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# COUNTRY MONOGRAPHS 1/

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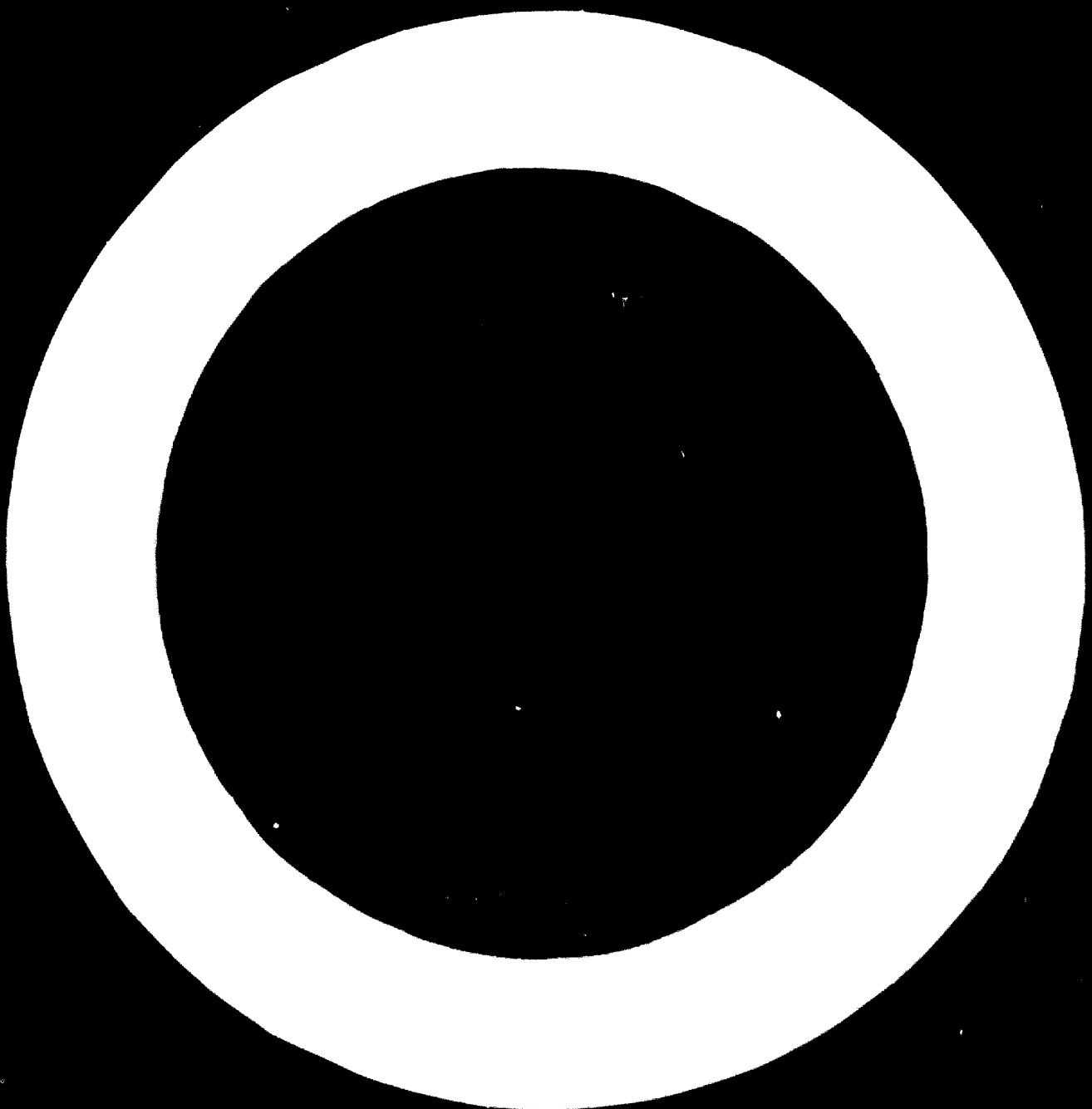

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# AFGHANISTAN

## A CASE OF EARLY INDUSTRIAL DEVELOPMENT INSTITUTION BUILDING

by

Aziz Rahim

It would be a great pleasure to be able to share the problems that make up the theme of this series of seminars, and it would be even more gratifying to be able to discuss with our colleagues our experiences in trying to solve them. To do so would indicate that Afghanistan had already achieved a state of industrial development that is, unfortunately, still some years away.

Although the earliest beginnings of Afghan industrial development can be traced back about fifty years, it was not until the enactment of the Foreign and Domestic Private Investment Law in 1967 that industrial growth began to accelerate. Approximately 180 private industrial projects have since been approved by the authorities of which 80 are now in production. Prior to the Law there had been no more than a few dozen industrial enterprises in Afghanistan, and the majority of these were sizeable state enterprises.

As may be expected, the major thrust of Afghanistan's industrial development activities has been to promote the formation of industries. To facilitate this effort it has been necessary to create a framework of institutional support from the ground up. At the present time even this basic structure remains to be completed. Still lacking are such fundamental institutions as an industrial development bank and an industrial area complete with all necessary infrastructure. Understandably then, Afghanistan has devoted and will continue for some time to devote its scarce organizational resources principally to the task of rounding out its complement of institutions needed to promote private industrial formation. Without this focus it would be difficult to imagine the growth of an industrial sector large enough to support even a modest research and development and standards organization.

Despite the small size of the Afghan industrial sector, it is painfully obvious that problems exist which can only be solved by the results of research and development and by the application and enforcement of standards. Notable among these are the difficulties with the quality of field grade raisins and raw hides and skins - two raw materials of the most important of Afghan exports. There are others too numerous to mention. Unfortunately, the size of most of our enterprises is too small to afford the resources needed for private R & D, although some *ad hoc* efforts have been made by individual industrialists to solve their problems. In the main, these efforts have been more courageous than effective.

Thus, though we are presently not equipped to work on the solution to these problems, we are well aware of them and are beginning to take the first steps in planning an organized attack on them.

Consequently, we very much appreciate the opportunity to participate in this series of seminars in the hope that we may learn from the experience of our colleagues and apply this learning to smooth the way in the establishment and effective use of research and development services and the development and application of industrial standards.

## CYPRUS

## CASE STUDY ON THE SITUATION AND EXPERIENCE IN THE FIELD OF INDUSTRIAL AND TECHNOLOGICAL RESEARCH AND DEVELOPMENT

by

Spyros Phylaktis

Cyprus is the third largest island in the Mediterranean with an area of 3,572 square miles and a population of about 630,000. It became an independent republic in mid-August 1960. Manufacturing is one of the most important sectors of the economy of Cyprus. In 1971 it employed about 36,000 persons or 13 per cent of the economically active population, contributed C£28 million or 12 per cent to the Gross Domestic Product and exports of manufactured goods amounted to C£10.5 million or about 25 per cent of total domestic exports.

Nevertheless, industrial development in Cyprus is of recent origin and due mainly to private initiative. Some of the factors which contributed to the slow rate of development in the industrial economy are the smallness of the local market, the limited supply of raw materials, the development of a lucrative import trade (which inter alia had the effect of conditioning the Cypriot consumer to foreign goods), the lack of enterprising initiative in the industrial sector and the relatively low standard of technical training.

The period since 1960 has seen the expansion and establishment of the majority of industries operating in Cyprus. The industrial structure is typical of a developing country. The major industries from the point of view of employment and value added are those producing foodstuffs, beverages, clothing and footwear. Other industries of some size are printing, furniture, brick-making and cement manufacture. In 1967 there were 6,766 industrial establishments, 84 per cent of which employed less than five persons. The big establishments (i.e. those employing five persons and over) contributed 79 per cent to the gross output of the manufacturing industry.

The industry is geared to the production of consumer goods mainly for local consumption, the only exception of importance being wines and spirits and canned products where by far the greatest quantity of production is exported. With the exception of the food industry, all other industry is heavily dependent on imported raw materials. There is relatively little interdependence within the industrial sector, except in the field of packaging and labelling where a number of firms supply the industry with its packaging and labelling requirements. Close interrelations exist between agriculture and food industry. In the area of management, with the exception of a number of large firms, there is little if any specialization of management functions and the owner/manager has usually to wear many hats.

The Government of Cyprus's policy in the industrial sector is to create a climate conducive to the development of private initiative and the attraction of foreign capital and technical know-how by such infrastructural works as the expansion of electrification, communications, water development and port development, by the granting of tax incentives and technical training, by the creation of industrial estates and by the granting of medium and long-term loans through the Cyprus Development Bank at reasonable rates of interest. The main objective of this policy is to use industrial development as a vehicle for restructuring the economy towards built-in stability and diminished dependence on external and extra-economic factors.

The overriding aim for achieving this objective is to build an industrial structure that is conducive to an accelerated and self-sustained long-term growth of the manufacturing sector. Specifically it is expected that industrial development at least during the next five years or so would:

(a) Make possible the utilization of local raw materials which at present are either not utilized sufficiently or are being exported in a raw material state;

(b) Improve the balance of trade through increased exports of manufactured goods and import substitution (Cyprus imports in 1971 amounted to CL107 million against total domestic exports of CL42 million);

(c) Make more efficient use of industry's resources;

(d) Create more productive employment opportunities.

The Research and Industrial Development Section of the Ministry of Commerce and Industry is the Government department responsible for the promotion of industry in general in Cyprus. Cyprus, because of its small size and its low level of industrial development, lacks the industrial research institutes or firms of consultants which exist in many other bigger countries. For this reason the onus of industrial research falls on the Research and Industrial Development Section of the Ministry of Commerce and Industry. In this connexion the Research and Industrial Development Section advises and assists in the preparation of programmes of industrial development and carries out:

(a) Surveys with the help of foreign consultants or UNIDO experts designed to identify new industrial opportunities and barriers to industrial development;

(b) Promotional campaigns to disseminate the findings of such surveys and to bring industrial opportunities to the notice of local and foreign potential investors.

Furthermore it promotes industrial projects and prepares and evaluates feasibility studies and pre-investment studies. Finally, it carries out research on general problems of industrial development and offers general information, assistance and guidance in the fields of production, quality control, standard specifications and finance.

In 1971 a team of UNIDO experts carried out a general survey of industrial development with a view to identifying investment opportunities and suggesting ways and means of accelerating industrial development. A summary of this study has been prepared by the Research and Industrial Development Section and distributed to potential investors both in Cyprus and abroad. As a result of this study a lot of industrial projects have been established or are under consideration or implementation. In addition many important studies have been carried out during the Second Five Year Plan (1967-71). For instance, a UNIDO expert carried out a study on the advisability of establishing an industrial extension service. A survey of the conditions prevailing in the packaging field was also carried out by a UNIDO expert. A food technologist also from UNIDO carried out a survey of the problems of the food industry in Cyprus.

The Research and Industrial Development Section engaged the services of overseas consultants or UNIDO experts who carried out specific feasibility studies for a fertilizer plant, a forest industries complex and a cement-asbestos plant. As regards forest industries a company has been formed with 51 per cent Government participation. The project is now under implementation. The drafting of the tender specifications for the supply of the necessary machinery as well as the evaluation of the tenders has been done by a consulting firm provided to the Cyprus Government by UNIDO.

In addition various UNIDO experts were assigned to a number of other projects in various fields. This assistance has proved very beneficial and made a positive contribution towards the industrial development efforts of the Cyprus Government. Many of the recommendations made by these experts have already been adopted by the Ministry of Commerce and Industry and are in the process of being implemented and others are under consideration. The attached appendix lists UNIDO experts or consulting firms which have carried out missions and assignments in Cyprus during the Second Five Year Plan (1967-71).

Cyprus has no Industrial Technological Research Institute. This is because of the small size of the country and the high cost involved. For this reason, the country has to rely almost entirely on imported technology. In this connexion, the Cyprus Government welcomes foreign investment in industry, particularly when this is accompanied with technical know-how and is intended to meet needs which cannot be properly served by local capital and skills. Foreign capital is accorded no less

favourable treatment than that accorded to local investments and available incentives and concessions are extended to foreign firms on the basis of non-discrimination. Furthermore, the Cyprus Government has no plans of nationalizing private industry. The Government's declared policy is one of non-interference in the sphere of the private sector.

There are no hard and fast rules regarding the extent of foreign participation in industry in Cyprus. Although the Government prefers joint ventures and that 51 per cent of the equity capital of an industrial enterprise should be owned by Cypriot investors, each case is considered on its merits. Cyprus is perhaps more fortunate than a number of other developing countries in that it has a dynamic class of entrepreneurs, a fairly high level of literacy, and a mobile and adaptable labour force. In addition, wages in Cyprus are relatively low when compared with those of Western Europe. These factors, together with Government policy of encouraging foreign investment, are already drawing to Cyprus well-known firms in joint or licensing ventures with Cypriots, not only to satisfy local demand but with an eye on exports as well.

In spite of the satisfactory development of the manufacturing sector during the last ten years or so, nevertheless there are a lot of problems to be overcome if industry is to grow at the desired rate in the future and if it is to become export-oriented. These problems are mainly the following:

(i) The relatively low level of technology prevailing in Cyprus.

(ii) The lack of industrial standards due to the absence of a national standards body. This has occasionally resulted in inconsistent quality of manufactured products which failed to meet adequately the requirements of competitive markets.

(iii) Industrial entrepreneurs have been establishing new enterprises often without sufficient techno-economic studies.

(iv) Sufficient assistance to enterprises has been lacking in formulating projects, in choosing suitable equipment and in providing "follow-up" services in the various sectors of production, management and marketing.

In order to overcome the above problems, the Government of Cyprus has recently negotiated with the United Nations a Five-Year Technical Assistance Programme for the development of Cypriot industry and the promotion of exports of manufactured goods. Under this Aid Programme, the United Nations will provide experts, equipment and fellowships for Cypriots to receive specialized training abroad, for the establishment of an Institute of Standards and Quality Control, an Industrial Extension Service, and Export Credit and Credit Insurance Scheme, Free Zone/Industrial Estates, and also for strengthening the Research and Industrial Development Section of the Ministry of Commerce and Industry. This Aid Programme will start being implemented during early 1973 and is expected to cost about C£630,000. The main objectives of this Project are as follows:

(a) To advise the Government of Cyprus on its industrial policies and regulations and to assist in the preparation of programmes of industrial development and of industrial feasibility studies;

(b) To assist in the promotion of industrial projects;

(c) To provide advisory extension services in all aspects of establishing industrial enterprises, production and operation, and in product adaptation and development;

(d) To assist in setting up a National Standards Body, including formulation of legal documents and regulations needed for its operation; to work out a methodology for formulation of national standards specifications and to promote their application in industries;

(e) To assist in establishing and administering a quality control and certification marking system, including consultative services for industrial enterprises on the organization and operation of in-plant quality control and to provide laboratory and testing facilities for checking and certifying the conformity of products with the specifications;

(f) To advise and assist the Government in establishing and initiating operation of a Free Zone/Industrial Estate;

(g) To advise and assist in providing an adequate range of export services to Cypriot manufacturers to enable them to meet the exports expansion and diversification objectives of the Government;

(h) To establish a national reference information service for industry which can provide a continuous and up-to-date flow of technical and economic information to industrial enterprises, potential investors and Government bodies.

