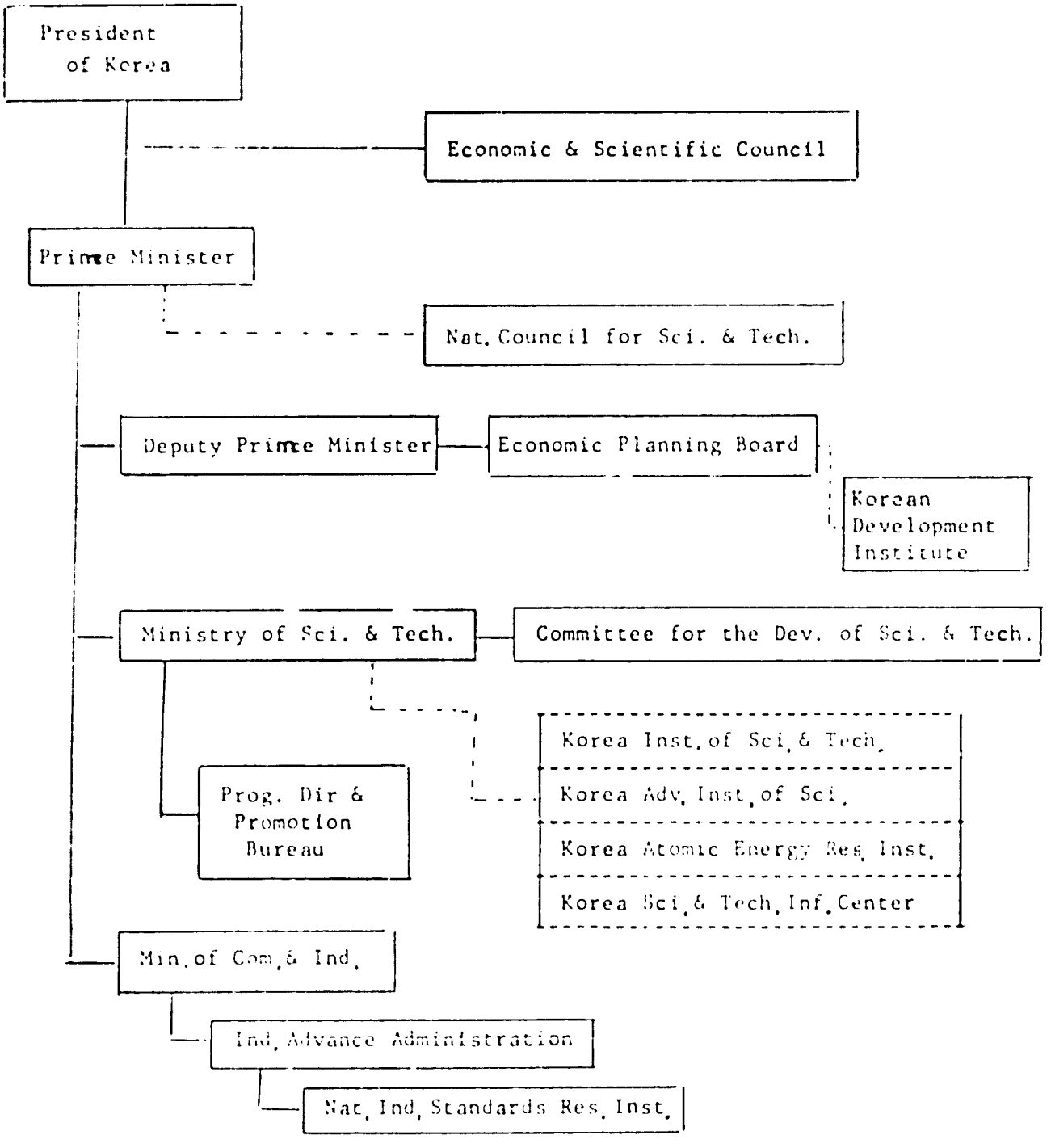
Ever since its inception ten years ago KIST has enjoyed high visability in the highest of Korean government circles, probably due in no small measure to the drive and vision of Dr. Hyung Sup Choi who served as KIST's first President and then was elevated to his present post, Minister of Science and Technology. By all reading it would appear that Dr. Choi has been a driving force in most scientific and technological policies instrumented by the Korean government. His influence appears substantial in the establishment of the Korean Advance Institute of Science, in the promulgation of the Technological Development Promotion Law No. 2399, in the establishment of the KIST subsidiary, Korea Technology Advancement Corporation, and the pending proposition to establish a quasi-government, venture capital corporation, loosely resembling the British National Research and Development Corporation. Dr. Choi was also instrumental in pushing for the pending Korea Science and Engineering Foundation.

The importance which the Korean government places on the contributions of research institutes (and institutions of higher learning) may be seen from the fact that these institutions are represented on the three highest planning organizations in the nation: the Economic and Scientific Council, advisory to the President; the National Council for Science and Technology, reporting to the Prime Minister; and the Committee for the Development of Science and Technology, reporting to the Ministry of Science and Technology, (see the details, following and the organizational chart presented in Figure 2).

The Economic and Scientific Council was established by the Organization Act of the Government to advise the President on the nation's economic and scientific issues. The Council is composed of five standing members and seven non-standing members. Each member is regarded as a minister and appointed by the Chief Executive from those who are most highly qualified and experienced in the economic and scientific fields of the nation.

The five standing members are government officials who devote full time to this position. The present status of the five non-standing members are three university professors, two

FIGURE 2


President of Korea
Economic & Scientific Council
Prime Minister
Nat. Council for Sci. & Tech.
Deputy Prime Minister
Economic Planning Board
Korean Development Institute
Ministry of Sci. & Tech.
Committee for the Dev. of Sci. & Tech.
Korea Inst. of Sci. & Tech.
Korea Adv. Inst. of Sci.
Korea Atomic Energy Res. Inst.
Korea Sci. & Tech. Inf. Center
Prog. Dir & Promotion Bureau
Min. of Com. & Ind.
Ind. Advance Administration
Nat. Ind. Standards Res. Inst.

Chairmen of the Board of Trustees of economic and scientific institutes like KIST, and two Presidents of industrial companies. Each of the seven non-standing members is appointed at the pleasure of the President.

The National Council for Science and Technology is controlled and presided by the Prime Minister, who serves as Chairman of the Council. The objectives of the Council are:

A. Coordinating and regulating the nation's scientific and technological advancement budget;

B. Establishing and coordinating the multidisciplinary plans of the national scientific and technological advancement;

C. Selecting important research and development projects according to national point of view.

There are no more than seventeen members, and twelve of them are ministers ex officios, i.e., Minister of Economic Planning Board, Minister of Home Affairs, Minister of Finance, Minister of National Defense, Minister of Education, Minister of Agriculture and Fishery, Minister of Commerce and Industry, Minister of Construction, Minister of Health and Social Affairs, Minister of Transportation, Minister of Communications and Minister of Science and Technology, and the remaining five members are appointed by the Prime Minister.

Present status of the appointed members are Minister without Portfolio II, President of Seoul National University, President of KIST, and President of Korea Federation of Science and Technological Societies. The Council is the consulting organization for the Prime Minister on scientific and technological problems.

The Committee for the Development and Technology was established by the Technology Development Promotion Law of 1973 for the purpose of execution of the Technology Development Fund and technology development policy formulation for industry.

The number of committee members is fourteen, consisting of nine ex officios and five appointees. Nine ex officios are the Director, Office of Planning and Management of the EPB, a Director from the Ministry of Finance, a Director from the Ministry of Agriculture and Fishery, a Director from the Ministry of Commerce and Industry, a Director from the Ministry of Communications, Vice Minister of Science and Technology, and Assistant Minister without Portfolio. The present status of five appointees are the Director, Technology Transfer Center of KIST, the President of Namhae Petrochemical Company; a professor of the College of Engineering, Seoul National University; the Vice President of Korea Atomic Energy Research Institute; and a member of the International Bank for Reconstruction and Development. The committee chairman is the Vice Minister of Science and Technology.

One measure of the coordination which exists between goverment ministries and KIST is seen in the procedure which must be followed for a Korean company to obtain approval to import patents or know-how. They must formally apply to the Economic Planning Board, and those applications dealing with technological subjects are referred to the Ministry of Science and Technology (MOST). The Ministry forwards them to appropriate technical personnel or organization, which then conducts an evaluation of the potential economic payout of the technology being performed versus the expense of procuring the technology, and in a second step evaluates the potential advantages of the new technology compared to existing technology currently in use by Korean industries. Of course, KIST quite frequently serves in this capacity.

The Economic and Scientific Advisory Council to the President, in addition to representation from KIST as one of the twelve members, has several subcommittees as follows:

A. Subcommittee on Long Term Use of Resources, composed of council Members plus experts from universities and research institutes.