It is hoped that the above Project will assist the Government to achieve an annual compound rate of growth of manufacturing industry of around 11 per cent during the Third Five-Year Plan (1972-76). The annual rate of growth of manufacturing industry during the Second Five-Year Plan (1967-71) was about 9 per cent.

N.B. One Cypriot Pound is equal to US$2.6.

APPENDIX

Experts assigned to the Ministry of Commerce and Industry during the Second Plan Period under United Nations and other Technical Assistance Programmes

1. Mr. D. P. Mein, Industrial Estates Adviser, 1964-1967.
2. Mr. M. Passer, Industrial Consultant, May 1965 - July 1968.
3. Mr. R. Lansler, Associate Industrial Economist, Februrry 1966 - May 1969
   Industrial Economist and member of UNIDO Industrial Survey Mission,
   May 1969 - August 1971.
4. Mr. B. Sahlberg, Pulp and Paper Study, June 1966.
5. Mr. M. C. Verghese, Fertilizer Study, August 1966.
6. Mr. A. Nielson and Mr. A. Kohen, Free Zones Industrial Estates Study,
   July-September 1967.
7. Mr. L. Alkalaj, Forest Industry Development Study, September 1967.
8. Mr. N. K. Wheatley, Industrial Standardization Study, May-July 1969.
9. Mr. G. Gopa, Cement-Asbestos Study, August 1969.
10. Mr. A. Sotlan, Packaging Survey, February 1970.
11. Mr. A. T. Wallbank, UNIDO Industrial Survey Mission, Cyprus Development Bank,
    Industrial Extension Service, since December 1970.
12. Polytechna, Czechoslovakian Consulting Firm, Wood Processing Study,
    since August 1970.
13. Mr. I. Roostal, Market Research, UNIDO Industrial Survey Mission, January-May 1971.
14. Mr. J. Noverraz, Industrial Engineer, UNIDO Industrial Survey Mission,
    January-May 1971.
15. Mr. J. W. Corran, Food Industry Study, March-April 1971.
16. Mr. J. Harrison, Pulp and Paper Exploratory Mission, May 1971.
17. Mr. L. J. Buck, Packaging Promotion and Quality Control Study, September-October 19
18. Mr. S. P. Padolecchia, UNIDO Senior Industrial Economic Advisor, Industrial
    Development Programme, since October 1971.

# HONG KONG
## INDUSTRIAL RESEARCH ACTIVITIES

by
Cecil S. O. Chan

### Industries in Hong Kong

Some twenty years ago, Hong Kong with its magnificent harbour, was merely an entrepôt port. There were a number of trading houses but no industry to speak of.

Then in the early fifties, Hong Kong began to see a change in its way of life. Factories were set up and such products as garments, textiles, plastic goods, electronic and electrical goods, wigs, metalware, footwear and toys along with many other types of products were manufactured and exported throughout the world, thus transforming Hong Kong from an entrepôt port into a thriving industrial city.

That Hong Kong is indeed an industrial city and has grown with spectacular growth over the past twenty years, is clearly indicated by the fact that there are now 20,000 factories in Hong Kong, employing over 600,000 workers, and that the exports of manufactured products in 1971 totalled US$2,500 million. Most of the factories are medium or small-scale factories employing less than 300 workers.

The major markets for Hong Kong products are the United States, United Kingdom, Federal Republic of Germany, Australia, Canada and Japan. There is approximately 75 per cent of all manufactured goods exported to these countries and their markets demand a high level of quality. Also, most of these countries have mandatory standards on hygiene or safety for a wide selection of goods.

Many Hong Kong manufacturers have been producing products to the designs and specifications supplied by overseas buyers and seldom manufactured their products to their own designs. However, that practice, the practice of acting as contractor, is changing. Centralized organizations are offering aid to manufacturers to produce goods to their own designs.

In order to achieve the goal of producing high quality products of local designs, the Federation of Hong Kong Industries, a statutory body set up to look after the interests of industries, established a series of testing and research laboratories to assist manufacturers, firstly in assessing the quality of manufactured products and secondly to improve the quality and design of their products.

It was based on the above purposes that industrial research activities carried out at the Federation of Hong Kong Industries were brought into being.

Testing and Research Centre of Federation of Hong Kong Industries

The Federation of Hong Kong Industries is a recognized industrial organization carrying out industrial testing and technological research in Hong Kong. The Testing and Research Centre was first set up in 1964 on a limited scale and since then has expanded gradually. The Federation now occupies 10,000 sq. ft. of floor area in a modern industrial building, employing approximately a staff of 50. (See Appendix for Organization Chart - page 17).

The present day value of investment in equipment is in the region of US$250,000, most of which was donated by industrialists. The annual recurrent expenditure of the laboratories now stands at approximately US$100,000, and this figure is rising at the rate of 25 to 30 per cent per annum. As the Federation is a non-profit making organization, industrialists are charged at cost for the projects they sponsor.

As testing and research facilities were set up to meet the needs of industry, the laboratories were designed to carry out testing and technological research on those products mainly exported from Hong Kong. These products include:

(a) Textiles - fibres, yarn, fabrics, made-up garments and articles.

(b) Chemical products - foodstuffs, pharmaceuticals, paints, organic and inorganic materials, plastics and rubber.

(c) Watches and watch-cases.

(d) Electrical products - accessories, appliances, cables and cords.

(e) Toys - plastic, metal and soft toys.

(f) Miscellaneous products such as wigs, metal wires, cords and paper.

Plans are now underway to establish laboratories for testing and analysing electronic products, and packaging material as well as biochemical analysis of foodstuffs and beverages.

Development in industrial research activities

Industrial research activities in Hong Kong are in an early stage of development. These were brought into being as a result of and as a by-product of product quality analysis and testing.

Generally, research activities in Hong Kong are carried out in response to requests made by industry and have been on fairly limited scale for short duration.

It should be pointed out that since industry in Hong Kong is growing rapidly, industrial research programmes of prolonged duration are of very little interest to industry, let alone the expenditure involved in long-term programmes. In general, programmes lasting more than two or three months would be considered too long by industry.

The major factor affecting the development of industrial research activities in Hong Kong is the lack of finance. Other factors are the lack of adequate equipment and the shortage of technically qualified personnel.

However, it should be emphasized that there is a considerable demand for technological research in Hong Kong from industry. The demand comes from nearly all sectors of industry, notably the textiles, rubber footwear, electrical and electronic industries. Generally, most of the programmes are connected with product improvement or development or with production techniques.

Design and packaging centres of Federation of Hong Kong Industries

Apart from the need for technological improvements in manufactured products and production techniques, the Federation of Hong Kong Industries recognized the need for product design and packaging as part and parcel of product improvement and development.

In 1968, an Industrial Design Centre was set up under the sponsorship of the Federation. The Centre's main consideration during the past years fell into the following main categories:

1. Promotional
2. Educational
3. Functional

In the area of promotional activity, a design competition was started in 1969, and esteemed awards were given annually to outstanding designs in Hong Kong manufactured products.

Courses were also conducted by local and overseas experts at the Design Centre on subjects related to industrial and product design.

A register of designers was set up in the course of the Centre's functional activities to enable the Centre to bring to the attention of manufacturers the services of suitable designers.

In 1970, a Packaging Centre was also set up. The objectives are similar in concept to that of the Design Centre. Briefly, the Packaging Centre is to:

1. Provide a forum for the exchange of knowledge on packaging.
2. Promote the development of packaging education and technology.
3. Disseminate information and knowledge of packaging.
4. Develop skills and expertise in packaging.

Integrated industrial research activities

It is felt that industrial research activities cannot be segregated from other facets of applied research activities relating to product development and improvement. Industrial research activities should be integrated with such activities as:

1. Standardization
2. Product testing and quality and value analysis
3. Industrial and product design
4. Packaging
5. Quality control and production control
6. Product development
7. Product improvement

It is based on the above concept of "Integrated" services that various activities were instituted at the Federation of Hong Kong Industries in order to promote effective growth of industry in Hong Kong.

International co-operation

The development of industrial research activities in Hong Kong and other developing countries would be accelerated through international co-operation, particularly by the assistance of countries that have reached the advanced stages of technological research. With encouragement from such world organisations as UNIDO (United Nations Industrial Development Organization) it is hoped the advanced countries will offer assistance to the developing countries in their development of industrial research.

It is also hoped that research papers will be made readily available through UNIDO to developing countries by special arrangement.

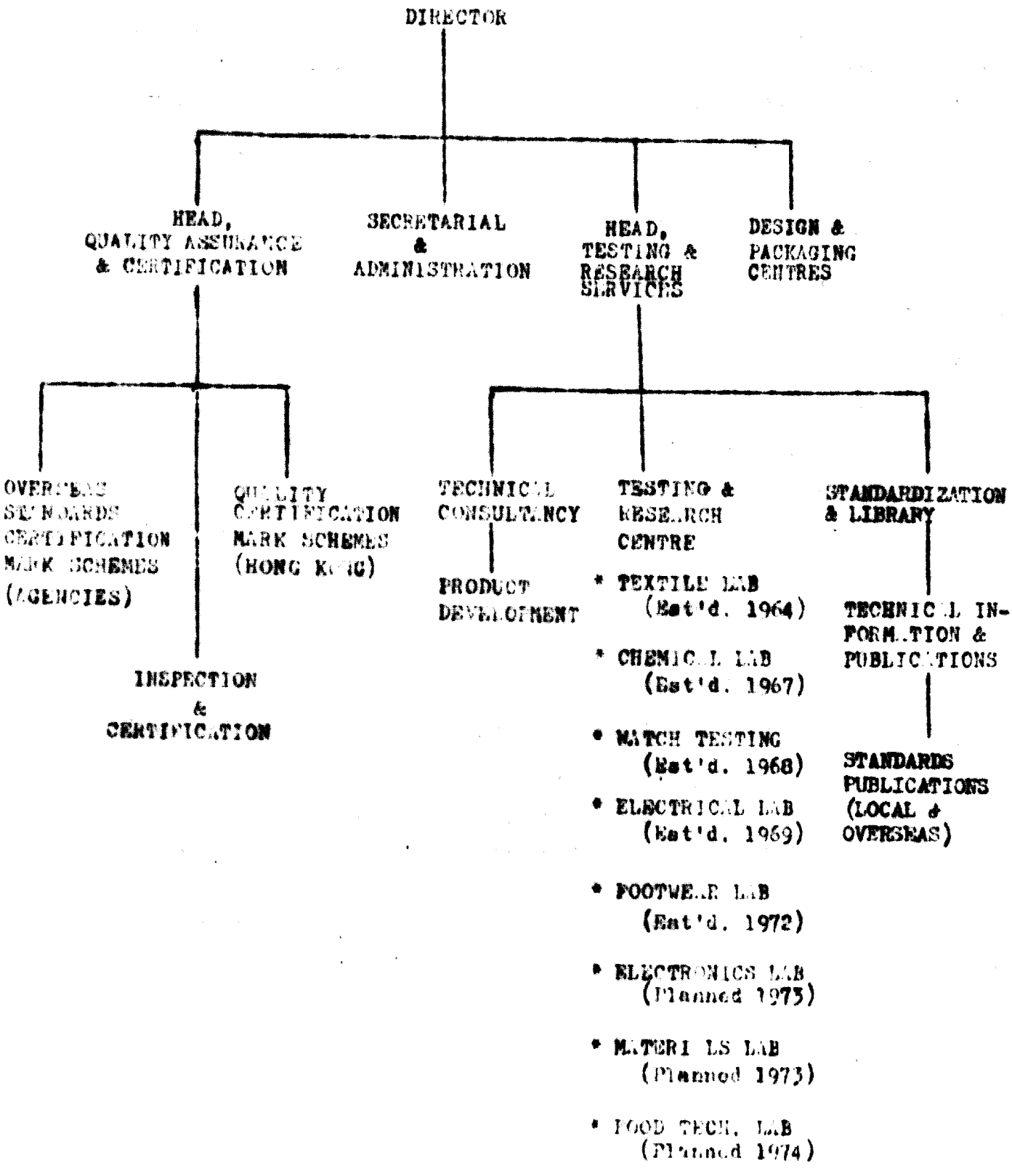
It is further suggested that consideration should be given to the setting up of mechanisms for regional co-operation in the field of industrial and technological research.

APPENDIX

ORGANISATION AND TECHNICAL SERVICES OF

FEDERATION OF HONG KONG INDUSTRIES

HONG KONG



KOREA, REPUBLIC OF

# RECENT TRENDS AND DEVELOPMENT IN INDUSTRIAL RESEARCH IN THE DEVELOPING COUNTRIES OF ASIA AND THE FAR EAST

by

Jae H. Yang

The research and development activities of a country are closely related to the level of industrial development that country has achieved. In other words, the industrial structure, the level of industrial technology and the number and quality of scientists and engineers, have great influence on research and development activities.

With progress in industrialization, research subjects change, and the pattern of research and development activities in developing countries changes according to the progress of industrialization in such countries.

For example, the following research and development work is relatively active in the initial stage of industrialization.

1. Research related to export promotion of primary products such as agricultural and mineral products.
2. Research on production of goods necessary to the daily living of the people, especially consumer goods being imported.
3. In this stage, most industrial enterprises are small or medium in business scale, and industrial research activities are seen only in a few larger firms, though they are chiefly of the nature of chemical analysis and quality control of products and of trouble shooting in production processes.
4. Basic research by individual scientists on their specialized subjects.

The research and development activities in the initial stage of industrialization take on the form of natural growth, but when the governments of developing countries began to pursue positively an industrialization policy in the 1960s, there appeared technology gaps between research organizations and industry because of the development of industries based on advanced technology such as cement, fertilizer and steel under this policy. The development of these industries was due largely to plants

which had been imported on a turn-key basis because of underdeveloped technology and as the experience of operating these plants accumulated, the industries became more advanced than research organizations in identifying technical problems facing the industries.

Under the circumstances, the technological problem facing developing countries today is how to narrow effectively the gaps between research organizations and industry. As a result, the training of qualified engineers and the development of technical manpower through establishment of new research institutes or merger of existing institutes poses an important policy problem for their governments.

Research activities related to such industries are as follows:

1. Research for digestion and improvement of technology imported along with plants.
2. Research on product application, mass production to reduce production costs and development of new markets.
3. Research for gradual import replacement of raw materials for new industries with expansion of their production scales.