B. Subcommittee on Alternate Energy Uses with emphasis on tidal and hydroelectric power.

The Economic Planning Board (EPB), reporting to the Prime Minister, probably has the greatest influence in charting Korea's economic and industrial growth. Referring to the membership presented earlier, the EPB meets once a week to coordinate problems common to two or more ministries, with a specified objective to reduce the bureaucratic "red tape."

The EPB has recently issued its Fourth Five-Year Economic Development Plan for the period 1977 through 1981. One of the key projections is that Korean investment in R & D will be increased from its current level of 0.5 percent of GNP to one percent in 1981.

The EPB operates a supportive organization, the Korea Development Institute, KDI. KDI is composed primarily of economists, and their staff numbers 200. KDI is responsible for much of the preparation of the Five-Year Economic Plans. Because of the emergence of the importance of technology in Korea, KDI has asked for increasing assistance from KIST, and in 1976 KIST conducted studies on the potential growth of Korean industries in the "Machinery Industry," the "Electronics Industry," and the "Fine Chemical Industry," which essentially has been incorporated in the Fourth Five-Year Economic Plan.

KIST itself has a well-developed program to establish network linkages with both the governmental and industrial sectors.

The Board of Trustees of KIST consists of a Chairman, Vice Chairman and nine Trustees, including five ex officios. The five ex officio Trustees are Vice Minister of Economic Planning, Vice

Minister of Commerce and Industry, Vice Minister of Science and Technology, Deputy Director, USAID/Korea, and the President, Battelle Memorial Institute. The six non-ex officio trustees are appointed from among representatives of industry and members of science, engineering, and academic communities. The President is appointed from among the trustees and only the President is a standing member.

The present status of non-ex officios are Chairman, Mr. Sukchoon Lim, the member of the President Council for Economic and Scientific Advisors; Dr. Sangup Choi, Vice President of Sukang University; Mr. Min Ha Lee, President of Dongyang Express Bus Company; Mr. Taejun Park, President of Pahang Integrated Steel Mill Company; Dr. Soon Tahk Cho, President of KAIS; and Dr. Sang Joon Hahn, the President of KIST.

The major functions of the Board of Trustees are as follows:

a. Approval of the annual operating program and budget,

b. Election and dismissal of officers,

c. Disposal of major property and loans,

d. Revision of Articles of Incorporation,

e. Establishment of branch laboratories and offices,

f. Acquisition and disposal of basic property, and

g. Formulation and revision of major rules.

II. INCENTIVES INITIATED BY THE KOREAN GOVERNMENT OR KIST DESIGNED TO ENCOURAGE INDUSTRIAL RESEARCH AND DEVELOPMENT

At the Ministry level, there appears to be wide awareness of the many different incentive programs in force around the world. In addition to the rather standard incentives practices, the following are noted.

A. On 28 December 1972, Korea enacted the "Technological Development Promotion Law No. 2399."

Purpose: To promote development of industrial technology, as well as to assist in the transfer of imported technology.

Method: Industry may, with the permission of MOST, set aside up to 10 percent of its profits, before taxes, and with MOST permission, can invest these funds in research and development, either in house or contracted to a research institute.

Progress to date: From both industrial and government reports, Korean industry is taking ever increasing advantage of this law. At the latest count 135 firms of differing size have set aside approximately 15 billion won ($30 million US). It is also encouraging to note that Minister Choi estimates that 50 percent of the new industrial business which is coming to KIST is as a result of this law. It is also speculated that the Ministry of Finance, a larger ministry than MOST, is increasingly interested in the benefits accruing from this law.

B. Another law passed in 1977 permits an industry building a research laboratory to take credit of such capital expenditures by reduction in taxes, up to 10 percent, and can carry the credit forward as long as five years, to obtain full write off, if possible.

C. The Ministry of Science and Technology (MOST) is giving consideration to the establishment of a quasi-government, venture capital corporation which can make forgivable loans to industry on high technology ventures, or it can take an equity position in the venture, or it can establish a subsidiary to commercialize for profit. Depending on the magnitude of the initial funding, the degree of flexibility and autonomy, and upon the type of staff, hopefully a mixture of bankers, economists and technologists, such an undertaking could be highly successful in transferring new high technology industry to Korea. This NRDC concept would also have the capability of making contractual agreements with such organizations as the Japan Engineering Development Company (JED), a profit corporation established in Japan to exploit foreign patents in Japan and export Japanese patents for exploitation in foreign countries.

D. KIST also has established numerous mechanisms to stimulate industrial R & D, such as the following:

In February 1976 KIST formed a Technology Transfer Center with the primary function to, under contract, acquire, evaluate, accumulate, and make prompt recommendations to domestic firms on overseas technological information. This Center has a Consultant Section to consult about technology transfer, recommend foreign suppliers of technology, and review appropriateness of the technology under consideration. It also collects information about advanced technology and locates equipment and material. It assists the businessman in negotiating favorable terms.

In September of 1974, KIST formed a wholly-owned subsidiary called Korea Technology Advancement Corporation (K-TAC), with initial capitalization of $1 million (US) to commerically exploit concepts developed in KIST or by cooperating industry. K-TAC can flow its profits back to KIST, either as cash dividends or by the purchase of contract research.

The hope was even expressed that in ten years the revenue produced by K-TAC would support 50 percent of KIST's budget. Although it is too early to assess the effectiveness of this new undertaking, it does potentially open avenues which could have substantial impact in encouraging the development of new technologies.

Some examples of projects now in process:

(1) Bronze (atomized) powder plant (for bearings)--K-TAC put up $140,000 (US), and a bank, KDFC, an equal amount. K-TAC will begin operation of the plant this year and has the option to manufacture for profit, or sell out-right or in part.

(2) K-TAC took a KIST project for the manufacture of Freon 12 and sold it to a Korean industry for a lump sum payment of $300,000 (US).

(3) K-TAC operated a plant for 6 months making a mod-acrylic fiber for artificial wigs in process developed by KIST and sold out to a nylon manufacturer for $600,000 (US).

(4) In following up an idea originating from a businessman, K-TAC retained KIST to develop the technology to permit Korea to manufacture "refractory sagga" for the firing of mosaic tile, a product heretofore purchased from Japan. K-TAC put up 50 percent, and three local businessmen plus the KDFC bank put up the other 50 percent with a total equity of $750,000 (US) and with $1,250,000 (US) in borrowed funds. The plant is scheduled to go operational in August, 1977.

KINGDOM OF THAILAND

Thailand is generally described as having an agriculturally based economy. In high government circles there seems to be a feeling that industrial development must continue to depend almost entirely on imported foreign technology because of the inadequacies of such talents in Thailand. Also, it was not possible to identify a strong spokesman at the Cabinet level consistently pushing to build up the nation's technological infrastructure.

As a consequence, there appears to be only nominal efforts to utilize the technologists in organizations such as the Applied Scientific Research Corporation of Thailand (ASRCT) and the Asian Institute of Technology (AIT), and it seems that these organizations, in turn, have only a small participatory role in Thailand's industrial planning and implementation process.

The National Social and Economic Development Board (NSEDB), operating directly under the Prime Minister, is responsible for the promotion of the total economic development of the nation, the administration of manpower and economic analyses, and the planning and coordination of the five-year economic development plans. This agency has a 300-man staff including 100 economists, but no technologists. It has a high-powered board and exercises considerable power.

Many are convinced that unless the government takes a much more committed role in the support of Thai technology, organizations like ASRCT will find it increasingly difficult to function effectively. As an example, the professional salary levels at ASRCT, a quasi-government corporation, have declined in a ten-year period from a level almost competitive with industry and about three times higher than equivalent government salaries, to a current parity with government salaries, but with fewer benefits and less job security. It is also a widely held opinion that the government funding of ASRCT is not adequate. It also appears that Thai governmental agencies may sponsor research with organizations outside of Thailand because of their concern that the requisite skills may not exist in Thailand, and thus possibly procure a higher quality study but at the risk of not improving the long-term capabilities of Thai organizations.

No person interviewed could identify any specific governmental incentive legislation designed to encourage industrial research and development.

Some senior governmental and industrial officials are concerned with this perceived deficiency and are pressing, against a certain amount of resistance, to establish a new ministry embracing industry, science, and technology. The opposing concerns feel that such a ministry will not be established and counter that, perhaps, Thailand should settle for a Science and Technology Advisory Committee to the Prime Minister.

Within this framework, there are two key governmental agencies which will control to a great extent the role that organizations such as ASRCT will play in the nation's industrial development; they are the National Research Council (NRC), and the Board of Investment (BOI), both functioning under the Prime Minister's Office (see Figure 3).