In carrying out such research activities, the following must be taken into serious consideration.

First, there must be correct data and information on industries. In other words, statistics on industrial structures, business status and the level of technology and production must be compiled. To this end, surveys on industrial establishments and markets should be conducted. It is also necessary to understand the nation's position in the world economy in order to establish a correct direction of industrialization and research and development activities therefor. Most developing countries lack information and data on their industries.

Second, there must be frequent inter-communications between industries and research organizations. As discussed above, there are conspicuous technology gaps between industries and research organizations due to the advanced technology the industries imported along with new plants. As a result, it is very difficult for scientists in universities and research organizations to identify technical problems of industries in their industrial research. On the other hand, engineers in industries are well acquainted with the technical problems of their plants. Thus, industrial research projects require close inter-communications between industries and research organizations.

Third, as technology develops and industrial structures become complex, the need for joint or group research increases. In a joint research project, the research subject is divided among its members according to their specialized fields. As a result, the role of the research co-ordinator becomes important. Recruiting qualified scientists who are able to carry out successfully their assigned research work is important to a joint research project. In this connexion, the technical manpower development policy must be so pursued as to produce research scientists according to research needs, which change as industrialization progresses.

Mobilisation of national resources and planning industrial research and development

The small number of scientists is a common problem facing developing countries in their efforts in industrial research and development. How to distribute the limited number of scientists and engineers among the universities, research organizations and industries is a big problem to these countries.

The relationship among these three sectors was somewhat ambiguous in the initial stage of development in developed countries. For example, scientists usually held two jobs - one at a university and the other at an industry or a research institute. In Japan, scientists of the Institute of Physical and Chemical Research during its initial years were mostly university professors and even today Japanese university professors have two jobs on the campus - one teaching and the other research at a university research institute. In the United States, which has a large number of scientists, industrial complexes have been developed near universities and universities and industries can thus use university professors in their research and development activities.

In Korea today, active public discussions are being held on the participation of college professors in industrial research and industry's use of college professors in its research and development work in the name of academy-industry co-operation. Also, efforts are being made to solve the problems involved in establishing a close relationship between college professors and industrial scientists and engineers.

KIST draws on college professors and industrial scientists and engineers, employing them on a part-time basis, when a research project is beyond its technical capability. On the other hand, KIST scientists are allowed to teach one class at a graduate school. Thus, KIST has established close relations between universities and industries.

The training of scientists and engineers in an effective manner is also important to developing countries. The overseas training of young students carries weight in developing countries. In this case, the young students usually study at universities and research institutes in advanced countries, and they can receive on-the-scene training at factories in advanced countries only when they are involved in such factories' exports of equipment and technology to the students' countries. Accordingly, the technology they learned at foreign universities and research institutes is mostly not immediately usable in their home countries. And since most students in developing countries go abroad for study with funds provided by foreign aid fund which cover travel expenses and so-called per diem expenses only, they cannot learn the technology their countries need at the universities and research institutes in advanced countries which accept them as students. Because there is a predominant trend in the development of science and because of their financial situation, students from developing countries studying in advanced countries usually do not learn the technology their home countries require. For example, Korean students of physics in the United States once almost unanimously adopted nuclear physics and elementary particles as their major subject of study.

On this consideration, it is necessary for developing countries to establish their own technical manpower development plans suitable to their own situations. In other words, the training of scientists and engineers in developing countries can be best done at home, not overseas.

In this view, Korea established the Korea Advanced Institute of Science to train scientists needed in Korea. A graduate school, it gives courses necessary to support the Government's five-year economic development plans and its curriculum was prepared to achieve this purpose. In order to recruit excellent students, students of this school benefit from a reduced term of military service and other privileges.

In order to increase the number of scientists, it is necessary to create a favourable environment and facilities for research and improve the treatment of scientists, including a high pay scale, so that they may take pride in their research work and lead a secure life. This can be done only with a positive Government policy and support. It will help developing countries solve the problem of the brain drain - the emigration of qualified scientists to advanced countries.

Together with a positive policy for technical manpower development, an effective increase in research investment poses a major problem in developing countries. Advanced countries spend, generally speaking, two to three per cent of their gross national product on research and investment, while developing countries invest only 0.5 per cent of their gross national product for such purposes. In view of the need of developing countries to expedite their industrialization process, it is more important in developing countries to spend more for research and development than in developed countries. On this consideration, developing countries must invest at least one per cent of their gross national product in research and investment. This is a general consensus of the world today.

In Korea, an effort is being made to exempt research funds from taxes and require corporations importing foreign loans and foreign technology to deposit a certain amount of money for research and development funds in order to increase investment in research and development.

Also important is establishment and use of an integrated research organization so as to ensure effective and systematic use of technical manpower and research funds. It is more useful and more effective for developing countries with limited technical manpower and research funds to have integrated research institutes conduct research and development for industries than to let industries do individual research and development work. Therefore, merger of existing research institutes into an integrated organization or establishment of a new integrated research organization must be seriously taken into consideration in developing countries.

Planning and implementation of research project

The Korea Institute of Science and Technology carries out research and development projects in the following manner.

Detailed information on various projects envisaged under the Government's five-year plan, including statistics related to the projects, and information and data on technical problems involved in industries obtained from related industry associations are given to senior investigators of laboratories for use in their preparation of project proposals. The project proposals prepared by laboratories are referred to the Techno-economics Group for its examination of the marketability of the results of the proposed research projects and the economic feasibility of the proposals themselves. The proposals determined to have no possibility of commercial success are rejected, and only those considered feasible are given priority. The priority-set proposals are then referred to the Research Activities Review Committee for financial approval.

The Research Activities Review Committee gives final approval to proposals on the basis of whether the expected results of the proposed projects will be applicable to industry, whether the proposed project leader is suitable, whether the proposed project will need non-KIST experts and whether the proposed research cost is proper.

When a research project thus approved is completed, a research report is prepared and submitted to the Techno-economics Group for its review and determination of the proposed plant's production capacity and production cost and the proposed investment in the plant. The report thus reviewed and determined is then forwarded to the Project Development Division for its contacts with the business firms which are interested in commercializing the research result.

When a contract is entered into with a business firm for the commercialization of the research result, the research result is applied on a bench-scale in the testing laboratory and a pilot plant is set up to determine plant designs and engineering plans for the projected plant. In case the Techno-economics Group reaches the conclusion that the research result requires pilot plant tests, it directly gives the research report to the testing laboratory and the pilot plant laboratory to obtain the necessary engineering data on the proposed plant.

In order to promote industrial application of the research result, industries are encouraged to provide part of the research cost even when the research project is carried on in direct connexion with the Government's industrial development policy, and projects for which industry provides part of the cost are given top priority.

When the firm which has bought the research result on a royalty basis develops financial difficulty, KIST recommends to the Ministry of Science and Technology or the Ministry of Commerce and Industry that the Government provide proper support for the firm after discussion by the State Council.

Development of suitable skills for industrial research

The construction and operation of an industrial plant derived from research requires skilled technicians.

In spite of the important role technicians play in the course of industrialization, the less a nation develops in industry, the less it respects the role of technicians. This is a general trend in developing countries today. As a result, in such countries

people prefer paperwork in offices to technical work in factories, and want to earn better positions in offices through advanced study, if possible. It is therefore necessary for developing countries to improve the treatment and social status of technicians if they are to meet the demand for technical manpower in their industrialization process.

The Korea Institute of Science and Technology provides a broad range of pay levels for technicians so that experienced technicians may earn more than young Ph.D. degree holders. Also, depending on their ability, KIST technicians can be promoted to the positions of supervisor and manager.

The Korean Government annually holds a national contest for industrial technician and those making good records in the contest are given medals. In addition, skilled technicians above a certain level are exempt from the duty of military service.

It is necessary and important for the Government to establish a system of guaranteeing a secure life and social status for technicians, like the Meister system of Germany and Switzerland. Especially, a system requiring college students to undergo practical experience under the direction of factory Meisters for a certain period is important in that it gives a sense of satisfaction to technicians by making them feel like professors.

There are now 425 vocational schools in various fields such as agriculture, fishery and engineering on the level of secondary education, and they turn out about 23,000 technicians annually.

In addition, large-scale business establishments run their own schools to train technicians needed in their plants.

Commercialization of industrial research results

The ultimate objective of industrial research is to apply the research result to production on a commercial basis. In achieving this objective, developing countries face many problems in their industrial research activities. These problems can be divided into four types as follows:

First, developing countries, in pursuing an industrialization policy, attach importance to the need to import industrial plants and technology in order to achieve projected economic development as soon as possible. Imported plants and technology shorten the development period, require small initial investment, have markets for their products and involve few risks in research and development. Because of these merits, industrialists prefer imported plants and technology to their own research and development on new technology and equipment for commercialization.

Accordingly, it is necessary for the Government to give as much incentive to industry's own research and development for a new product or a new process for commercialization as to import advanced technology and new plants. Such an incentive will promote industrial research and development activities.

In Korea, a law for the development of technology is under deliberation as a means of promoting industrial research and development activities. Under the proposed law, corporations which have imported technology are required to deposit annually an amount equivalent to the royalties paid for imported technology or 15 per cent of the total sales for use in their own research and development, and the amount thus deposited will be exempt from taxes. Also, products manufactured with newly-developed technology and processes will be exempt from commodity taxes for the first five years and long-term, low-interest loans will be provided for industry's research and development activities.

Second, most industrialists in developing countries are reluctant to commercialize research results because of the risks involved in their scientists' research and development and because of the disparity between the industrial structure and the technological level of their countries. When they commercialize research results, they do so after testing them in laboratories and pilot plants and with engineering service guaranteed. But this requires large investments. For example, a pilot plant test costs 10 times the cost of a bench-scale test in a laboratory. Thus, without the Government's financial support, expensive work such as a pilot plant test would be almost impossible in developing countries.

Third, it is necessary to apply a thorough follow-up control of research results. Follow-up control here means the work necessary to make a successful research result into a commercial product. Without such work, research results would

be useless, however successful they might be. For example, a newly-developed radio circuit would be useless as a commodity if you fail to design and make a case suitable to the new circuit. A chemical product may be easily synthesized in a laboratory's bench-scale experiment, but its production on a commercial scale would be impossible if one of two ingredients were not importable. Such a case often takes place, so it is important to take into consideration all factors, especially non-research factors, involved in the commercialization of research results. Unlike advanced countries, developing countries face problems due to underdeveloped related industries and technology in commercializing research results.

Fourth, in selecting research subjects, a thorough techno-economic feasibility study must be made. In developing countries, industrial research is completed not by submitting the report but with the commercialization of its results. In case a research project has been done under a contract with a corporation, therefore the research scientists should share the responsibility for commercializing the research results with the corporation. It is desirable that the corporation consider commercialization in financing research projects.

International co-operation for industrial research and development

The Korea Institute of Science and Technology has carried on international co-operation with foreign research organizations as follows.

Upon its founding in 1966, KIST entered into a five-year technical assistance contract with Battelle Memorial Institute of the United States. Under this contract, joint KIST-Battelle techno-economic surveys of Korean industry in about 20 fields were conducted while KIST buildings were still under construction. Battelle sent its experts to Korea to form bi-national teams with Korean scientists and economists, including KIST members, for the surveys.

The objective of these techno-economic surveys was to identify the technical problems of Korean industry and project their evolution into the foreseeable future so as to determine the laboratories and research staff KIST needed in approaching these problems. As a result of these surveys, KIST established laboratories for research and development in five fields - materials science and metallurgy, electronics and electrical engineering, chemistry and chemical engineering, food and food technology. In addition, the Economic Analysis Group, the Machine Shop, the

Electronic Data Processing Department and the Technical Information Department were set up to provide supporting services for these laboratories. The techno-economical surveys also provided data for the determination of potential research projects in the five fields identified, and KIST began to recruit overseas Korean scientists and engineers suitable for the carrying out of such research projects. Some 79 Korean scientists who earned Ph.D. degrees applied for employment at KIST.

The Korean scientists and engineers thus employed by KIST underwent a training of three to six months at Battelle's Columbus laboratories before their return to Korea. In this training, they became acquainted with contract research, had a preliminary study on the industrial research projects they would work on at KIST, selected research equipment necessary for their future research work at KIST and learned laboratory management and the responsibility accounting system.

Upon the expiration of the five-year technical assistance contract with Battelle, KIST renewed it in the form of a sister relationship between the two organizations. Under this relationship, KIST and Battelle exchange technical information and research scientists and conduct joint research projects as occasion demands. In addition, KIST has also established a similar relationship with the Research Triangle Institute and Bell Laboratories of the United States and the Nippon Steel Corporation, the Sharp Corporation and the Mitsubishi Research Institute of Japan. In the near future, KIST will establish similar relationships with research organizations in France, Germany and the United Kingdom.

In response to the increasing demand of Southeast Asian nations for a multi-disciplinary research institute, KIST provided assistance in the establishment of the Union Research Institute in Taiwan on the basis of its experience in construction and operation. In 1970, KIST experts in electronics, mechanical engineering and techno-economics visited Taiwan to form a bi-national team with their Taiwanese counterparts for techno-economic surveys of the electronic and machinery industries of Taiwan. After this, Taiwanese scientists visited KIST for a one month stay to study the management and operations of KIST.

In 1972, KIST scientists joined Hawaii's East-West Centre survey team on the construction of the Institute of Technology in Bandung, Indonesia, and they have already finished a preliminary study on opportunities for industrial research in Indonesia for the proposed Bandung institute.

KIST has also conducted joint research projects with foreign research organizations to promote international co-operation in industrial research and development activities. For example, joint research on liquid crystals is now under way between KIST and Japan's Institute of Physical and Chemical Research. This project was designed to develop a better quality liquid crystal. The two organizations conduct separate research on new methods and devices for synthesizing liquid crystals at their own cost and exchange technical information and samples developed in their respective research for the purpose of testing the physical properties of the samples developed by the other side. If necessary, they exchange scientists engaged in the project for exchange of opinions and experience. International co-operation in research on subjects of common interest to two or three countries is important in that it complements and saves effort and cost for the countries involved.

In 1970, KIST played a central role in transferring several items of highly sophisticated technology developed by NASA of the United States as were applicable to Korean industry. In this project, KIST scientists applied such items of NASA technology into Korean industry on the basis of all available information and data they obtained from NASA. And as a result, some of these items have been sold to industry on a royalty basis for application to the production of export commodities. In fact, Korea now exports products derived from NASA technology.

In order to provide other developing countries with information on the KIST experience of transferring NASA technology for application to Korean industry, KIST will hold a three-day "International Seminar on Dissemination of Technology" at KIST beginning from 20 November 1972. Invited to the seminar are representatives of the IITRI, a NASA-related research institute, the AID and the Organization of American States and such Asian countries as Korea, Thailand, the Philippines, Malaysia, India, Indonesia and Pakistan.

MALAYSIA

# ROLE OF ENGINEERS IN INDUSTRIAL RESEARCH IN DEVELOPING COUNTRIES

by

Mr. Abdul Rahim Bidin

## 1. Industrial research in developing countries

The almost direct relationship between the economy of a country and its technological and industrial capability is an obvious and accepted fact. In these days where scientific skills run supreme, a country even though endowed with abundant natural resources but lacking in technological know-how is always at the mercy of the country with highly developed sophisticated technology and industry, economically as well as politically. As technological progress and industrial progress advance hand in hand, it is hardly surprising developing countries, conscious of the desire to raise the living standards of its people, are embarking on a programme of upgrading their technological skills and know-how, so necessary these days for development of its industries. As some kind of research is necessary for any kind of development, the need for industrial research establishments and manpower to carry out the research work must necessarily follow.

## 2. Research manpower

The bulk of the composition of manpower for industrial research will invariably be "scientists" i.e. people with scientific training or technical background. In this category of people are the chemists, physicists, engineers and to a lesser extent biologists and mathematicians. How does the role of engineers differ from the role of the "pure" scientists i.e. chemists, physicists etc. in industrial research? Although in many instances, a clear line of demarcation between the two roles is not always possible, in broad general sense, there is a distinctive difference in the approach and the work they carry out.

Too often the role of engineers in industrial research is misrepresented. While the work of the engineers in the provision of public services and industrial production is well recognized, the important role of the engineers in research is often not well understood. To a layman, engineers are viewed as "professional" people as distinct from "pure" scientists, and since an achievement made by engineers or of engineering interests is often hailed as a "scientific" achievement, a layman may often not appreciate the engineering contribution in research.

3. Distinctive roles between engineers and pure scientists

Before we look into the exact roles of engineers and pure scientists in industrial research, let us examine closely the difference between an engineer and a pure scientist. By virtue of their training an engineer and a pure scientist are conditioned to think and work in almost the same fashion i.e. methodical, reasoning with logic, resorting always to experimental observations and data. But while a scientist is concerned with the fundamental laws of nature and the hows and whys of a phenomena taking place, the engineer is concerned with the application of such natural laws and phenomena into the design of a device or a contraption. An engineer has to consider not only whether the contraption he designs can perform tasks in the fashion he requires it, but he also has to continue to experiment with various design models of the contraption further so as to determine the model which gives the most satisfactory results in terms of both performance and economy.

Furthermore a "pure" scientist is satisfied with the discovery he has made and probably stops there without undergoing further research or thought on the application of his discovery for commercial purposes, but an engineer has to look into the design of a contraption or a rig that will utilize that discovery for practical purposes and he continually modifies his design until it has become commercially viable and competitive. An engineer, apart from being an applied scientist, is also an economist in the sense that he has to ensure the design he has produced involves the minimum of production procedures, thus economizing in costs of production and labour in order to ensure it will be popularly accepted.

4. Role of engineering research in developing countries

The scope of research and development in engineering field in developing countries is great and varied. It can be roughly categorized into four main lines, though it should be stressed that the engineering field is very much interwoven so that a clear division between these categories must not be attempted.

5. Applied research

Very often, engineers in developing countries have to carry out research work similar to their counterparts in the more advanced countries. In this respect the engineering research field is that of applied scientists. There are areas in this

field where extensive research is not of interest in advanced countries, but which has much relevance to the developing countries e.g. research in solar energy for drying and utilization, and engineering materials research which are peculiar to a specific country.

6. Pilot plant research

A scientific discovery cannot be commercialized until it can be proved to be useful and economically viable. To do this, a pilot plant has to be constructed which must resemble a commercial production plant. Research engineers engaged in pilot plant design are, in fact, utilizing the bench or laboratory scale discovery in a production scale technology for commercial viability studies.

Although a pilot plant may not be as large as a commercial production scale, it nevertheless shall resemble the production scale in all the other major characteristics, particularly in the method of production. The role of engineers in this transfer of technology is apparent.

7. Technical innovation

Technical innovation may be defined as the process of developing a new product to satisfy needs which have heretofore not been satisfied and often have not even been recognized prior to identification of the product.

Technical innovations of some kind are often required in developing countries because of the existence of many cottage and small-scale industries. These industries require small inexpensive machines for thei production which are unavailable on the market. Some of the examples are portable tapioca chipping machines, wax-breaking machines for the batik industry, and chilli grinders for the chilli sauce industries.

Design and construction of those inexpensive and simple machinery for these industries are greatly needed.

8. Machinery adaptation

Many of the developing countries have an abundance of labour. Since the wages are low, labour-intensive industries are viable and appropriate. Many of the machinery used by industries are, however, supplied by developed countries which, because of low labour supply and high wages tend to make machines which are largely automated for industries that require the minimum of labour. As these machines are very expensive, developing countries tend to lose by heavy capital expenditure

and not be able to exploit the inexpensive labour force. It would be far better for such countries to purchase only the main items of the machinery and modify or adapt the machinery in such a way as to replace the expensive devices required for automation by cheap attachments but which require labour force during operation.

The role of the engineers here is to identify the components that can be replaced and design the cheap devices needed for replacement of the expensive components.

## 9. Conclusion

The role of engineers in industrial research in developing countries is indeed an important one. In many respects, engineers can be considered as converters of technology i.e. converting ideas, laboratory discoveries into viably commercial projects. The developing countries would stand to gain by emphasizing the engineering role in any research and development work.

## 10. Appendix

### Portable chipping machine

Here is a typical case example of engineering innovation as required in the developing country.

At the National Institute of Scientific and Industrial Research in Malaysia, we have developed a portable chipping machine for cutting tapioca roots suitable for use in rural areas for small-holders.

In many areas in Malaysia, tapioca cultivation is done by small-holders. After harvesting tapioca roots must be dried within two days because of adverse chemical reaction taking place in the roots. To dry the tapioca, the roots must be chipped into small pieces to be sun dried. We have developed a small, inexpensive chipping machine which can be powered by electric motor or engine and is portable.

The main feature of the machine is a vertical mild steel drum of about 2 ft. in diameter. Part of the top of the drum has been cut and modified to facilitate the loading of the roots. At the bottom of the drum, is a mild steel disc with slits cut into it. The disc rotates centrally in the drum and acts as a cutter and is powered through a shaft by a motor or engine which is attached at the top of the drum. The funnel-like device at the end of the drum directs the chips as they fall to the ground.

These portable chippers have been found to be popular.

# MALAYSIA

## INDUSTRIAL RESEARCH

b.

Teh Hock Heng

Malaysia is well-known for its rubber and tin. In the past much of the research in the rubber industry was concerned with the increase of latex production through the development of a better type of rubber tree, the so-called three-part tree which has a good system of roots, a high latex yielding trunk and a good crop of leaves. In recent years, stimulants are being used on rubber trees in order to accelerate the flow of latex thereby increasing the yield. The increase in production arising from the botanical and chemical processes seems to be very satisfactory, but the long-term effects of stimulants on the rubber trees is not yet fully ascertained. Further tests are being carried out.

Owing to the fall in rubber price in recent months, it is now realized that industrial research on rubber should from now on be concentrated on rubber technology. If rubber production is increased while its consumption remains stagnant, supplies will eventually outpace the demands and a fall in price is inevitable. Through the development of rubber technology which is expected to lead to a greater utilization for natural rubber, it is hoped that demands for natural rubber will increase at the same rate as its production. The research programme of the Rubber Research Institute in Malaysia has therefore been adjusted to emphasize rubber utilization. In accordance with this policy, its rubber technology division is being greatly expanded. While the Natural Rubber Producers Research Association's Laboratory will carry on its research in rubber utilization as before, the expanded division of rubber technology at the Rubber Research Institute in Malaysia will supplement such research efforts. By expanding this rubber technology division it is expected that a reservoir of rubber technologists will be available in Malaysia itself to provide technical services to the rubber consuming countries around Malaysia, such as Japan, Australia and Asia.

The second largest industry in Malaysia is the tin industry. The technology employed in the tin industry is of foreign origin. In the past there was no necessity for Malaysia to develop its own mining and beneficiation processes since the tin deposits were rich and plentiful and the well-developed technology was adequate for such deposits.

As is to be expected, after half a century of exploitation, the tin deposits in Malaysia are getting scarce and the ores need a higher degree of beneficiation. The Mines Research Laboratory of the Mines Department is engaged in the research and development of mining technology and beneficiation processes of the low grade tin ores and the ores which are compounded with iron. Since such processes are difficult, the research and development efforts are not expected to produce results in the near future.

In connexion with the tin industry, other heavy minerals have been produced in Malaysia, such as ilmenite, monazite, columbite, wolframite, xenotime and zircon. So far these minerals have been sold as such at very low prices. Efforts are being made now to process these minerals before they are exported. The National Institute for Scientific and Industrial Research has carried out work on the processing of monazite and xenotime to produce rare earth oxides and thorium oxide. By processing these heavy minerals, it is hoped that Malaysia would get greater benefits from its mineral deposits.

Although Malaysia is one of the world's leading producers of tin, its own consumption of tin is negligible. In Malaysia tin is mainly used in the pewterware industry. Efforts are being made to carry out research and development in the utilization of tin in Malaysia. The Tin Research Institute in London has done the fundamental work on the properties of tin and tin utilization. What has been done should not be duplicated. The efforts in Malaysia will, therefore, be concentrated on the transfer of technology from TRI and other tin research organizations and to make use of the research and development results which have been obtained by these organizations.

The third largest industry in Malaysia is palm oil with timber following close behind. The palm oil industry arose from the necessity to reduce Malaysia's dependence on rubber whose price is rather unstable. In the past, palm oil was exported as such, but recently a number of processing plants have been established to process palm oil before it is exported.

There are technological problems associated with the processing of palm oil and with the utilization of palm oil. The newly established research institute called the Malaysia Agricultural Research and Development Institute or MARDI is entrusted with the task of looking after the research and development work of the palm oil industry besides the other agricultural produce of Malaysia such as paddy, coconut, pineapple and pepper, except rubber.

With the establishment of MARDI all research and development activities related to agriculture are now brought under one roof. Besides the agricultural stations, MARDI controls the Freshwater Fish Research Centre, the Food Technology and Research Division, the Veterinary Division, the Fishery Division. Besides carrying out research and development work in the above-mentioned areas, MARDI also performs the functions of crop improvement and pest control. In other words, MARDI is responsible for all research and development activities of the agricultural industry.

Soon after MARDI came into existence, the National Institute for Scientific and Industrial Research was established to:

(a) Provide industrial consultancy service;

(b) Adopt and adapt foreign technology for the use of the local industries;

(c) Exploit local raw materials and industrial by-products;

(d) Develop new technology for the use of local industries;

(e) Disseminate technical information to the local industries; and

(f) Train research and technical personnel.

To carry out these roles, the National Institute for Scientific and Industrial Research or NISIR has established a library for its technical documentation centre and a number of laboratories with facilities for research and development work in mechanical engineering, materials science, glass and ceramics, electronics, electrical engineering, chemistry, chemical technology and physics. It provides testing and analytical facilities in the above areas to the industries.

Being the national institute, NISIR also plays the role of stimulating and co-ordinating research and development efforts in other research institutes which have relevance to industries. Its role in this particular aspect will be expanded when the National Science Council is established with NISIR as its secretariat.

In exploiting the raw materials of Malaysia, NISIR is paying particular attention to Malaysian plants which are known for their medicinal values and are found in abundance. NISIR is also assisting the other institutes in developing uses for Malaysia's raw materials such as minerals, palm oil and timber. Although the Institute of Forest Research has all along been entrusted with the task of timber development together with its main function of forest research, the extent of timber development in Malaysia is so vast, owing to the large varieties of tree species, that NISIR's assistance is readily accepted. With combined efforts, it is hoped that timber development will be accelerated and an impetus be injected into the timber industry.

## NEPAL

### INDUSTRIAL RESEARCH TRENDS

by

D. P. Regmi

### Background information

Industrial development in Nepal started with the establishment of Nepal Industrial Development Centre in 1957 which was later converted into Nepal Industrial Development Corporation in 1960. However, this autonomous body mainly dealt with banking activities and did not provide extensive industrial research activities. A subsidiary organization of the NIDC called Industrial Promotion and Productivity Centre was established in 1965. Its main concentration was in the field of non-banking activities such as to conduct feasibility studies of various projects, productivity and training functions, publicity and promotion, market survey etc. Soon after its establishment it went into liquidation mainly because of financial reasons. Some of these activities were later on carried out by the Department of Industries and some went to the NIDC. At the moment, the Department of Industries is in principle doing

the function of productivity, training and feasibility study. The NIDC is engaged in industrial consultation and training, raw material and product laboratory analysis, survey of markets etc. in addition to financing.

The Kingdom of Nepal is still in the early stage of industrialization. Moreover, there is at present in the country a limited capability to conduct feasibility studies which might lead to industrial projects. There is further no industrial focus at present for the broadly-based economic research necessary to provide the Government with the basic data needed to arrive at policy decisions in the field of industrial development. To fill these needs the Government intends to establish an Industrial Services Centre.

A UNDP-financed Industrial Advisory Mission (IAM) provided by UNIDO and ILO, which spent a year in Nepal from July 1970 to July 1971, strongly recommended a special country project for Nepal which is known as the Industrial Services Centre, a joint project of HMG/Nepal and UNDP. This will come under the SIS programme of UNIDO in which UNDP's contribution will be US$891,600 and HMG's contribution is Rs.3,724,300 for a period of three years. A final request from HMG is still on its way and the document will be signed very soon. The broad objectives and functions of this Centre is given below:

A. Long-range objectives

1. The general aim of the project is to co-ordinate the provision of the central services necessary to accelerate and maintain the pace of industrial development in Nepal, and to supplement existing services.

2. Industrialization has not hitherto progressed far in Nepal, and the management of such industries as there are, is in general weak. One of the main aims of the Government's current Five-Year Plan for economic development is to accelerate and intensify industrialization. The institutions concerned with achieving this aim are not at present fully effective. The project is intended to rationalize and render more effective the activities of these institutions, to prevent overlapping, and to provide services which are needed but not at present available.

B. Immediate objectives

The immediate objectives of the project are:

(i) To provide the services needed to improve the performance of existing industries and to stimulate the growth of economically viable new industries based on the resources available in Nepal.

(ii) To provide technical and managerial consultancy services.

(iii) To devise and carry out management training programmes.

(iv) To develop the capability to undertake techno-economic feasibility studies (including resource and market studies) and to evaluate project proposals and reports.