THE NATIONAL RESEARCH COUNCIL (NRC)

The NRC, established in 1956 under the Prime Minister, would appear to be the governmental organization which could effectively influence, at the Cabinet level the establishment of science and technology policy as it relates to Thailand's developing industrial economy. However, it is the strong consensus that NRC is not capable of mounting an effective position on this subject, primarily because of multiplicity of vested interests, occasioned by having ten scientific branches: physical sciences and mathematics, medical sciences, chemical and pharmaceutical sciences, agriculture and biology, engineering and industrial research, philosophy, law, political science and public administration, economics, and sociology.

The NRC Executive Board is composed of the chairman of the ten scientific branches and five people appointed by the Cabinet.

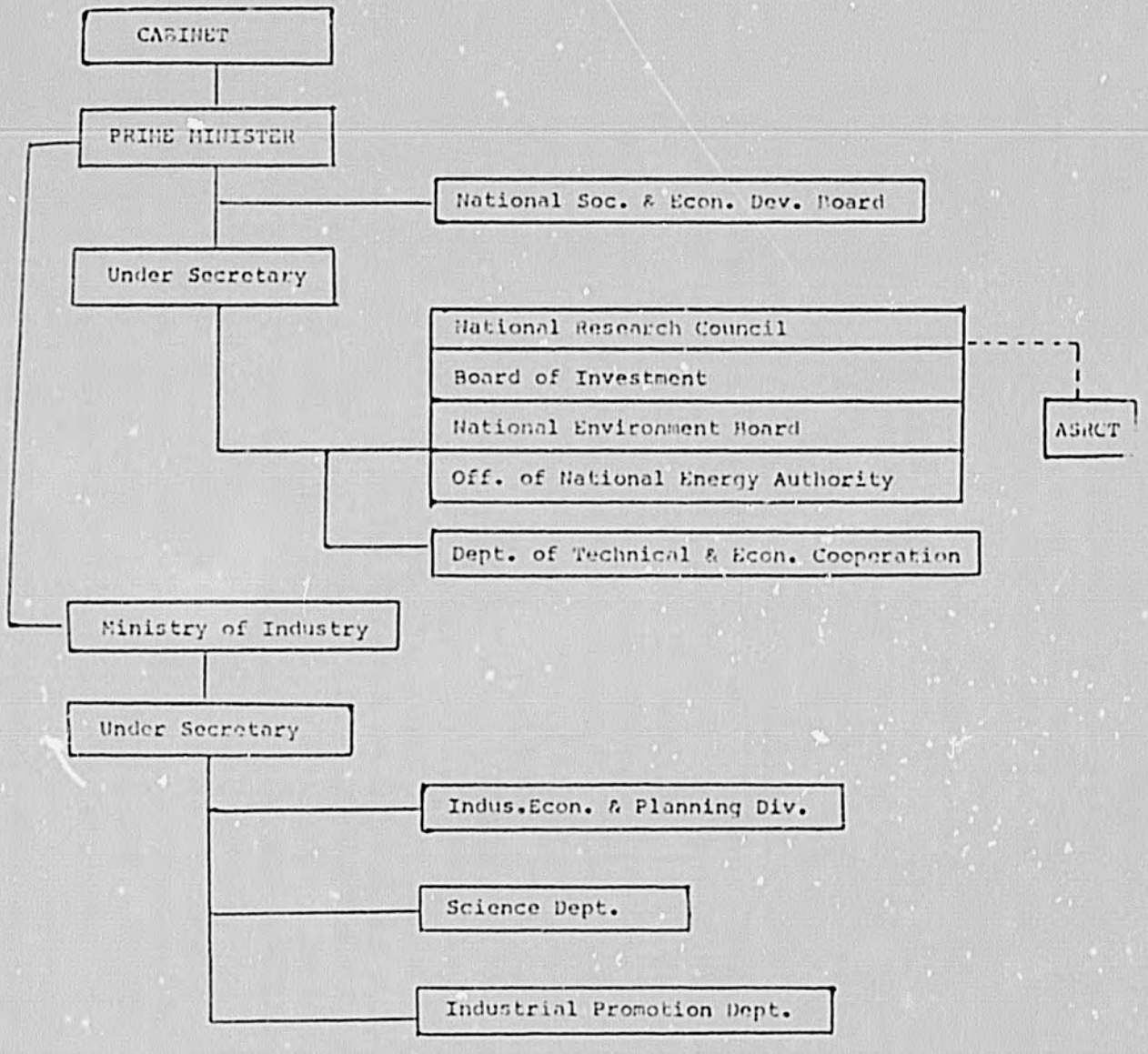
The mission of NRC is published as:

a. Determine research policy and planning

b. Promote and support research

c. Coordinate with government agencies and other institutions.

FIGURE 3


CABINET
PRIME MINISTER
National Soc. & Econ. Dev. Board
Under Secretary
National Research Council
Board of Investment
National Environment Board
Off. of National Energy Authority
ASRCT
Dept. of Technical & Econ. Cooperation
Ministry of Industry
Under Secretary
Indus.Econ. & Planning Div.
Science Dept.
Industrial Promotion Dept.

THE BOARD OF INVESTMENT

The Board of Investment has discretionary powers to promote and regulate both foreign and domestic investments in areas deemed profitable to Thailand.

The Prime Minister is Chairman of the Board and seven Cabinet ministers are members, making BOI probably the most important office in Thailand on matters concerned with industrial and commercial development. Also on the board are two bankers and one member from the private sector.

BOI defines priority areas and decides which industries shall receive "Promotional Status," although BOI is not involved in the capitalization of such programs. Target areas for foreign investment currently are defined as follows:

- Agro industries
- Labor intensive industries
- Export oriented industries

The major discretionary power exercised by BOI is the granting of "Promotional Investment Privileges," including a 26-point package of incentives and tax concessions, alleged to be the most attractive inducement offered in the Orient.

TWENTY-SIX INCENTIVE PROGRAM

Guarantees

- o Against nationalization
- o Against competition of new state enterprises
- o Against monopolization of sales of products
- o Against price control
- o Permission to export
- o Against imports by state enterprises with taxes exempted

Protective Measures

- o Imposition of surcharge on foreign products
- o Import ban on competitive products
- o Tax relief option

Permissions

- o Foreign national investment studies
- o Foreign technicians
- o To own land
- o To transact with foreign currency

Tax Incentives

- o Exemption or reduction of import duties on imported machinery and raw materials
- o Corporate tax exemption for three to eight years with five-year loss carry forward
- o Exemption up to five years on withholding tax on royalties remitted abroad

There are additional incentives granted for enterprises operating in "Investment Promotion Zones" or for those firms primarily in the export business.

INDIA

I. AN INDIAN GOVERNMENTAL INCENTIVE MECHANISM FOR THE TRANSFER OF TECHNOLOGY - THE NATIONAL RESEARCH DEVELOPMENT CORPORATION OF INDIA

A. INTRODUCTION

It is the author's contention that the primary yardstick which should be used to measure the degree to which a research institute is contributing to its country's welfare, and thus justifying its consumption of governmental funds, should be based on a measurement of the research institute's performance in transferring technology to the industrial/business sector, with an identifiable increase in "value added," and that all other functions, such as testing, training, and field service, even collectively, are not a sufficient raison d'etre. Further, it would not seem to matter whether the technology was developed in-house or whether it was indigenous to the country or imported, as long as the institute served a role in the process of commercializing the technology.

For these reasons, the investigator is interested in any governmental incentive program which stimulates the transfer of technology from a research institute to a commercial enterprise. It was noted in an earlier progress report that Korea's KIST had recently formed a Technology Transfer Center as well as a wholly owned subsidiary, the Korea Technological Advancement Corporation, both committed to these objectives. While these two Korean organizations are too young to have demonstrated that they are achieving their goals, a most impressive record has been achieved over a long time span by the National Research Development Corporation of India (NRDC).

B. THE PROBLEM

Dr. C. V. S. Ratnam, the Managing Director of NRDC, identifies the problems of a developing nation, heavily dependent upon imported technology, somewhat as follows:

1. The imported technologies have not always been the best or the most suited to the needs of the country.

2. The prices paid for the imported technologies have at times been excessive.

3. Mechanisms have not evolved for adapting or indigenizing imported technologies.

4. Imported technologies do not necessarily result in exportable products.

5. To compete in the export market, countries must import some technologies which hurt the sale of products manufactured with indigenous technologies.

6 Lack of coherent policy has resulted in the import of several similar technologies from several foreign countries, resulting in nonstandardization of products, spares, and components.

7. There has been a tendancy for importers of technology to be dependent on their collaborators for all new ideas.

C. THE NRDC MECHANISM

The National Research Development Corporation of India (NRDC) was established in 1953 for the promotion, development, and exploitation of inventions, processes, and know-how from all sources with India. Its staff currently numbers 100.