## PAKISTAN

## SOME ASPECTS OF INDUSTRIAL RESEARCH

by

A. Hamid Chotani

During the last twenty-five years there is not a single sector of human activity which, on a global scale, has developed with such remarkable speed as that of science and technology. New thoughts and new theories, new products and new processes have totally revolutionized the thinking of man so much that nothing appears to be out of reach or beyond his grasp. The release of enormous quantities of energy from the annihilation of a tiny mass of atom, the conquest of space demonstrated by the landing of the man on the moon, the split-second solution of problems by the electronic computers, are all manifestations of the master of the laws of nature by the scientists and technologists of the 20th century. Although the impact of this scientific explosion on the socio-economic development is a phenomenon which has been experienced by all countries without exception, its origin and, therefore, its contribution to the increase of wealth and prosperity has been confined to those countries of the West and the East which have consciously and deliberately nourished scientific education and research as a part of their national policy. In fact the percentage share of the Gross National Product (GNP) of a country, allocated to science and technology is an index or measure of the prosperity and advancement of that country

The table below shows the names of some selected countries, the percentage share of their GNP spent on scientific research and development (R & D) and the national income of those countries:

| Name of the country | % share of GNP for scientific research and development | National income (millions $) |
|---|---|---|
| USA | 3.4 | 620,968 |
| UK | 2.3 | 63,064 |
| Netherlands | 2.0 | 16,961 |
| France | 1.5 | 76,153 |
| Germany | 1.5 | 90,610 |
| Japan | 1.5 | 78,222 |
| Sweden | 1.5 | 12,333 |
| Canada | 1.0 | 39,691 |
| Belgium | 1.0 | 14,310 |
| Norway | 1.0 | 3,834 |
| Italy | 0.0 | 49,066 |
| India | 0.45 | 39,401 |
| Pakistan | 0.13 | 11,800 |
| Other countries | 0.5 or less | |

It will be seen from this table that the direct relationship between the percentage expenditure on scientific R & D and the national income is clearly established. It can also be seen that countries which spend less than 1 per cent of their GNP on scientific R & D are generally underdeveloped and poor. In the strategy of all future economic planning in Pakistan, therefore, it is proposed to give scientific research and development its rightful place and to deal with it under a separate chapter. In the Fourth Plan period, attempt will be made to prepare the infrastructure for the implementation of a sound science policy and to extend the results of research already done to the field and factories wherever possible, with co-ordinated direction.

The main responsibility for scientific research in Pakistan is at present concentrated in six autonomous research councils:

1. The Agricultural Research Council
2. The Medical Research Council
3. The Council of Scientific and Industrial Research
4. The Atomic Energy Research Council
5. The Council for Engineering and Works
6. The Council for Irrigation and Flood Control.

Plan for industrial development and research

In Pakistan, the production activity of industries, both private and public, was greatly hampered by the lack of facilities for research relating to industrial materials and processes at the time Pakistan launched its first five-year plan (1955-60). The plan therefore provided for the further development of the laboratories of the Pakistan Council of Scientific and Industrial Research (PCSIR), with the emphasis on applied research, in order that, for the most part, the work of these laboratories should consist of obtaining the results of local conditions. The laboratories engaged on industrial research are to be regarded as productive, functional parts of the country's industrial development facilities; and their results are to be measured by their direct effect in improving efficiency and increasing industrial output. However, investment in industrial research is not to be considered as solely the Government's responsibility, associations of manufacturers, co-operative societies and individual industrial firms are urged to make a beginning in conducting research in matters of special concern to them; a study of the industrial research organizations in Pakistan reveals that, as in most countries of Asia and the Far East, industrial research activities have been sponsored more by the government than by private industry, in spite of the fact that industrial development has taken place to a very considerable extent as a result of the successive five-year plans.

Pakistan Council of Scientific and Industrial Research (PCSIR)

Recognizing that scientific and technological research is a vital instrument in developing the human and material resources of a country, and that industrial research is of fundamental significance in establishing the foundation of a sound industrial base, and in accelerating the economic growth of the developing countries, the Government of Pakistan constituted the Pakistan Council of Scientific and Industrial

Research as an autonomous body in 1953, with the broad object to initiate, promote and guide researches in pure and applied fields relating to the industrial utilization of the raw material resources of the country.

The aims and objects of the PCSIR are as below

(a) Initiation, promotion and guidance of scientific and industrial research having a bearing on problems connected with establishment and development of industries or with any other allied matter referred to the Council by the Central Government;

(b) Establishment or development of National Institutions for research, testing and standardization, with the overall object of utilizing the economic resources of the country in the best possible manner;

(c) Making grants-in-aid for specific schemes at universities and other research;

(d) Undertaking and fostering developmental research for the utilisation of discoveries and inventions resulting from researches of the Council;

(e) Establishment and award of research fellowships in subjects within the sphere of the work of the Council;

(f) Collection and dissemination of information on scientific and industrial matters and the publication of scientific papers, reports and periodicals relating to the activities of the Council;

(g) Encouraging the establishment of industrial research associations by various industries;

(h) Maintaining contacts with scientific and industrial research organisations in other countries;

(i) Make purchases of scientific stores including technical books and journals;

(j) Accepting fees, donations, endowments and gifts for furthering the objects of the Council;

(k) Taking out patents and arranging industrial utilisation of research processes developed in the institutes and laboratories;

(l) Establishment of libraries, museums, experimental plantations and scientific herbaria in respect of scientific subjects concerning the activities of the Council; and

(m) Any further activities to promote generally the objects of the Council.

The organizational structure of the PCSIR has undergone a process of re-organization in pursuance of one of the recommendations of the Scientific Commission and the policies of the Government to provide wider autonomy to the PCSIR and increase its impact on the economic development of the country. This is also reflected on the research programmes of the multi-functional laboratories of the PCSIR, located at Karachi, Lahore and Peshawar which together comprise the following broad fields:

I. Karachi Laboratories

(a) 1. Physical Research and Testing Division.
2. Chemical Research Division, including paints, plastics and building materials.
3. Biochemical Research Division.
4. Drugs and Pharmaceutical Research Division.
5. Engineering Division with Workshop and Pilot Plant Section.

(b) Fuel and Leather Research Centre

1. Fuel Research Division.
2. Leather Research Centre.

II. Lahore Laboratories

1. Metallurgical Research Division including ore dressing and testing of minerals.
2. Industrial Fermentation and Biological Evaluation Research Division.
3. Oils, Fats and Waxes Research Division.
4. Glass and Ceramics Division.
5. Food Technology Division.

III. Peshawar Laboratories

1. Indigenous Drugs Research Division.
2. Fruit Technology Research Division.
3. Mineralogical Research Division.
4. Wool Research Division.

A Precision Mechanics and Instrumentation Centre with the collaboration of the Swiss Foundation has also started functioning in Karachi from September 1965 and has been imparting training in the design, fabrication and repair of precision instruments.

PANSDOC

The Pakistan National Scientific and Technical Documentation Centre, in short PANSDOC, was established in 1957 with the assistance of UNESCO and was placed under the aegis of the PCSIR by the Ministry of Education. The technical services of PANSDOC are provided through four units, viz. 1. Document Procurement, 2. Bibliography, 3. Translation and 4. Document Reproduction. These sections have specific responsibilities for carrying out the jobs in co-ordination and co-operation with each other. It has been catering to the needs of the Scientific Department, universities, laboratories, scientific organizations and private parties in the fields of the above sections.

The PCSIR representing the major industrial research potential of the country can only meet its responsibilities towards the nation by drawing up programmes of research which are realistic and which truly reflect, and are oriented towards the genuine needs of the end users, besides becoming fully associated with the following objectives of industrial research:

1. To develop new materials, processes or devices for existing or new industries.
2. To improve the quality of products.
3. To develop new uses for existing materials, processes or devices.
4. To effect savings in cost.
5. To prevent and rectify trouble of production or use.
6. To assist in standardisation.

A number of additional functions and achievements of the PCSIR can be dealt with here to indicate in some measure its significant contributions in promoting the overall scientific potential of the country, and in providing a direction in undertaking of researches and investigations relating to the economic utilization of the raw material resources of the country. Some of these contributions may be seen as follows:

(a) Permanent buildings of laboratories at Karachi, Lahore and Peshawar, have been constructed.

(b) Starting from a nil base, a total of over 2,000 scientists and the supporting staff are now working in the various laboratories of the Council.

(c) About 400 scholars have returned from abroad mostly with their doctorate degrees in various fields and over 100 scholars are still pursuing their studies abroad.

(d) The Pakistan National Scientific and Technical Documentation Centre (PANSDOC), which was established in 1965 with UNESCO aid, is now internationally recognized as a regional centre.

(e) There is a dearth of skilled technicians to meet the growing demands of the industry and the research organizations in Pakistan. In order to fill this lacuna, the Council has established with the assistance of the Swiss Foundation the Pak-Swiss Precision Mechanics and Instrumentation Centre. The main function of this Centre is to train talented young men with High School certificates for a period of three years in precision mechanics under the supervision of Swiss instructors. Pakistan instructors have now taken over from their Swiss counterparts. The first batch of twenty-four trainees came out in August, 1968. Hostel facilities, and a stipend of Rs.75/- per month for a trainee, are provided by the PCSIR.

(f) The PCSIR has been financing specific research projects at the universities and other research centres.

(g) The PCSIR has, from time to time, and on specific requests, made the services of its scientists and technologists available to industry for rendering technical advice to improve efficiency, quality of products and to ensure better utilization of locally available raw materials.

(h) The PCSIR has organized a number of seminars and workshops on specific topics such as leather products to focus attention on the needs of these industries and bring scientists and industrialists closer together for a meaningful collaboration.

Research and investigations

As a result of researches carried out in the various laboratories of the PCSIR in the fields of natural products building materials, drugs, pesticides, food and nutrition, glass and ceramics, paints and plastics, fuels, ore-dressing and metallurgy etc., well over 800 research papers have been published. In addition, patent coverage has been obtained for about 125 processes, more than 40 of which have been leased out for commercial utilization. Nearly 100 industries based on the Council's processes have been established, resulting in a production of over 20 million rupees. It would be pertinent to make special mention of some of the projects which are of long-range character.

1. Chlorinated and phosphatic pesticides

A process developed in the laboratories of the Council deals with the production of chlorinated pesticides (Petkolin and Makrolin) entirely from indigenous raw materials. The actual position in this regard is that large-scale field trials on them carried out in association with the Department of Agriculture have given positive results, and the laboratory findings have been fully corroborated by the world-famous pesticides firms abroad. The most outstanding feature of these pesticides is their extremely low fish and mammalian toxicity (LD 50 subcutaneous 10,000 mg/kg as against 20 mg/kg in the case of Endrin), combined with highly effective pesticidal activity over a broad spectrum. A pilot plant of half a ton/day capacity for the production of Petkolin has already been set up and arrangements are now underway in collaboration with a local industry to establish a production unit to manufacture the production within the country.

Investigations on phosphatic and thiophosphatic insecticides which have little residual effects have also been undertaken.

2. Utilization of agricultural and industrial wastes

The Council has concentrated its attention on more effective utilization of the agricultural and industrial wastes of the country. A few processes and projects of economic importance which have been successfully completed are listed below:

Production of dyes and pharmaceutical products from industrial wastes

Considerable success has been achieved in the conversion of certain industrial wastes into a series of dyes and pharmaceutical products. Arrangements are underway to establish full-scale production based on these investigations.

3. Utilization of mineral resources

An important activity of the Council pertains to the maximum utilization of the mineral resources of the country. This has been achieved in a number of ways involving materials, which are good substitutes for their imported counterparts, conversions of minerals into fine chemicals which would initiate pioneering efforts in this field in the country. Particular mention may here be made of the work done by the Council in upgrading of low-grade materials which have led to a considerable increase in the use of indigenous raw materials by the glass and ceramics industry.

4. Utilization of protein resources

The Council has not been oblivious to problems of long-range importance which would ultimately have an impact on the national economy. Mention may be made of investigations for a more effective utilization of protein resources of the country in the form of fish protein concentrates and deoderized and detoxicated guar meal. Considerable work has already been done on these projects and it is expected that these two projects, which have already been approved by the Government for the establishment of pilot plants, will prove to be a fillip in the acute protein deficiency in the national diet.

A large number of problems to meet the deficiency of protein in the country are being tackled in the Council, such as protein from hydrocarbon, extraction of proteins from leaves, preparation of protein concentrates and amino acid preparation for treatment of protein deficiency diseases, protein hydrolysates mixtures, enriched starch and cereal foods from tubers, rhizomes seeds etc.

5. Building materials

A number of processes developed by the PCSIR in this field have led to the commercial production of several low-cost building materials. A number of industries have been established on the basis of these processes and with the production of building materials there has been a considerable saving in foreign exchange.

6. Wood and fruit resources

Some useful work has been done in this field in the laboratories of the Council, which could be a source of great saving in foreign exchange. Some of the processes which need mention here are terpeneless orange oil, lemon oil, canned foods and food products and their preservation in fresh and processed states, citric acid, lactic acid, baker's and edible yeast from molasses and vinegar from guars, caffeine from tea waste, glucoses from waste starch resources and invert sugar from sucrose etc.

7. Medical plants

Pakistan is endowed with a rich variety of forest wealth, much of which remains yet to be exploited. The Council has made investigations on a number of locally available plants. "Serpajmaline", which has been produced from the roots of Rauwolfia serpentina, is an example of this kind. This drug has a very potent blood pressure-lowering agent.

Further, a systematic study of the indigenous medicinal plants has been undertaken. For the present, efforts are being concentrated on the isolation and characterization of:

1. Hypotensive agents;
2. Anti-cancer agents;
3. Anti-diabetic agents;
4. Blood cholestrol-lowering agents.

8. Leather resources

The Council has been instrumental in the promotion of leather industry which is next to cotton in foreign exchange earning. Besides evolving various processes to substitute imported raw materials or products used by the tanning and leather industries, the Council has been as a technical advisory arm of the Export Promotion Bureau. It has also been offering advice and guidance to the leather industry in

the solution of their operational problems, in order to improve the quality of their products and thus render them more acceptable in the international market. In recognition of the vital importance of this field to the economy of the country, the Government has sanctioned a sum of Rs.2.5 million for expansion of these activities into a Leather Research Centre.

9. Glass and Ceramics

The Council's activities in the fields of glass and ceramics have paid rich dividends to industry by way of increased production through better techniques, improved quality of products, better utilization of indigenous raw materials, self-reliance, reduction in the cost of production and foreign exchange savings.

In addition, the Council's activities have included short-term and long-term investigations of oils, fats and waxes, ore dressing and metallurgy, chemical engineering, wool industry etc. A number of processes evolved as a result of these investigations have already gone into commercial production.

Industrial liaison and extension

In the initial stages of the development of the PCSIR, considerable stress was laid on evolving new processes and products based on the raw material resources of the country, and comparatively little attention was paid to the resolution of many operational problems faced by the industry. This was to some extent due to the fact that, in the advanced countries, this responsibility is handled by research associations of which there are about fifty in the United Kingdom and to quite a large extent also research centres of vast industrial complexes. It was later on realized, however, that under the conditions prevailing in Pakistan, where both these facilities are absent, the PCSIR would also have to shoulder this responsibility in an increasingly larger measure through industrial liaison and extension. The PCSIR has already made a beginning in this direction, and established industrial liaison cells for this purpose in its laboratories to cope with the demands of the industry in the country.

In order to further strengthen liaison with industry, liaison cells have also been established in the Chambers of Commerce and Industry and Functional Committee, comprising scientists and technologists, constituted.

Industrial economic cell

This cell has already started functioning in the Secretariat of the PCSIR. It is responsible for assessing the economics and marketability of the Council's processes. Similar Centres are also being established in some of the laboratories.

It has been realized that effective utilization of the results of research involves close co-operation between scientists, technologists, engineers and industrial economists on the one hand, and Government and semi-government organizations like the Planning Commission, Pakistan Industrial Development Corporation, the Investment Promotion Bureau, the Pakistan Industrial Credit and Investment Corporation, the Industrial Development Bank of Pakistan, and the various Ministries concerned, on the other.

In a sense the problem of industrial research and research utilization has the following three aspects:

(i) Keeping the scientists and technologists of the research organizations by and large on their creative jobs, away from the managerial worries relating to the commercial development of the results of their work.

(ii) Integration of pilot plant and engineering sectors of activities with the Industrial Liaison and Industrial Economics Sections of the PCSIR.

(iii) The closest possible association of the human resources involved in the activities under (i) and (ii).

It is now a universally recognized fact that, in order to bridge the technological gap and to hasten the process of entry into an era of progress after centuries of stagnation and foreign domination, science and technology should be placed on a proper pedestal in countries of the third world and scientists and technologists afforded every opportunity to make their contributions for the creation of an egalitarian society. It was in recognition of this fact that the Government of Pakistan recently announced the creation of the Ministry of Science and Technology. More recently, with a view to bringing about greater unification of scientific effort, the Government placed the Council of Scientific and Industrial Research, the Agricultural Research Council, the Medical Research Council, the Council for Housing and Works, the Irrigation Research Council and certain scientific departments of the

Central Government under the administrative purview of the Ministry. It is hoped that this decision, which had been awaited for many years, will have a salutory effect in quickening the pace of research and of its utilization for raising the standard of living of the common man.

The Government has recently approved the creation of the Pakistan Science Foundation, with the primary object of strengthening research in universities and thus promoting the healthy growth of scientific traditions, which would result in the provision of financial support for well-merited projects. This would greatly help in improving the quality of science education and the calibre of our scientists, thus enabling them to make greater contributions in their chosen fields of endeavour.

There is a growing realization of the need for re-organizing our scientific research effort in order to make it goal oriented. It is in recognition of this fact that the Ministry of Science and Technology has been vigorously pursuing the formulation of proposals for the establishment of mono-purpose institutes with clearly defined objectives, keeping in view the national requirements and the manner in which research and development could be harnessed as effective tools for the economic development of the country. Furthermore, in drawing up these proposals, efforts have been made to ensure the closest liaison with industry and the end users of research Chambers of Commerce and Industry and other agencies, as members of the various Committees constituted for the purpose of drawing up details of the projects before submitting them to the Government for approval.

The broad fields of activity proposed to be covered in the future programme of the PCSIR are natural products, leather, food, glass ceramics, minerals, fuel, chemicals, drugs, engineering, cotton textiles. In formulating these proposals for the establishment of mono-purpose institutes in areas of national importance, the PCSIR has given due consideration to the availability of raw materials. To cite an example, indigenous ores, particularly antimony and iron ores are available as low-grade ores, but remain to be beneficiated. Similarly, the glass and ceramics industry can receive a sizeable boost from improvement in the quality of cotton textiles to compete in the highly competitive international market and the improvement in the woollen fibre, are some of the objectives for which the PCSIR plans to work by building up sizeable research facilities in its mono-purpose institutes.

The Government has recently approved in principle the establishment of technological research institutes in the following industrial fields:

1. Cotton textiles
2. Fuel
3. Glass and ceramics
4. Leather
5. Minerals
6. Drugs, pharmaceuticals and tropical products
7. Agro-chemicals
8. Oils and fats

In addition to these mono-purpose institutes, the following national centres are envisaged:

(a) Pakistan Scientific and Technological Information Centre
(b) Design and Development Bureau
(c) National Engineering and Standards Laboratories

Projects for the establishment of these Institutes and Centres have been finalised and are under submission to the Government for processing and approval.

Unlike many countries of the world, research endeavour in Pakistan has been almost wholly financed by the Government. It is indeed unfortunate that industrialists and agriculturists have not come forward in a big way to sponsor research either within their own establishments or in agencies engaged in research relevant to their fields of interest. Pakistan could greatly benefit from the concept of co-operative research which has been established with significant success in Britain and certain European countries where private industry and the Government have become partners in the promotion of research and development in selected fields of endeavour.

Such a step would pay rich dividends to them and to the country in the long run through better utilisation of indigenous resources, improvement in quality of products and reduction in costs of production, thus opening up the possibilities of export and increased foreign exchange earnings. Such an approach would also ensure more effective utilisation of results of research because of the active involvement of the end-users of research in the management of the research institutes.

The development of intermediate technology assumes a role of paramount importance in a developing country like Pakistan, as this could lead to better harnessing of our human and material resources for the benefit of the country. In recognition of the importance of this field, the Ministry of Science and Technology has been actively pursuing proposals for the establishment of a National Engineering Laboratory and a Central Design Bureau where prototypes of pilot plants and commercial units based on results of research and development could be designed and fabricated and ultimately made available to industry for commercial exploitation. As a further step in this direction, proposals like the establishment of industries of an agency for embarking upon the establishment of industries by the Government, based on results of research, in joint collaboration with the private sector are also active consideration of the Ministry.

The vital importance of strengthening extension activities in the existing research organization is being increasingly recognized, so that the useful work already completed up to a pilot stage could be exploited on a commercial scale. Vigorous efforts are called for to create intimate contacts with the end-users of research in industry. This might involve frequent visits to the industrial establishments and might necessitate stays of 2-3 months in order to ensure proper orientation of the scientists to the needs and requirements of industry. The foremost task before the research organizations is to utilize in an effective manner the sizeable scientific and technological potential already built up by them. It is here that the need for a more purposeful training of the scientists to acquaint them with the problems of national importance, and the operational aspects of industry, assumes paramount importance. The need of the hour is to make the scientists more industrial-minded and goal-oriented. By the same token, the industrialists should become more science-minded and fully utilize the facilities created for them by the Government in its research establishments.

The need for providing incentive to the scientists of the country by way of better emoluments, attractive pay scales and congenial conditions of work is receiving the attention of the Government. The Ministry of Science and Technology has constituted a Committee to consider merits of the proposals for the creation of Scientific Service of Pakistan.

It would be seen from the above facts that the Government is fully alive to the need for harnessing science and technology as an instrument of economic growth, for the prosperity of the country and well-being of its people.

# PHILIPPINES

## RECENT TRENDS AND DEVELOPMNET IN INDUSTRIAL RESEARCH

by

Mrs. Magdalena Alde Temple

Summary

Government interest in scientific and technological research dates back to 1901 when the Bureau of Science, now the National Institute of Science and Technology (NIST) was created. This scientific body engaged in food, chemical and biological researches. As years went by, the NIST expanded its activities and covered research and development projects for industry, tests and standards of products and technical manpower training.

In 1958, Republic Act 2067 created the National Science Development Board (NSDB) the highest science policy making body in the country. The NSDB directs government efforts towards an integrated, co-ordinated and intensified research and development in science and technology for national progress. Under the NSDB are various implementing agencies:

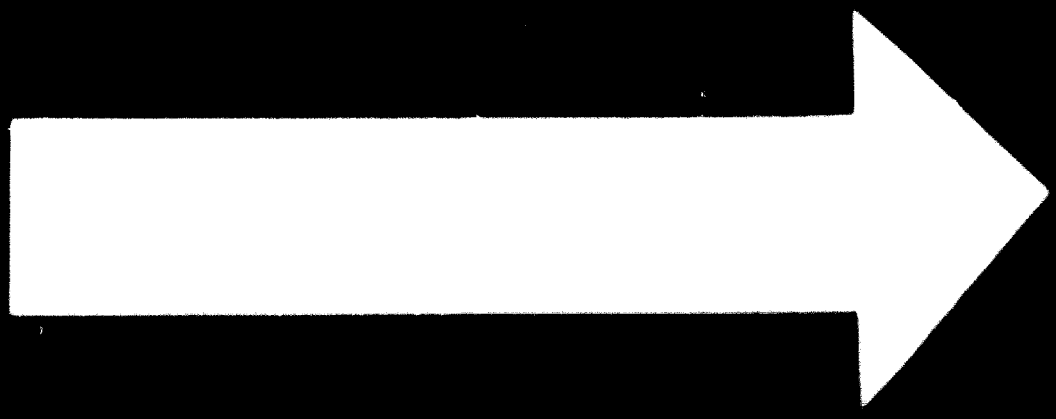
The National Institute of Science and Technology whose functions are mentioned above.

The Philippine Atomic Energy Commission (PAEC) conducts nuclear research and development projects on the utilization of special nuclear materials and radioactive materials for commercial, industrial, medical, biological and agricultural purposes.

The Forest Products Research and Industries Development Commission (FORPRIDECOM) undertakes research on forest-based industries and on the utilization of wood.

The Metals Industry Research and Development Centre (MIRDC) is supported by the Government and the private sector. It renders technical assistance to the metals and allied industries and conducts researches and development work along this line.

The National Water and Air Pollution Control Commission (NWAPCC) conducts scientific investigations on the prevention of air and water pollution as well as formulating policies and standards, rules and regulations for the guidance of industry.



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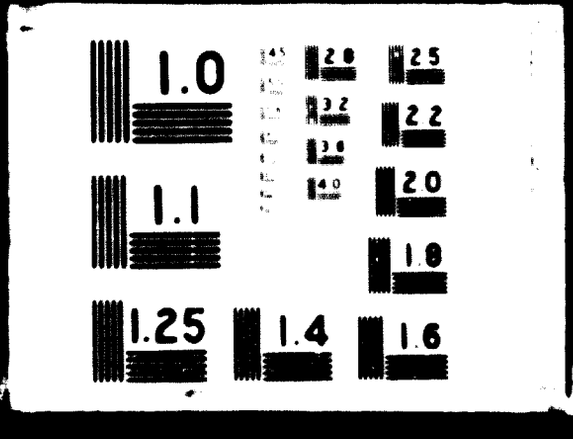


The Philippine Textile Research Institute (PTRI), jointly supported by the Government and the private sector undertakes researches for the textile industry.

The Philippine Coconut Research Institute (PHILCORIN) conducts researches on coconut production.

The Philippine Inventors Commission renders technical and financial assistance to inventors.

The Philippine Science High School (PSHS) is responsible for the training of outstanding students in science and technology.

In the implementation of its functions, the NSDB in its formulation of a national programme for scientific research and development uses the following guidelines on areas of priorities:

I. Substitution of imports - researches directed at increasing the utilisation of indigenous raw materials in the industries.

II. Expansion of exports - researches directed at upgrading and expanding export products to improve the country's dollar-reserve.

III. Product development - researches directed at economically processing agricultural raw materials and residues into dollar-saving consumer goods and dollar-earning export commodities.

IV. Science education and promotion - measures directed at ensuring a reservoir of competent scientists and technologists for the country.

The NSDB closely co-ordinates with the Board of Investments, the National Economic Council, Government agencies and the private sector in the formulation of its national research and development programmes. Results of the scientific and technological researches are channelled to the rural areas as much as possible. Training of personnel to apply the technical know-how is undertaken. The Government is aware of the impact to industry of these scientific results and concerted efforts are being taken for the successful implementation of these researches.

Introduction

The Philippines, an agro-industrial country of 7,000 islands has a population of 39,000,000 and an area of 30,000,000 in he tares. Its socio-economic advancement depends greatly on the development of its rich natural resources, its agricultural lands, mineral deposits, water and geothermal power and the conversion of indigenous materials into industrial commodities essential to human needs.

Science consciousness could be traced back to our Philippine Constitution, Article XIV, which provides that the policy of the State should be to promote scientific and technological research and development, foster invention and utilise scientific knowledge as an effective instrument for the promotion of national progress.

In 1901, Act No. 156 was passed providing for the establishment of Government laboratories for the Philippine Islands. The Act established two laboratories. The biological laboratory was for research work and reporting on the causes, pathology and methods of diagnosing and combating diseases of man, animals and of plants useful to man and for biological work. The chemical laboratory was for research activities on foods and drinks; studies on the composition and properties of gums, resins, drugs, herbs and other plant products of commercial value; research studies on soils and fertilisers; on minerals and minero-medicinal waters of the Philippine Islands; and for other such chemical investigations.

Then the Bureau of Science was established and it absorbed the functions of the biological and chemical laboratories. With limited appropriations, this research institute became the scientific pace-maker in the Far East. Its science library was acclaimed as the best between San Francisco and the Suez Canal. Research activities were, however, limited to the biological sciences and a few projects on technology.

The establishment of the University of the Philippines on 18 June 1908 and the National Research Council further enhanced scientific research in the country. The various colleges and schools of the University conducted research studies and experiments in various scientific fields.

The National Research Council was aimed at stimulating research in the mathematical, physical, biological and social sciences and in the application of these sciences to engineering, agriculture, medicine and public health and other useful arts.

Scientific and Technological Advancements

The role of science and technology achieved official recognition when in 1956, Republic Act 1606 was enacted. This Act created the National Science Board. Then in 1958, Philippine Congress passed Republic Act 2067 creating the National Science Development Board (NSDB), the highest science policy-making body in the country. The NSDB is charged with the responsibility of directing the efforts of the Government towards an integrated, co-ordinated and intensified research and development in science and technology, foster invention and utilize scientific knowledge as an effective instrument for the promotion of national progress.

The National Science Development Board has six principal agencies and three associate agencies, namely:

- The National Institute of Science and Technology (NIST). It is the former Bureau of Science established in 1901. The NIST is charged with the functions of undertaking scientific and technological research and of rendering services to industry in all aspects of activity except those involving nuclear energy and radioactive materials. The functions of the NIST may be categorized into the following broad areas: research and development, testing and standardization, documentation, evaluation, patents and grants, technical manpower training and scholarship and industrialization.