The Principal Functions of NRDC are as follows:

- Licenses, processes, and patents developed in governmental agencies, such as the Council of Scientific and Industrial Research (CSIR) and the Indian Council of Agricultural Research.

- Finances up to 50 percent of the development expense, including pilot plant demonstration, either independently or in collaboration with industry.

- Participates in equity capital of companies established to commercialize a technology owned by the corporation.

- Fills technological gaps in the country by promoting development projects in collaboration with industry.

- Provides technical description of processes in its portfolio in newspaper advertisements and technical journals.

- Provides financial assistance in the development and patenting of commercially viable ideas.

- Promotes the export of Indian technology.

- Extends services as a broker for the import or export of technology.

- Licenses know-how assigned to it by the public or private sector industry, or by individuals.

The Board of Directors of NRDC, which meets bi-monthly, consists of representatives of the Department of Science and Technology of the Prime Minister's Office, the Secretary General of the Council of Scientific and Industrial Research (CSIR), the Secretary of

Technical Development of the Ministry of Industry, the Planning Commission, and Atomic Energy Commission.

D. ACHIEVEMENTS OF NRDC

Over 1,000 processes have been assigned to NRDC, of which about 345 are in commercial production by 350 licensees. In 1976 the production of these goods amounted to approximately Rs 23 crores (230 million rupees or $30 million US).

The 1977 NRDC budget is based upon royalty payments of 60 lakhs (6,000,000 rupees or approximately $750,000 US) of which NRDC distributes 70 percent to the laboratory developing the process and retains 30 percent for its own operational expenses.

During 1976, 95 new inventions were received by the corporation and 119 new license agreements were signed.

The following NRDC processes went into production during 1976:

- Nasal mechanical filters
- Potassium based calcium and acid resistant cement
- Silicon carbide
- Iron powder from mill scale
- Photocopying lens system
- Water level meter
- Transistorized capacitors
- Portable acidity testing kit
- Electrical relay tester
- Lithium carbonate and fluoride from lepidolite
- Vinayalak - 0
- Silica gel
- Hollow carbon
- Sac element
- Rubberized cork sheets
- Fruit bars

Increased emphasis is being placed on establishing development projects, preferably in collaboration with industry. During 1976 NRDC approved the following projects:

1) Block co-polymers of styrene and butadiene

2) Transparent fused quartz

3) Recovery of gallium

4) Development of tool room microscope

5) Development of hydraulic machine

NRDC is also taking active steps to export Indian technology to other developing countries and is implementing on behalf of the Government of India 15 projects in Burma at a cost of 20 million rupees ($2.5 million US).

II. RESEARCH INSTITUTES INTERACTIONS IN INDIA'S NATIONAL IMPLEMENTATION PROCESS

The five-year plans of India are drawn up by the Planning Commission, which is chaired by the Prime Minister, and includes a Science and Technology Plan which is prepared by the Department of Science and Technology of the Ministry of Science and Industry. Unfortunately, there was not sufficient time to explore in depth how the research institutes interacted in the preparation of the plans.

One very interesting governmental regulation was observed which closely linked the research institutes with one element in the implementation of the nation's development program.

The Government of India publishes guidelines indicating the areas in which technology could be imported, including those in which the imported technology could be accompanied by foreign equity participation, and also specifying the areas in which no technology could be imported. The import of technology is regulated through the Foreign Investment Board, the Secretariat for Industrial Approvals, and the Project Approvals Board.

The availability of indigenous technology is important in considering the granting of permission to import technology and must be reviewed by a Technician Evaluation Committee (TEC). TEC has representation from NRDC, the Council of Scientific and Industrial Research (CSIR), the Department of Science and Technology (Ministry of Science and Industry), etc., and meets once a week. These same organizations also have representation in the Foreign Investment Board.

III. OTHER INCENTIVES INITIATED BY THE INDIAN GOVERNMENT, NRDC, OR CSIR TO ENCOURAGE INDUSTRIAL RESEARCH AND DEVELOPMENT

- Industry can write off 100 percent of its expenditures on "Approved Projects" with NRDC.

- Industry can write off 35 percent of its capital expenditures on "Approved NRDC Projects."

- Industry contracting with a recognized research institute can claim one and one-third times its actual research expenditures.

- NRDC has recently been authorized to collaborate with industry to finance development projects on a 50:50 basis, and under certain circumstances the loans are forgiveable. NRDC can also take an equity position.

- Of the 6 million rupees ($750,000 US) which will be received by NRDC this fiscal year from royalty and other premiums, approximately rupee ($525,000 US) will flow to the research laboratory developing the process and of that rupee ($300,000 US) or 40 percent of the total, will be distributed to the principal investigators/inventors, a handsome incentive reward system.

- The Minister of Finance has recently announced his intentions of pushing for a new law for a "Research Case" or tax.

- The Council of Scientific and Industrial Research (CSIR) which is composed of about two score of specialized government industrial research laboratories, with an aggregate staff exceeding 12,000 employees, initiated a new policy several years ago designed to encourage its professional staff to spin off and establish new industrial organizations, by granting three-year leaves of absence and rather permissive use of CSIR facilities. Twenty employees have opted for such leaves, and to date four have established operating companies.

HASHIMITE KINGDOM OF JORDAN

I. JORDAN - A DEVELOPING NATION

Jordan has a population of 2.7 million, including about 800,000 in the West Bank presently under Israeli military occupation. The area of the West Bank is only 15 percent of the total nation, contains 30 percent of the population, and its loss as an economic unit of Jordan represents a 70 to 75 percent loss in the nation's consumer power.

There are less than fifteen industrial organizations employing 100 or more people, about 580 establishments employing from 5 to 99 people, while the remaining establishments are estimated to number about 6,000.

A large percentage of the local industries are processing industries which depend mainly on imported raw materials.

Although the exports of goods and services have steadily increased to an estimated JD 136 million ($410 million US) for fiscal 1977, there continues to be a chronic imbalance occasioned by imports during the same period estimated at JD 344 million ($1,030 million US).

II. THE ROYAL SCIENTIFIC SOCIETY'S INTERACTION IN JORDAN'S NATIONAL PLANNING AND IMPLEMENTATION PROCESS

Since its inception in 1970 RSS has consistently had a high degree of interaction in Jordan's national planning process, much more so than might be expected from a nongovernmental organization.

Beginning in the early 70's, the Head of RSS's Economic Department was appointed by the Prime Minister as one of seven men responsible for the formulation of, first, the Three-Year Development Plan (1973 - 1975) and, then, followed by the Five-Year Development Plan (1976 - 1980)

The government organization responsible for the preparation of the development plan is the National Planning Council, having a Board chaired by the Prime Minister. Other board members include the Minister of Finance, the Minister of Industry of Trade, the Director of the Central Bank, the Director General of the Royal Scientific Society, the President of Jordan University, the Chairman of the Chamber of Industry, and the Chairman of the Chamber of Commerce.

It is more difficult to determine the role of RSS in the implementation of the Development Plans, primarily because this process is not clearly identifiable. Several years ago the RSS had a JD 80,000 ($240,000 US) project financed by the National Planning Council to conduct a systematic follow-up on the major

elements of the Three-Year Development Plan (1973 -1975), but the program was not completed because the data forthcoming reportedly was too extensive for the staff of the National Planning Council to assimilate.

There is a governmental agency, the Directorate of Industrial Studies and Encouragement of Investment of the Ministry of Industry and Trade, which is performing a function with a seven man staff that, if coordinated, should be an important implementation to the Development Plan. It is difficult to tell if the efforts are directly linked to the plan. This function consists of a series of studies to determine the feasibility of establishing new industries with consideration to import substitution, natural resources, availability of technology, etc. One study is being done in cooperation with Amman Chamber of Commerce.

This Directorate has been assisted by a number of foreign experts, financed by UNIDO. In addition, the World Bank and other international agencies assisted in financing a JD 100,000 ($300,000 US) study contract with an Australian firm to prepare for this Directorate a number of such feasibility studies. The Director of this Directorate, an economist, is well acquainted with the Director General of RSS but not with the head of RSS's Economic Division, possibly because the latter has only been in his post for about a year. Neither the RSS Economics Head nor the RSS Industrial Chemistry Head had known of the existence of these studies, which were in areas of their professional activity. The head of the Directorate appeared favorably disposed to working cooperatively with RSS, but felt that his contract activity should be used to retain foreign experts and had not appeared to have weighed the consideration that such an approach neglected the nurturing of indigenous talents.

In a similar fashion, one of the newest and promising industries, created as the direct result of the Three Year Development Plan and a feasibility study conducted by the aforementioned Directorate, the Jordan Ceramics Industries Company, has recently made a request to the National Planning Council to provide them with three foreign experts on finance, marketing, and new product lines.

It would appear that the government agencies feel no sense of responsibility to include the RSS in the process of implementing the Development Plans, and one might speculate that this could be a manifestation of a minor resentment that RSS is not a government agency.