- The Philippine Atomic Energy Commission (PAEC) charged with the function of promoting and developing atomic energy and its uses in Philippine agriculture, medicine, industry and science in general. Among others, the PAEC is empowered to establish laboratories for nuclear research and training; conduct research and development relating to nuclear processes and techniques; theory of atomic energy; utilization of special nuclear materials and radioactive materials for commercial, industrial, medical, biological, agricultural and other useful purposes. All researches of the PAEC are conducted at the Philippine Atomic Research Centre. They are geared to the national programme and tend to be applied-slanted. They are primarily directed towards agricultural production, public health and safety and the improvement of local products to enhance their usefulness.

- The Forest Research and Industries Development Commission (FORPRIDECOM) is the Government agency for research and development in wood utilization. It is contributing to the overall effort of building up the forest-based industries of the country and its export trade through maximum utilization of wood as well as the minor produots of the forest. Among the projects being undertaken by the FORPRIDECOM are those on pulp and paper production, veneer and plywood manufaoture, sawmilling, woodblending and lamination and timber testing, studies to improve and prolong the service life of wood.

- The Philippine Textile Research Institute (PTRI) is a joint project of the Government and the private textile industrial sector. This project is of great significance because it is a pioneering undertaking wherein the industry concerned assumes an active role in the implementation of the project. Local textile millers contribute one percent of their gross sales annually to be used for textile researoh. The PTRI is engaged in researches and studies that would contribute to the local production of raw materials, and improvement and/or invention of textile machinery, processes and production methods needed by the textile industry.

- The Philippine Coconut Research Institute (PHILCORIN) is the oentre of all agricultural research on coconut production. It oonducts scientific researohes and investigations on the botanical and genetic aspects of coconut improvement, etiology and control of important pests of the coconut palm, among others.

- The Philippine Inventors Commission (PIC) is engaged in the promotion of inventions. It was created to encourage and promote Philippine inventions by financially and technically assisting inventors in the development, perfection and production of their individual inventions for manufacture and marketing. The PIC provides inoentives to inventors by giving annually sizeable cash awards and medals known as the "Presidential Awards for Inventions" to patented inventions in the Philippines.

The associate agencies of the National Science Development Board are:

- The Metals Industry Research Development Centre (MIRDC) is charged with the function of rationalizing the growth of the metals and allied industries by providing management and technical expertise and creating the needed government-private sector machinery for the implementation of priority projects. The MIRDC is jointly supported by the Philippine Government and the private sector of the metals and allied industries.

- The National Water and Air Pollution Control Commission (NWAPCC) was created to conduct scientific experiments, investigations and research aimed at discovering economical and practical methods of preventing water and air pollution; encourage co-operation among the people in the proper utilization and conservation of waters and/or atmospheric air; develop comprehensive plan for the abatement of existing pollution as well as the prevention of new pollution; issue standards, rules and regulations for the guidance of those concerned with pollution, among others.

- The Philippine Science High School (PSHS) is the staging area from which talented young boys and girls can go on to careers in science and technology. It is the first of its kind in Asia. The school offers a five-year course and its curriculum was set up by experts with no regard for the usual rules for the course of study on the regular public or private high schools. Emphasis is placed on science subjects. The PSHS gives nationwide competitive examinations annually and these are open to the first three honour graduates from all public and Government recognised elementary schools. The top 150 successful examinees are awarded the scholarships in the Philippine Science High School.

Areas of research priorities

In the implementation of its functions, the National Science Development Board formulated a five year science and technology research programme, national in scope and based on the following scale of priorities:

Priority I - Substitution of imports. Researches directed at continually increasing the economic utilization of the nation's agricultural and natural resources to meet expanding needs of the population for more and better food, clothing, shelter and medicine, including capital goods, vital raw materials and sources of power required by the intensified industrial activities of the country.

Priority II - Expansion of exports. Researches directed at continually upgrading and expanding the nation's export products to further improve the country's foreign exchange position and, consequently, the national economy.

Priority III - Product development. Researches directed at economically processing substantial waste products in agriculture and industry into dollar-saving consumer goods and dollar-earning export commodities.

Priority IV - Science education and promotion. Measures directed at ensuring for agriculture and industry, educational institutions and Government agencies, a reservoir of competent scientists and technologists in the conventional and nuclear science.

Research and development programme

The National Science Development Board is supporting a research and development programme national in scope consisting of properly selected and co-ordinated research projects in the fields of agriculture and natural resources, industry and engineering, medicine and allied sciences, food and nutrition, social science and inventions. The programme provides grants-in-aid to individual scientists, Government and private research and/or educational institutions and the private industrial sector, according to the established system of priorities.

The industrial and engineering research programme

The industrial and engineering research programme is focused to meet the expanding needs of industry, engineering and trade and ultimately assist in the overall research and development efforts for nation building.

In the formulation of this programme and in the establishment of priority areas, close collaboration and co-ordination with the Board of Investments, the National Economic Council, Government and private agencies and the industrial sector and other research institutions is established.

The following is the set of criteria for priority areas in industrial and engineering research:

1. Socio-economic impact to the country
2. Availability of raw materials
3. Status of research in the area
4. Urgency of research

The Board of Investments is the Government agency charged with the implementation of two laws - Republic Act 5186 or the Investment Incentives Act, and Republic Act 5455 designed to achieve national economic development, away from overcrowded and light finishing types of industries into intermediate and capital goods production. Republic Act 5186 expressly welcomes and encourages foreign capital to establish pioneer enterprises which are capital intensive and which utilize substantial amounts of domestic raw materials in joint ventures with Filipino capital.

The BOI prepares the Investment Priority Plan which is the basis for the evaluation of industrial projects for registration giving emphasis to capital goods and intermediate goods industries and encourages export-oriented dollar-earning projects.

The National Economic Council serves as the national centre of the Government to assist the President of the Philippines in the formulation of the guiding plans and broad policies with regard to economic and financial matters.

Researches on the utilization of abundant indigenous raw materials and residues for the production of substitutes for imports as well as the development of exportable manufactures, new processes, materials, techniques and the adoption and application of methods for quality standard industrial products for local and foreign market, exploration of the physical and chemical properties of locally available raw materials and the possibilities of producing from these materials basic and/or intermediate imported products, in the development of new industries are given prime consideration.

The engineering research projects are focused in the development of the following:

1. Mineral beneficiation, metallurgical and chemical processes for local materials;
2. Food processing of abundant Philippine fruits, fishes and other seasonal foods;
3. Improvement of the design of facilities and structure on irrigation;
4. Flood control and drainage;

5. Development of means of deriving power, fuel and water from available sources for urban and rural areas;
6. Improvement of the quality and development of new engineering construction materials;
7. Development of methods of fabricating scientific instruments, engineering equipment and machinery using local raw materials; and
8. The development of new materials to improve the efficiency of transportation and communication facilities.

Some of the research projects presently supported by the National Science Development Board under this category are:

- The development of geothermal fields as sources of power and for industrial purposes. The geothermal project in Tiwi in the province of Albay is now in the commercial exploitation stage. The geothermal fields in Tongonan and Burauen, Leyte Province are being studied for power utilization.

- The conversion of numerous packaging and assembly industries into full capacity manufacturing concerns. Included here are research projects on the development of shipping containers and crates for fruits and vegetables; soil cement research for low-cost housing which is aimed to assist in solving the housing problems in the rural areas.

- Products standardization studies and the development of quality control devices aimed to protect consumers, open new and stable markets for Philippine products as well as expand local industries.

- Solar salt project directed towards solving the shortage of industrial salt particularly the needs of salt-based chemical industries and to minimize the importation of industrial salt.

- Studies on the performance of an integrated system of copra drying and charcoal production and the industrial utilization of coconut coir dust, a waste in coir fibre manufacture.

- Applied and developmentel studies in the primary metal industries, the chemical, pulp, peper and cottage industries, textile and food technology.

- Studies on methods of controlling air and water pollution emanating from industrial factories and other sources.

- Studies on the beneficiation of local raw materials to utilize the country's substantial mineral resources.

- Research studies on chemical derivatives from coconut oil and other indigenous oils for the chemical, cosmetic and pharmaceutical industries.

- Assistance to projects and activities relative to the promotion and development of inventions by Filipinos through financing to push through the patenting of meritorious work by applicants as well as the promotion of said inventions and their marketing and financing aspects.

- Extensive surveys of minerals, forest, water, fishery, geothermal power, petroleum, gas and nuclear raw materials to establish a reliable and accurate source of information on the national patrimony for research and development planning.

Co-ordination with private industry

Industrial research activities are undertaken by Government agencies, universities and research institutions. The industrial private sector with the exception of big ones, are much dependent on Government assistance and are adamently investing for research.

The NSDB co-ordinates, plans and programmes research projects with the private sector with the end in view of eventually helping them solve problems of industry.

Results of scientific as well as technological researches are carefully studied on its techno-economic feasibility and applied to the rural areas. The application of this technical know-how is done by training first the people with the proper methodology until such time as they are able to apply it by themselves. Technically trained personnel are sent to teach the people. The Philippine Government is very much aware of the impact to industry of these results and thus concerted efforts are being made to bring about the success of the research and development programme.

## SRI LANKA

# THE CEYLON INSTITUTE OF SCIENTIFIC AND INDUSTRIAL RESEARCH - ITS ROLE IN INDUSTRIAL DEVELOPMENT

by

Solomon Fedric Laurentius

The overall objective of the creation of the Ceylon Institute of Scientific and Industrial Research by the Government in May 1955 as an autonomous organization following on the World Bank Mission report on Economic Development of Ceylon, was to further Ceylon's productive development through applied research and technology. The acceptance by Government for the need for such an organization implied that the Government was alive to the fact that indigenous science and technology has to play an important role in the industrial development of the country.

Seventeen years later it has become very apparent that the mere creation of such an organization was not a guarantee that science and technology would be effectively used for industrial development. If we accept the broad definition of science as the means of understanding man's environment and that technology is the means of using such knowledge, then it must follow that science and technology are necessary for industrial development. It would not be possible to conceive of increases in production or to make such productive increases cumulative or self-sustaining without science and technology.

In setting up this institute the Government also accepted that there is a fundamental need to build up local scientific capability so that we would have the capacity to define, analyse and solve our problems. It also accepted the thesis that while there is a vast stock of world scientific and technical knowledge, there are still larger gaps in scientific and technological areas of particular interest to the developing countries. These are important to us and to our economy but have no relevance to the political and economic objectives of the advanced countries. Unless we have the scientific capability to solve our own problems, they are not going to be solved by others for us.

Unfortunately the establishment of a nucleus - for that is really what CISIR was in 1955 - for developing this scientific and technological capability made only a limited impact on industrial development. As has been demonstrated, much more than an applied research institute is required for the application of science and technology to development. There has to be a perceived need for inputs of science and technology and complementary inputs must be mobilized and institutional conditions must be created for this purpose.

In the developed countries, many of the consumer goods which are marketed today were unheard of even ten years ago. These are chiefly products of science based industry such as the communication industry, drugs, industrial chemicals and foods, to mention just a few. There is thus a perceived relation between application of science and technology and advances in the standards of living of the people as well as increased profitability to the manufacturers. There is thus a perceived need for the application of science and technology for better and cheaper products and higher outputs. Management of such enterprises are always on the lookout for such opportunities.

In our country, the "need" for science and technology on a continuing basis has rarely taken the form of a commercial demand coming from either the individual entrepreneur or the public industrial corporations. Practically all our technology as well as our know-how is imported, and even with this imported technology, it has become difficult for our industrialists to operate efficiently in view of the large number of outside constraints within which these enterprises have to be operated. Even though we are not insulated from the operation of the "demonstration effect" the urge to innovate and introduce technological changes for better products is hamstrung by the non-availability of capital and foreign exchange.

If there is this lack of organic cohesion between local science and technology and its application in industry, then it is only if the planning bodies see a role for science and technology in the development effort, that a need for science and technology would be manifest. As with many planning bodies, economists are dominant in formulating development plans and policies in Sri Lanka. Because of their training planners and others associated with them often find it difficult to conceive the role of science and technology in development. More so, because it is difficult to measure results of the application of science and technology to industrial development in a developing country in terms of inputs and outputs.

Another drawback is that the need for science and technology can only be perceived if a long-term perspective view of development is taken, as the "pay out" of much research and development expenditure is only realized after a long time. This means that the "present need" for research and development is only capable of being satisfied over a long-term plan. It requires faith - and more than faith, confidence, in the ability of local scientists, to espouse the concept that indigenous science and technology can accelerate economic development.

The Institute came into being in 1955 against a background of an emergent industrial sector - both State and private. As was the pattern in most developing countries, industrialization was conceived in terms of import substitution and took place entirely through import of capital embodied technology as well as of "know-how". The Institute had no significant role to play in establishing these new technologies. At that point of time, there was no "perceived" need for indigenous science and technology either by the State, planners or the private entrepreneur.

While this process of transformation of our economy was taking place through imported technology and know-how, the local personnel available to man industry at all levels of management and skills were comparatively untrained. However, the Institute was staffed with the best qualified personnel available, even though the numbers were small, and was therefore able to provide specialist services in some instances, or provide personnel trained in the application of scientific methodology who could analyse and solve or assist in the solution of problems arising in the implanting of this new technology. Thus in its formative years, the Institute was able to service industry with acceptance but not act as a catalyst for industrial development which was the overall objective of establishing the Institute.

The next decade turned out to be a difficult era for the Institute. Handicapped by the non-availability of funds or inadequate funds, the Institute was unable to keep abreast of industry in developing either centres of excellence required to serve key sectors of industry or to recruit and train staff in adequate numbers to keep pace with the development of industry, both in the public and private sectors. The need for training of staff was accepted by many of the "big" and medium-scale enterprises, but where technological changes were required, the organizations once again turned to the foreign source for such assistance. By and large, industry tended to become "self-sufficient" in terms of skills while technology was obtained at a price. This resulted in industry moving away from the Institute.

Over the period of the last sixteen years, the Institute was gradually pushed into a role of passivity in the industrial scene. With successive changes of governments, the Institute had to keep changing its role. It was difficult to lay down a planned programme of expansion and staff training as the Institute did not have the necessary finances to support such programmes. Perforce, such expansions were sporadic and not sustained. The Institute played no part in formulating industrial development plans, and though the Government did provide the funds for the Institute, there was no conscious effort on the part of the policy makers to integrate the Institute with development. Local industry was also afforded a large measure of protection which tended to minimize the value of science and technology to the entrepreneur as a means of bringing about cumulative production increases and improving product quality. Lack of competition and working at low levels of production capacity were additional factors which made the entrepreneur oblivious to the need for science and technology in keeping abreast of technological advances.