Some nations feel that one of the major missions of their research institutes is to have direct technological and even entrepreneurial input into the implementation of their industrial development plan. It is hoped that Jordan's central government will give increasing attention to this subject, for the Five-Year Plan clearly postulates such a policy for RSS as follows:

> Establish an industrial research and consultancy unit for conducting economic, technical and financial feasibility studies for medium and small - scale industries and extending advice to the public and private sectors for the purpose of identifying economically feasible projects.

III. INCENTIVES INITIATED BY THE JORDANIAN GOVERNMENT OR RSS DESIGNED TO ENCOURAGE INDUSTRIAL RESEARCH AND DEVELOPMENT

It was the unanimous consensus that there are no Jordanian laws designed to provide such incentives. In fact it was rather uniformly voiced that Jordan did not have a mechanism to formulate national science and technology policy and several well-informed officials felt that there was no established policy for industrial development.

However, it was interesting to note that the "Development Strategy" of the Five-Year Plan (1976 - 1980) contained the following comment:

> Research ought to be utilized in dealing with problems facing the Jordanian society. The government development policy should be based on the results of such research, and a certain percentage (1 percent) of GNP should be allocated to financing research and to increasing cooperation between the various research institutes in the Kingdom.

The investigator did not have the opportunity to ascertain the significance of this comment.

If Jordan does develop a sense of responsibility to encourage industry to engage in research and development, it would only require a minor revision to the "Encouragement of Investment Law No. 53 of 1972." This law provides three inducements for "Approved Economic Projects."

1) Exemption from custom duties for "fixed assets."

2) Exemption of net profits from income tax from 6 to 9 years.

3) Exemption of land taxes on buildings and lands from 5 to 7 years.

This law is administered by the Encouragement of Investment Committee chaired by the Minister of Industry and Trade. Also on the committee are two other representatives of the same ministry, and representatives from the Ministry of Finance, the National Planning Council, four from the public sector, and bankers from the Central Bank of Jordan and the Industrial Development Bank.

The Industrial Development Bank also has a key role in implementing the Five-Year Plan, with the functions typical of IDB's, and an authorized capital of JD 3,000,000 ($9,000,000 US). It is managed by a board of nine directors, including four bankers, and representatives of the National Planning Council, the Amman chamber of Industry, and the Ministry of Industry and Trade. Like most financial institutions, they rarely have technologists on their boards even though a sizeable proportion of their investments are on technology-based industry.

Perhaps, more to balance the budget than to serve as an incentive, the RSS, in recently established policy, has initiated a practice of charging industry for a portion of the expenses generated on their behalf, where industry pays for supplies and expenses at cost and about 20 percent of the labor costs incurred and with no overhead charge.

TRINIDAD AND TOBAGO

I. TRINIDAD - A NATION OF NEW WEALTH

An analysis of the research establishment in this nation and its interactions with industry and the government is only meaningful in the context of the drastic and radical upswing in this oil exporting nation's economy which occurred in late 1973, upon the formation of the new OPEC pricing structure for oil.

The annual revenue received by the government went from $474 million TT ($197 million US) in 1973 to $2,000 million TT ($830 million US) just two years later. Whereas in 1973 the oil revenues provided only 23 percent of the government's income, this rose to 75 percent or an actual two year change in oil revenues to the government of from $45 million US to $620 million US. During this same period, the balance of trade went from an extremely worrysome negative $400 million TT ($170 million US) to a positive $700 million TT ($290 million US).

Further analysis shows a softening or worsening of the nation's total economic picture during this short two year period if oil income is excluded. Without oil, the 1973 balance of visible trade was a negative $502 million TT ($210 million US), and in 1975 this deficit increased to $656 million TT ($270 million US) and to $712 million TT ($300 million US) in 1976.

Even with this oil income, the economy is not on a sound basis, with inflation continuing to increase at a rate in excess of 15 percent per year and with unemployment levels reaching 15 percent.

Obviously, the Government of Trinidad and Tobago and all elements of its professional community have a deep awareness of the magnitude of the problem confronting them as well as the almost unprecedented opportunity to effect major change in the diversification and the strengthening of their nation's industrial sector by the infusion, in planned fashion, of massive oil revenues.

In 1976, the government projected an expenditure of $8,000 million TT ($3.3 billion US) over the next 6 years on petroleum and energy related industrial development, an expenditure of 8 times the average annual expenditure on development programs over the last three years, and this is in addition to the normal development program expenditures.

II. THE NONEXISTENT GOVERNMENT INCENTIVES FOR THE ENCOURAGEMENT OF INDUSTRIAL RESEARCH AND DEVELOPMENT

As was true in Jordan, it is uniformly felt that there are no laws in the Republic of Trinidad and Tobago designed to provide such incentives. This in itself is not discouraging since such laws must sequentially follow the establishment of policy issues dealing with science/technology/industrial development, and these are receiving increasing attention.

III. THE GOVERNMENT PLANNERS AND IMPLEMENTORS AND CARIRI'S INTERACTION

At the expiration of the Third Plan in 1973, no formal action was taken to embark on a Fourth Plan. In announcing in his 1977 budget speech the establishment of a new National Advisory Council (see Section IV of this report) entrusted with "national economic planning," the Prime Minister said, "Planning had not enabled the developed industrialized nations to avoid inflation, pollution, shortages, the problems of urban congestion, human settlement and economic recession," and then went on to add that in view of the fact that this new council "contains people who possess expertise in a variety of fields, the question of the adaptation and utilization of planning as a development tool for Trinidad will be comprehensively re-examined."

Nevertheless, a number of Trinidadian governmental agencies have been continuously planning and working towards the industrialization of this nation. The principal agencies are the Office of the Director of Planning in the Ministry of Finance (Planning and Development), the Industrial Development Corporation (of the Ministry of Industry and Commerce), and the Trinidad and Tobago Development Finance Co. Ltd.

A. DIRECTORATE OF PLANNING, MINISTRY OF FINANCE

This is a key office with a support staff of professionals giving attention to the whole spectrum of planning issues confronting the nation and accountable really to the Prime Minister, who also holds the post of Minister of Finance.

The Director of Planning, Mr. Richardson Andrews, is also on CARIRI's Board of Management. He projects increased emphasis on developing the food industry and diversifying the metals and plastics industries, in addition of course, to the country's commitment to developing an integrated steel complex and a petrochemical industry.

The Director of Planning has called on CARIRI in a non-scheduled fashion to do feasibility studies, and mentioned a current one being undertaken in conjunction with engineering faculty of the University of the West Indies in the area of construction materials.

B. THE INDUSTRIAL DEVELOPMENT CORPORATION

The IDC is essentially an agency of the Ministry of Industry and Commerce, established in May 1970, to assist in carrying out the Government's plan for industrial/business development. It has a 135 man staff of economists and planners but has not developed an in-house competence in engineering, although they have authorization to do so.

The final decisions with respect to many of the applications submitted to the Corporation are decisions of the Minister of Industry and Commerce or of the Cabinet. The IDC makes the final decision only with respect to:

- o Small business loans up to $50,000TT ($21,000 US).
- o The leasing of industrial sites and factory buildings.
- o Training subsidies.

IDC has an eight man board chaired by Professor Ken Julien, and its roster includes three from business, one consulting engineer, one trade unionist, and two government officials. Both Dr. Julien and Mr. Eldon Warner, the General Manager of IDC, are on CARIRI's Board of Management

The Corporation provides a wide range of services, free of charge, to the businessman, including:

- o Information on the business environment.
- o Access to the Corporation's library and its selection of "industry profiles for investment."
- o Advisory functions to smaller business.
- o Project and product development assistance to manufacturers.
- o Locating and screening potential joint venture partners and sources of technology, and guidance in "joint venturing and technology sourcing."

In addition, the Corporation administers for Trinidad the "Harmonization of Fiscal Incentives to Industry" act, supplementing the Caribbean Community Treaty, which attempts to harmonize and rationalize the various industrial incentive laws existing in the region.

There is a Coordinating Task Force, headed by IDC's Chairman of the Board, which establishes priorities between competing government projects.

Mr. Max Cuffie, the Deputy General Manager of IDC, expressed interest in forming a team from IDC and CARIRI to identify ten to twelve medium to small new industrial opportunities. He also expressed the thought that perhaps CARIRI and the University publish a listing of their patented processes.

The Director of the IDC's Economic Studies and Planning Division expressed interest in having CARIRI assume increasing "technological undergirding" within Trinidad's industrial development. However, he felt that CARIRI should not conduct "feasibility"

studies; instead, they should be concerned with the technology and not with the economics of new development programs.

C. THE TRINIDAD AND TOBAGO DEVELOPMENT FINANCE CO., (DFC)

DFC should be one of the key ingredients in this nation's continuing industrial development and for several reasons could be increasingly interactive with CARIRI.

DFC, a joint venture between the government and the private sector, was incorporated in 1970 to promote economic development by assisting and financing profit oriented, productive enterprises. DFC can finance firms whose assets exceed $100,000 TT ($43,000 US) in loan amounts not less than $50,000 TT ($21,000 US), at interest rates of about 10 percent and can take a minority equity position. It also provides financial and management services.

In the first seven years of operation, DFC has granted 148 investment approvals totalling $43 million TT ($18 million US) and indicates that this has created 3,300 new jobs. In 1976 DFC financed 43 projects (including 15 new projects) totalling $15.2 million TT ($6.3 million US).

DFC has an eight-man board chaired by a Minister in the Ministry of Finance, and includes the Managing Director of DFC, Mr. J. E. N. Scoon, two bankers, one industrialist, one trade unionist, one businessman, and the Executive Secretary of the National Advisory Council.

Mr. Scoon would like to see CARIRI take a strong role in the identification of industrial development opportunities and intends to involve CARIRI to an increasing extent in analyzing the technological aspects of new investments under consideration (see Section V).

Mr. Scoon, although not on the Board of Management of CARIRI, personally interacts with the board members. He is one of the 15 members of the National Advisory Council and is Chairman of the Board of British West Indian Airline Company.

IV. THE EMERGING SCIENCE/TECHNOLOGY POLICY MAKERS AND CARIRI'S LINKAGE

There is an obvious awareness in Trinidad that their nation has a difficult task confronting them to use effectively the financial windfall from oil to bolster their entire economic/social future.

Recognizing the central role that technology must play in the immediate years ahead, the Prime Minister has created two new entities in the last eighteen months, the National Council For Technology In Development and the National Advisory Council.

A. THE NATIONAL COUNCIL FOR TECHNOLOGY IN DEVELOPMENT (NCTD)

This council was formed in January of 1976 and has met monthly since that date. The council reports directly to the Prime Minister through an inter-ministerial group. The charter permits three-year terms for fifteen members and to date eleven have been appointed. By design, there are no government appointees. Six members are on the faculty of the University of the West Indies, one is a medical researcher, three are from industry, and one is a retired educationalist. This council was charged with the following responsibilities:

1. To coordinate scientific and technology research and development activities funded by the government;

2. To advise on national policies affecting activities in science and technology;

3. To recommend priorities in the national research program;

4. To promote research and development as is needed to meet the national needs, sometimes by direct funding;

5. To assess ongoing or proposed research and development programs that have or are seeking government funding, including in-house government research programs, and to make recommendations;

6. To be the direct liaison with external programs in science and technology such as the multi-national programs of the Organization of American States, the Commonwealth Science Committee, etc.;

7. To advise on cooperation with other countries on scientific and technological activity;

8. To disseminate scientific information including the publication of scientific reports, journals and other such documents; and

9. To compile an inventory of the country's scientific resources (including manpower resources) and to keep government advised of all research and development activities in technology in the private and public sectors.

B. THE NATIONAL ADVISORY COUNCIL (NAC)

This council was initiated by the Prime Minister in December, 1976 to deal with certain "matters of urgency and priority." The three major areas with which NAC will be concerned are:

1. National economic planning;

2. Administrative improvement in the public service; and

3. The efficiency of the utilities and public enterprises.

There are fifteen council members including four University professors, five businessmen, a banker, a lawyer, a trade unionist, and a retired civil servant.

C. CARIRI'S GOVERNANCE - A LINKAGE WITH THE POLICY MAKERS

The governing board of a research institute is charged with establishing the objectives to be pursued by the corporation. As will be noted, CARIRI has not benefited from consistent board direction.

By charter, CARIRI is governed by a Board of Management consisting of twelve members appointed by the Ministry responsible for Planning and Development and includes a representative of the Government to serve as Chairman, a representative of the Industrial Development Corporation, four from the University of the West Indies, three from the industrial/commercial sector, and the UNDP regional representative. Unfortunately, because of reasons not germane to this report, this Board of Management did not function for approximately two years. The Prime Minister announced in December, 1976 that the newly established National Council For Technology In Development ("NCTD") "should be assigned full responsibility for the operation of CARIRI" and that in turn, "CARIRI be designated the executive agency for NCTD." This seems to interpret as follows:

1. Most of the nongovernment members of CARIRI's Board of management are also from the existing eleven members of NCTD, and thus the Prime Minister's wishes are being followed; in fact, seven of the ten discretionary CARIRI Board appointees are among the eleven NCTD members.

2. The permanent full time five-man Secretariat of NCTD, as yet to be hired, will be hired for this purpose by CARIRI and will not fall under government civil service.

This linking together of NCTD and CARIRI, as well as by the fact that two of CARIRI's Board members are also members of the NAC, could be extremely beneficial in keeping CARIRI in the mainstream of the nation's science opinion formers, although the investigator is a little uneasy that NCTD does not have a clear-cut technology/industrial development mandate and that the heavy preponderance of university professors (six of the eleven appointed to date) may be accompanied by a greater emphasis on RESEARCH than on DEVELOPMENT.

In addition, other important linkages occur as follows:

1. One CARIRI board member is also Chairman of the Board of the Industrial Development Corp. as well as Chairman of the National Advisory Council;

2. Another board member is also the Director of Planning of the Ministry of Finance;

3. Another CARIRI board member is also the General Manager of the Industrial Development Corp.;

4. This is further rounded out by having an industrialist/engineer as Chairman of CARIRI's Executive Committee.

CARIRI's Board is its most valued asset, and, in turn, this Board should contribute must to the growing success of CARIRI.

V. A CENTRAL THEME? A REQUIREMENT LOOKING FOR A MECHANISM? A POSSIBLE SOLUTION?

Nearly all officials, regardless of organization, expressed acute awareness that Trinidad was at a unique point in history where it must invest their accumulating oil revenues in increased industrial development activities and that they have not yet been able to marshall all of their resources in a total, planned, coordinated attack on the problem.

Mr. Frank A. Barsotti, Chairman of the Board of the Development Financy Company (DFC) said the following in the company's 1976 Annual Report,

> ... there is need for institutional mechanisms to coordinate research and to develop and package bankable projects that could provide some avenues for investment by the private sector and the existing financial institutions. Unless some positive attempt is made to develop projects, the banking system will continue to remain short of good investment avenues.

The Deputy General Manager of the Industrial Development Corp., Mr. Max Cuffie, had obviously given this subject much thought, ranging over a variety of possible approaches to the problem,

including the concept of India's National Research and Development Corp. (NRDC). Several of those interviewed, including government officials, were intrigued with the concept of K-TAC, the venture capital subsidiary of the Korea Institute of Science and Technology.

On another vein, the Managing Director of DFC, Mr. J.E.N. Scoon, expressed the opinion that CARIRI should take an increasingly aggressive role in the identification of new industrial opportunities and provide leadership in the acquisition of appropriate technology. Some senior staff of CARIRI who have devoted appreciable energies to product and process development and feasibility studies feel that their efforts could be focused on higher commercialization probabilities if their programs were coordinated at the outset with a broad spectrum of interests, ranging from industrial policy formulators, to planners, to venture capitalists, to entrepreneurs and on to potential industrial operators. In CARIRI's last annual report, Prof. J.A. Spence, Chairman of the Board of Management said,

> CARIRI has up to now built its reputation on the basis of work carried out largely in response to requests received from industry and Government agencies for advice, consultancy and trouble-shooting of an ad hoc nature. In the initial stages it was essential for CARIRI to function in this manner in order to establish its credibility and the competence of its staff. Having established itself as a viable national organization with a regional and international reputation, CARIRI's modus operandi and long-term orientation need to be re assessed.

Dr. Lenny Saith, Chairman of the Executive Committee of CARIRI's Board of Management, extends this theme and expresses the requirement to formulate new objectives to guide this organization into an increased leadership role on technological issues. Mr. Hollis Charles, the Director of CARIRI, has a sound grasp of the problem from the vantage point of the perspective of the functioning of a large number of research institutes throughout the world coupled with a realistic assessment of what may be achievable in Trinidad. Along this line, CARIRI hosted in February 1977, under UNIDO's auspices, a meeting (see Part Two, Section III, in the main body of this report for additional information) attended by five directors of research institutes, including Korea's KIST and India's NRDC, where,

> The purpose of the Meeting was to examine the major elements of industrialization to which national technological institutions could make a contribution.

In view of the high degree of interest evidenced by government officials and other Trinidad leaders in exploring new concepts in organizational mechanisms designed to enhance the transfer and commercialization of new technologies, coupled with the investigator's inherent interest in the subject, the writer, in the spirit of friendly interaction, presents the following thoughts to serve as the framework for a hypothetical organization structured to achieve these goals....

(Please refer to Part Two, Section III, in the main body of this report for a discussion of a new concept, the Venture Technology Corporation).

APPENDIX D

MAIN KOREAN SCIENCE AND TECHNOLOGY DEVELOPMENT POLICIES IN 1970'S

Issued in 1975 by the Ministry of Science and Technology
Republic of Korea

(Note: Chapters I and II have not been included in this Appendix.)

CONTENTS

NOTE: Chapters I and II have not been included in this appendix.

III. Strategic Development of Industrial Technology

1. Direction for Development of Industrial Technology

The following are major policies for the development of industrial technology.

For the successful achievement of the $10 billion export target in the early 1980's and of the aims of Heavy and Chemical Industry development, there will be a drastic rise in the demand for high industrialization and the development of science and technology and of skills and crafts.

It will be necessary to increase our science and technology development efforts by possibly as much as 10 times to support the export target which has been increased by six times (600%) for the coming decade. The example of Japan, where imports of foreign technology increased 12 times and expenditures for R&D 10.4 times, especially expenditures for R&D from private companies which now 15.7 times, while exports increased from $2 billion in 1955 to $10 billion in 1967, should be born in mind. Taking into account our present industrial technology situation and our R&D capability, everyone, should concentrate his efforts on initiating innovation by the selective import of advanced technology from foreign countries and by domestic R&D. For this purpose, there should be:

1) A concentration on developing the strategic technology selected in accordance with the criteria set up to suit our needs, and a propagation and dissemination of developed technology.

2) The importation of foreign technology connected with our continuing R&D activities and the absorption and improvement these imported foreign technologies.

3) The introduction of standardization and quality control systems, which are vital requirements for industrialization.

2. Strategic Technology Development

A. Strategic Technology

Major pursuits are the development of the strategic technology for the heavy and chemical industries, the high level industrial technology necessary for the construction of strategic, export oriented industries, and handicraft products for the increase of rural employment and income. The technology development of handicrafted products is centered in rural areas, is the

responsibility of the New Community Movement, and is vital to industrial technology development requiring balanced government assistance.

Among these are:

1) Raw and intermediate materials technology development for products necessary for heavy and chemical industry construction.

2) Precision machine design and processing technology for the development of technology intensive exports.

B. Establishment of five major Industrial Technology Research Institutes

1) Some measures are needed to induce and provide leadership so that private companies can participate actively in their own industrial technology development. In advanced countries technology development is often assumed by private companies. So far the Korea Institute of Science and Technology has played the role of a central intermediary agent for industrial technology development until the present time.

2) KIST was established in February 1966 with the cooperation of the government of the USA to promote the development of technology and industry by conducting research and surveys concerned with science and technology, and then disseminating the results. It recruited competent scientists in various fields in the country as well as from abroad. The research staff totals about 150. The KIST undertook 831. contracts during 1967 - 1973, these totalled 5.7 billion won. The KIST research staff has taken part in government science and technology policy making and industrial development and has thus made a great contribution.

3) The Korea Institute of Science and Technology has been a consolidated research center in this country for industrial technology development. A research institute dealing with comprehensive technology such as KIST can hardly today cover all the concentrated development of strategic technology as required by the rapid economic growth which causes a drastic expansion of the demand for technology and the increasing specialization of technology. Consequently the Ministry of Science and Technology has determined the need to establish five major specialized research institutes for concentrated development for the heavy and chemical industries.

Shipbuilding Industry Technical Services

Need

(1) To build a core of shipbuilding technology to support the shipbuilding industry

(2) To relieve of foreign currency drain due to the expected purchase of technological know-how and construction plans

Korean Ocean R&D Institute

Need

To establish a core for the survey and dissemination of data on such marine resources as minerals, fish tideland, etc.

Korea Electronics Technical Research Institute

Need

(1) Standardization and local manufacturing of communications equipment; technology import and manpower training

(2) Development of high speed, high capacity transmission system.

Korea Petroleum Institute

Need

(1) To solve technological problems in energy and petroleum products supply as well as in petrochemical industries

(2) To have self-sufficient technical capability as well as to digest the imported technology

Mechanical Engineering Research Institute

Need

(1) To solve problems arising in casting industries, which have fine prospect for an export industry

(2) To develop design and nigh quality machining technology, which are the weak spots in machine industry and machined parts

(3) To develop the die making technology which are needed in all products in mechanical industry

3. Establishment of Science Town

Background

1) Modern industrial technology is characteristically diversified and complicated. To assist in the heavy industry in technology new discipline oriented research institutions corresponding to developing diversified industries are needed. On the other hand, these institutions must have systematic joint team work to promote the best utilization of manpower and facilities.

2) It will be effective for the institutions to be concentrated in a science part to promote information exchange, and reduce the cost of investment for jointly used facilities and equipment.

3) Most of the present national institutions in Seoul must be moved because sites are so limited and expensive that they have no opportunity for expansion, and also the environments are not proper for research activities.

4) Building a Science Town in a region far from the capital city will contribute not only to regional development, but also to distribution of Seoul's overflowing population.

Phase of Construction

Location: Dae-Duk Gun, Chung-nam province

Phase : a. A new town with proper environment and facilities to R&D

b. A satellite city of Dae-Jeon

Scope

Population	50,000 persons	Area	6,632 acres
Research Inst.	4,000 persons	Research Inst.	670 acres
Education Inst.	1,000 persons	Education Inst.	411 "
Service	6,500 "	Apartment	564 "
Families	35,000 "	Public Service	33 "
College Student	3,500 "	Road and Others	4,954 "

4. Encouragement of Technology Transfer (Import)

1) The role of foreign capital inducement in industrial development is very important to Korean industries which were ineffective in importing technology.

2) In the inducement of foreign capital, most factories were supplied on a turn-key basis thus eliminating the training of personnel and domestic technology service groups.

3) Since the promulgation of the foreign capital inducement in August 1966, foreign technology imports totalled 426 projects by June 30, 1974. An analysis of the technological fields included set up of machinery, operation of machinery, maintenance and repair of machines etc, and some manufacturing methods, process designing of machinery, and production.

Status of Foreign Technology Import

Year	Country	U.S.A.	Japan	Germany	Others	Total	Remarks
1966		5	8	2		15	
1967		7	25	1	1	34	
1968		12	35	1	3	51	
1969		10	40	1	2	53	
1970		18	61	1	3	83	
1971		5	33	2	3	43	
1972		10	30	2	2	44	
1973		15	41	1	1	58	
1974	6.30	3	24	1	3	31	

4) For the successful achievement of the $10 billion export target in the early 1980's there will be a drastic rise in the demand for high industrialization and development of science and technology and of skills and crafts. The present industrial technology situation as it concerns innovation must be taken into account to formulate an effective advance technology import policy.

To simplify and facilitate the administrative procedures for foreign technology import, an automatic permission procedure will be effected and a "substitute machinery for foreign technology import system" should be studied and carried out so that specialized technical institutes such as KIST can absorb and adapt special foreign technologies and know-how something private industries can hardly do and then distribute them to private industries.

5. Enlargement of Research & Development for Self-Sustaining Economy

1) Dissemination of Imported Technology

We will place Government R&D strategic technology development, and private industry R&D emphasis on the adaptation

and improvement of imported foreign technologies by such institutes as KIST, thereby making the imported technologies our own.

To carry this out:

A. We will induce private industries to entrust their R&D projects to reliable institutes such as KIST this is anticipated to proceed efficiently through the applying of the Law for Encouraging Technology Development.

B. We will invest government budget in R&D, contribute to KIST R&D, and concentrate on those R&D projects directly related to production and industrialization. We can thereby induce private industries to recognize that R&D expenditures are never an unprofitable investment, but are profitable.

C. The technical diagnosis and counselling programs for export industries which have been carried out by KIST will extend their coverage to designated small industry companies, and will strengthen policies so that industries can set up and achieve their own technology development targets.

We will also develop an award system for the encouragement of technology development by selecting model technology development industries.

2) Support for Research and Development Activities in Private Industries.

A. R&D has been led by National and Public Research Institutes. Only 3,381 million won was expanded by private on R&D out of the 10,667 million won national gross research investment in 1971. There are only 118 enterprises which have research departments out of the 244 enterprises with over 500 employees. There is an average of 8 persons in each research department most of whom work on testing of raw resources and of products, compared with developed countries, where more than 50% of the gross R&D investment is contributed by private enterprises, the private enterprises contribution to R&D in Korea must be increased.

Foreign Investment by Fund Source

Classification (year)	U.K. (69)	Germany (69)	Japan (69)	Sweden (69)	Republic of Korea (71)
Government	49.6	41.3	30.2	42	68
Private	50.4	58.7	69.8	58	32

B. The law encourages technology development and aims at comprehensive government support to encourage the active technology development activities of private companies. It enables the government to provide financial support for R&D expenditures as well as tax exemptions and joint government-private company research work.

C. Korean private industry is short of R&D capability; businesses are small scale and lack recognition, so technology development is needed. Taking into account these problems, measures are needed to induce and provide active indigenous industrial development. Joint investment contract research between universities and KIST are to be encouraged. This Ministry has effected a joint research system between the government and private companies which resulted in a total of 21 projects in 1971 and the system is to develop and continue.

3) Exchange of Science and Technology with other countries.

A. Korea received considerable funds and trained personnel in technical aid from foreign countries, but this aid did not produce the satisfactory result of transplanting techniques because of differences between Korean industrial needs and conditions and those of donor countries.

Result of Technical Assistance
(1951-1971)
(In Korean Won*)

Classification	AID	UN	Colombo	Others	Total
Expert	35,480.4	5,673.1	856.6	731.0	42,741.1
Fellowship	12,975.4	5,009.5	4,291.8	8,638.0	30,014.7
Service	46,963.7	19,255.4	---	973.0	67,192.1
Equipment	21,051.0	14,529.4	1,933.6	2,170.6	39,685.5
Total	115,571.4	44,467.4	7,082.0	12,512.6	179,633.4

* 500 Won = $1.00 US

B. Changing foreign country approaches to technical cooperation to promote effective cooperation.

We will emphasize increased benefits through a concrete technical cooperation plan and systematic coordination according to our own policy based on greatest needs. From 1973, the Block Grant System of AID assistance has gone into effect.

C. Technical Cooperation Promotion

A Policy of selection of multilateral and bilateral technical assistance from countries is to be followed, and we will develop a system of resident science attaches at Korean missions abroad beginning in 1973 to facilitate participating by domestic scientists and engineers in international scientific and technical conferences and to promote the invitation of prominent scientists from foreign countries.

D. Strengthening Technology Information Activities Measures to strengthen coordination through interchange of technical information are needed to counter the swift changes in advanced technology. Information is required to support domestic research activities effectively.

1. We will increase the quantity of information collected by the Korea Science and Technology Center acquire to 6,000 pieces about 20 percent of the 30,000 pieces of published professional science and technology publications world-wide.

2. We will reorganize the interchange channels of the information system and promote the automatic handling of information documents.

IV. Establishment of Favorable Science and Technology Environment

A. People's Understanding of Science and Technology

1. Since the public has lived in a pre-modern, society for a long period, attitudes are non-scientific and irrational as they relate to thinking patterns and ways of life, thus resulting in backwardness in science and technology development.

2. Therefore, great effort for the creation of an environment, favorable for the development of science and technology. long range perspectives, as well as foundation building for further science and technology promotion are required.

3. While scientists and engineers work toward indigenous R&D, capable youth should develop scientific and creative minds to future become the scientists and engineers.

B. Para-Technical Activities of all People

1. Basic techniques and skills should be mastered at an early age, so it is necessary to strengthen science education, teacher in charge of the science program and by reforming the science curricula in elementary schools. Also the curricula in middle schools must be charged to vocation oriented curricula similar to those in most industrialized countries.

2. To meet these needs, the following should be strengthened for the future development of science and technology: The defining of basic techniques and skills, introduction of basic skill tests, mobilization of non-school youth as craftsmen, reforms of curricula in colleges of engineering and vocational high schools; social acceptance of technicians and craftsmen, systemization of vocational training in army, re-enforcement of vocational training for prisoners, etc.

C. Nationwide Diffusion of Technology, Technical Assistance to Sae Naul Movement.

Emphasis should be given to the nationwide diffusion of every day and farming and fishing technology techniques and also to the development of farm house holds and specific local products for the betterment of living conditions in rural areas.

The publication and diffusion of the Technology Guidance Handbook and field guidance for "Sae Naul Movement" by the Technical Service Corps should be strengthened.

D. Academic Activity Support

The efforts must be made to expand the science and technology potential, to speed up cooperation between industry and academic, and to increase the exchange of information among international academic institutions. Industrial inventions and their application should also be systematically supported for commercialization.

V. Function and Organization of Ministry of Science and Technology

A. Functions

The Ministry of Science and Technology (MOST) was established as a center of science administration on April 21, 1967, under Presidential Decree No. 2996 and is in charge of

the establishment of overall basic policies and plans on promotion of science and technology and of a system for carrying out such policies and plans. Before the establishment of MOST science and technology was administered by Technology Management Bureau of Economic Planning Board. But the science and technology administration was integrated into the newly established MOST after 1967.

As indicated in Government Organization Law, Article 25, the Ministry of Science and Technology shall coordinate the various planning and management activities of the ministries concerned for the promotion of science and technology. The major functions of the Ministry follow:

1. Establishing of overall basic policies and plans for the promotion of science and technology

2. Integrated coordination of science and technology plans

3. Overall management of technical cooperation activities

4. Development of policies for the creation of an environment favorable for science and technology

5. Establishment of basic policies for the utilization of atomic energy

B. Organization

The Ministry of Science and Technology is composed of a minister, vice-minister, two offices and three bureaus and has National Science Museum, and Central Meteorological Office under its control. The Ministry of Science and Technology established the Office of Policy and Planning in September 1971 by reorganizing MOST functions. It is responsible for overall basic policies and plans for the development of science and technology.

C. Major Roles of Selected Institutes of Science and Technology

1) The Korea Institute of Science and Technology

The Korea Institute of Science and Technology (KIST) was established to help develop the industry by carrying out research and development programs and providing the technical services needed by industry.

The Institute is responsible for:

1. Research, investigation, and examination with respect to science and technology and engineering economics and dissemination of the results.

2. Cooperation with universities and other research organizations and professional societies in and out of Korea.

3. Contracts for research and technical services or for such services performed by other organizations in and out of Korea.

4. Other necessary activities to accomplish the purpose of the Institute.

5. Supplemental activities with respect to the above.

2) The Korea Advanced Institute of Science

The Korea Advanced Institute of Science (KAIS) is a new graduate school of applied science and engineering established by the Korean Government with the cooperation of the United States. Its prime objectives are to produce capable graduate scientists and engineer vitally needed for the fast growing Korean economy; to modernize and upgrade Korean higher education, to undertaken mission-oriented basic research of prime interest to Korean industry and to foster, encourage and engineer the continuing progress and development of science and technology.

In general, KAIS will assume a central role in the development Korean scientific activities and will strengthen relationships among Korean academic circles, research institutions, society and industry.

3) The Korea Scientific & Technological Information Center

The primary objective of KORSTIC is to facilitate the international transfer of scientific knowledge in general, and contribute to the development of Korean science and technology in particular. To attain this objective, KORSTIC is devoted to collecting, processing and disseminating scientific and technical information comprehensively and systematically on a nonprofit basis.

KORSTIC has, for its secondary objective, the playing of a leading role in the field of documentation and the integration of related information activities in Korea.

4) The National Science Museum, as an institution for the promotion and diffusion of knowledge of science and technology among people, serves the public as follows:

1. Research in such areas as basic applied science

2. Display of scientific materials and diffusion of knowledge

3. Leading of the public into a scientific way of life

5) The Central Meteorological Office

The fundamental duties of Central Meteorological Office are determined by the provisions of the Meteorological Service Law, and the aim of the service is to contribute to the development of public welfare, in such ways as preventing weather disasters, assuring transport safety, prosperity of industries and so on, as well as in conducting international cooperation related to weather service through the World Meteorological Organization of the UN.

6) The Korea Atomic Energy Research Institute

In February 1973, the Korea Atomic Energy Research Institute was established as a corporate body, incorporating the former Atomic Energy Research Institute, the Radiological Research Institute, and the Agriculture Radiation Research Institute. The Institute activities follow:

1. Overall energy development and environmental research

2. Development of power reactor technology

3. Development of nuclear fuel technology

4. Utilization of radiation and radioisotopes in industry and agriculture

5. Cancer research and operation of center hospital

6. Utilization of reactors for fundamental and applied research

7. Basic research in physics, chemistry, and life science

ANNEX 1. MAJOR SCIENCE AND TECHNOLOGY LAWS

A. Science and Technology Promotion Law

The purpose of this Law is to contribute to the development of industries, and the stability and improvement of the living conditions of the people through regulating matters concerning the establishment of a system for carrying out such policies and plans, and studying financial measures.

B. Technological Development Promotion Law

The purpose of this Law is to promote independent development of industrial technology, and digestion and improvement of induced technology, and to diffuse achievements thereof, and thus contributing to strengthening international competitive capacity of enterprises and to development of the national economy.

C. Engineering Services Promotion Law

The purpose of this Law is to ensure a sound promotion of engineering services in Korea and improvement of engineering capability in Korea, thereby contributing to development of the national economy.