A further factor that tended to isolate the Institute from the development scene was that the Institute's programme of work was conceived and planned by its own staff. Of necessity this programme may, at times, have been out of kilter with national priorities. It has, however, all along endeavoured to fulfil the objectives embodied in the Act - Appendix III (see page 72), but it has never been possible to adequately cover all the areas specified due to scarcity of resources. Much of the work undertaken by the Institute has been of an applied nature in the areas of our local resources, in keeping with one of our objectives, but this in itself did not impose limits on the breadth and depth of our scientific attack. We were convinced that if our work was not to become pedestrian and in the long-term, largely sterile, there had to be a firm association of applied investigations with that of a basic scientific character.

It would be as well at this point, to touch on some of the work of the Institute. Investigations into tea, rubber and coconut have been undertaken with a view to obtaining new products or establishing new processes in these areas. The laboratory work and some of the pilot plant work on production of instant tea from green leaf was carried out in the CISIR laboratories. A carbonated tea beverage is in the process of being commercially manufactured. Pilot scale trials are being carried out on a process of extraction of coconut oil from the wet coconut meat. Formulations for various rubber compounds have been worked out and supplied to manufacturers. The

use of grafted rubber latex in the production of emulsion paints has also been established. The Institute has also carried out factory trials using rubber wood in pulp production for paper. It is also developing a latex rubber based adhesive for use in the plywood industry.

A programme of investigation and study into the composition and production of essential oils from locally available materials has got under way Using the data obtained from composition studies, the Institute has been able to assist local distillers to market an improved quality oil, while the study of distillation equipment has reulted in the design of an improved still for this purpose.

In addition to investigational studies, the Institute provides a testing service for both Government and private industry. A wide variety of manufactured goods and raw materials are tested in the laboratories for conformity to specifications. This is a much appreciated service rendered to industry by the Institute.

Many public corporations have come to the Institute with ad hoc problems facing them. In cases such as the Parathan Chemicals Corporation and the Oils and Fats Corporation, the Institute was able to provide solutions to their problems. The private sector has also been provided with assistance over some of their production problems. But at best, they involved changes in techniques and not changes in technology.

Even though the Institute has operated under many constraints, it has endeavoured to discharge its responsibilities to the country as best it could. Government has been aware of some of the institutional shortcomings and decided to invite a team of Soviet scientists to report on the reorganization and development of the Institute during the latter part of 1970. It may be pertinent to quote here a relevant extract of the report.

> "But the existing practice of planning scientific research in CISIR, limited and non-permanent financing, shortcoming in organizational structure, relative scantiness of scientific personnel as well as weak links of the Institute with planning bodies and industry lead to such a situation that CISIR is unable to provide for the solution of problems raised by the developing economy of the country."

The Soviet team made a number of proposals directed towards increasing the effectiveness of the Institute in assisting industrial development.

Institutional proposals:

1. Creation of a Research Planning Council to serve as an advisory body to the Director of the Institute. All section heads would be members of the body as well as scientists from outside the Institute.

2. The Institute is now organized on a functional and scientific discipline basis with provision for setting up of project teams where warranted. This organizational structure should continue and a number of new sections should be created - Appendix I, (page 70).

3. Scientific and ancillary staff

The scientific and ancillary staff should be increased from its present strength of 132 (69 scientific and technical and 63 ancillary) to 344 (214 scientific and technical and 131 ancillary staff) over the next three years.

4. Training

The Institute should be given, upon its request, the required number of vacancies granted to Ceylon by various countries and foreign universities at the expense of international scholarships and funds by specialities in line with major research activities of CISIR.

5. Buildings

The present floor space available to the Institute for all its activities is 41,500 sq.ft. It is recommended that additional floor space of 50,000 sq.ft. be provided for the increase in staff and facilities.

6. Funds

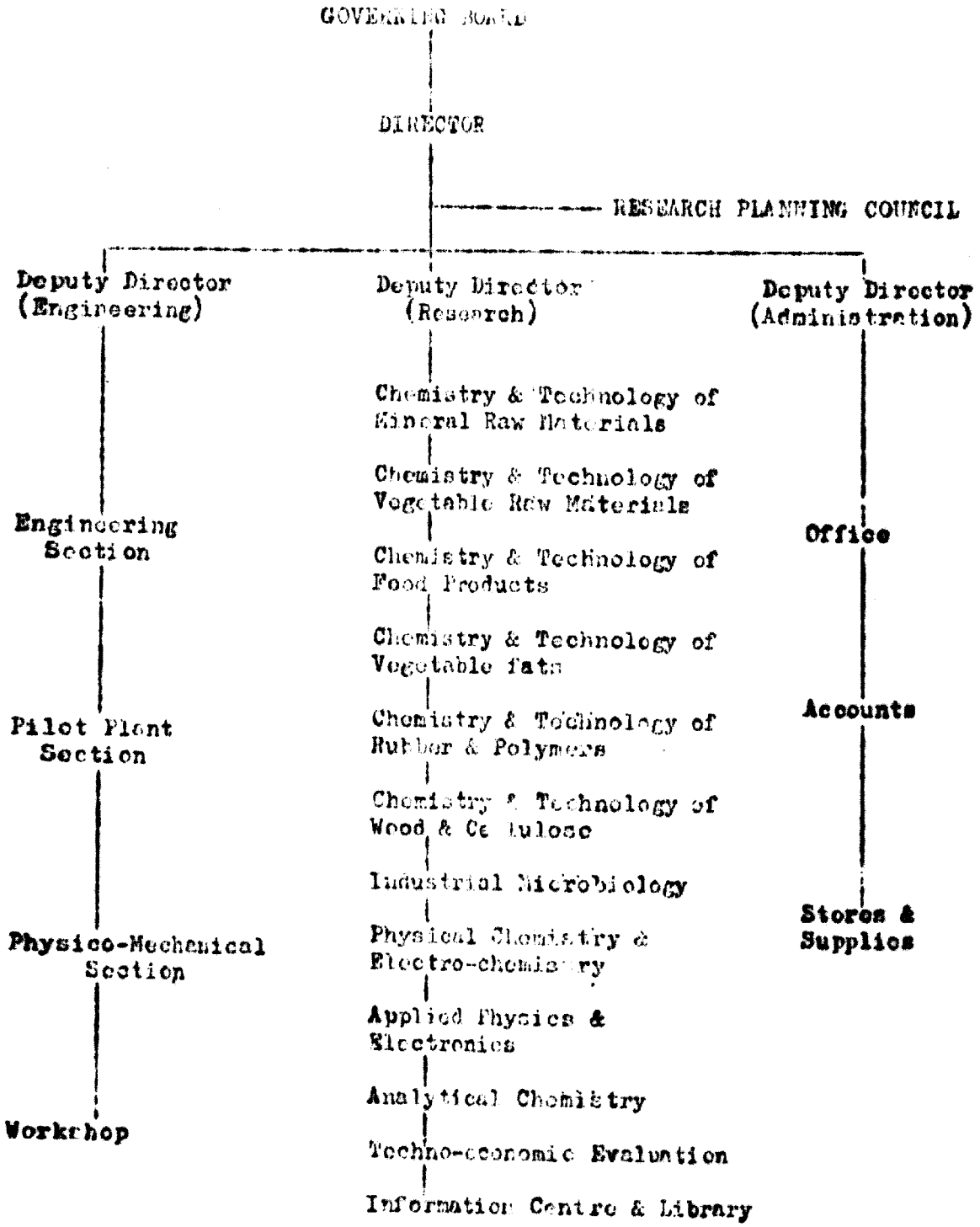
It was recommended that in the first year of implementation of the recommendations, the Institute should be provided with Rs.7.5 million, with Rs.9-10 million in the next year and Rs.9.5-10.5 million in the third year. For the purpose of further development of the Institute, it is advisable, beginning from the third year, to increase the annual volume of financing by 7-9 per cent providing for outstripping the development of CISIR in comparison with the increase of GNP of Ceylon.

7. **Planning:**

Long-term and short-term planning of scientific research should be done in close inter-connexion with the planning of the national economy. The five year plan of scientific research should be based upon the five year plan of national economic development.

Government has accepted these recommendations and some of them are being implemented. Recruitment of scientific staff has begun, while plans are being made for provision of new buildings. However, due to the stringent financial situation facing the country, it is doubtful whether the expansion programme would be carried through within a three year period as recommended.

## APPENDIX I


GOVERNING BODY
DIRECTOR
RESEARCH PLANNING COUNCIL
Deputy Director (Engineering)
Deputy Director (Research)
Deputy Director (Administration)
Chemistry & Technology of Mineral Raw Materials
Chemistry & Technology of Vegetable Raw Materials
Chemistry & Technology of Food Products
Chemistry & Technology of Vegetable fats
Chemistry & Technology of Rubber & Polymers
Chemistry & Technology of Wood & Cellulose
Industrial Microbiology
Physical Chemistry & Electro-chemistry
Applied Physics & Electronics
Analytical Chemistry
Techno-economic Evaluation
Information Centre & Library
Engineering Section
Pilot Plant Section
Physico-Mechanical Section
Workshop
Office
Accounts
Stores & Supplies

## APPENDIX II

### TOTAL GRANTS TO DISTRICT DEVELOPMENT

| | | Recurrent & Capital |
|---|---|---|
| 1955/1956 | ..... | Rs. 1,000,000/- |
| 1956/57 | ..... | Rs. 1,000,000/- |
| 1957/58 | ..... | Rs. 1,000,000/- |
| 1958/59 | ..... | Rs. 1,000,000/- |
| 1959/60 | ..... | Rs. 1,000,000/- |
| 1960/61 | ..... | nil |
| 1961/62 | ..... | Rs. 750,000/- |
| 1962/63 | ..... | Rs. 750,000/- |
| 1963/64 | ..... | Rs. 788,250/- |
| 1964/65 | ..... | Rs. 750,000/- |
| 1965/66 | ..... | Rs. 750,000/- |
| 1966/67 | ..... | Rs. 2,506,000/- |
| 1967/68 | ..... | Rs. 2,000,000/- |
| 1968/69 | ..... | Rs. 2,000,000/- |
| 1969/70 | ..... | Rs. 2,000,000/- |
| 1970/71 | ..... | Rs. 2,000,000/- |
| 1972 | ..... | Rs. 4,600,000/- |
| 1973 | ..... | Rs. 3,521,000/- |

## APPENDIX III

OBJECTIVES OF THE CEYLON AS LAID
DOWN IN THE CEYLON INSTITUTE OF SCIENTIFIC
AND INDUSTRIAL RESEARCH ACT, NO. 15 OF 1956

The objects of the Institute shall be -

a) to undertake testing, investigation and researches in such manner as the Institute may deem advisable with the object of improving the technical processes and methods used in industry, of discovering processes and methods which may promote the expansion of existing or the development of new industries or the better utilisation of waste products.

b) To advise on questions of scientific and technological matters affecting the utilisation of the natural resources of Ceylon, the development of her industries, and the proper co-ordination and employment of scientific research to those ends;

c) to foster the training of research workers;

d) to foster the establishment of associations of persons engaged in industry for the purposes of carrying out scientific and industrial research;

e) to undertake or to collaborate in the preparation, publication and dissemination of useful technical information;

f) to co-operate with departments of government, universities, technical colleges and other bodies in order to promote scientific and industrial research and the training of investigators in pure and applied science and of technical experts, craftsmen and artisans; and

g) to assist otherwise in the advancement of scientific and industrial research and technical training.

# THAILAND

## INDUSTRIAL RESEARCH ACTIVITIES

1/
Tab Nilanidhi

Thailand as a developing country has been promoting industrial development under the Industrial Promotion Act since 1962. Due to the size of the local market on which most of the industries are based, the majority of the industries are of small-scale, labour-intensive type. Very few industries are considered to be of economic size of operation in the concept of the more industrially developed countries and a limited number are export-oriented. On the other hand, with about 35 million population, the increase rate of demands for consumers products have advanced far beyond the industrial growth and the unbalanced trade consequences are inevitable. In recent years, therefore, considerable attention has been given to the need to promote and upgrade the industries to a more satisfactory level. The need to create and transfer modern technology to the expanding industries is thus of paramount importance which represents no small task for this country.

### Applied research activities in Thailand

It has been generally accepted that scientific research which is meaningful for a developing country in national development value is the applied and industrial research. The more fundamental research for the advancement of science is best left in the hands of the academic scientist. The applied research activities in Thailand are operating at the Applied Scientific Research Corporation of Thailand which is a Government Agency, and, to some extent and in limited fields, at the Science Department of the Ministry of Industry. Some specialized development work but somewhat fragmented is undertaken in several Government departments. Specialized research and development facilities in the field of pulp and paper have been set up at the Department of Forestry, and in agro-industry particularly concerning vegetable oil at the Department of Agriculture. The Ministry of Industry has also established a textile centre dealing with some work on textile processing but mainly focusing on training of industrial personnel. Some applied engineering research is conducted at the Asian Institute of Technology. With few large-scale industries based on turn-key operation, and a large number of small-scale industries, there has been no significant research and development facilities in the private industrial sector.

## The Applied Scientific Research Corporation of Thailand

The Applied Scientific Research Corporation was set up in 1964 as a multidisciplinary research organization and as an autonomous Government Agency. The establishment and operation of this institution has been assisted by the United Nations Industrial Development Organization (UNIDO) under the United Nations Development Programme. The broad objectives of this organization are to conduct and apply research in science and technology with a view to utilizing national resources for the economic and industrial development of the country, and to provide scientific services to the Government and the public, notably in the areas of scientific documentation, instrument repair and calibration and metrology.

Since its inception, the major effort at ASRCT has been devoted to research on adaptation of foreign technology for local application and considerable attempt has been exercised to co-ordinate its activities with those of the Government departments. The areas of research so far initiated cover chemical technology, food industry, minerals and metals, building industry, agro-industry and environmental engineering. Since as stated earlier, there is no research activity undertaken by the industry, there is a wide scope for the ASRCT in opportunities for industrial consultancy and some contract research has already been undertaken.

Funds for the ASRCT research are provided largely in the form of Government grant although it has been possible to secure some contract fees through industrial sponsored research.

## Problem of technology transfer

Several years ago when the need for applied and industrial research in developing countries was recognized, establishment of research institutions in several of these countries was considered a logical step in the right direction. In most cases, such establishment has been supported by one or the other international aid programme. The outcome of such action, however, has proved to be a formidable task and several factors involved which govern the varying degrees of success are found in different countries. Some of the experiences gained in the implementation of the programme of establishment of applied research in Thailand may be considered in comparison with those of other developing countries.

A. Problems at the organization level

The need for autonomy in the ASRCT policy was recognized at the early stage when the feasibility of the proposal for establishing the research institution was accepted. The policy for the ASRCT is set up by the Board under the framework of the legislation guidelines approved by the Cabinet.

The Chairman of the Board who acts as the Chief Executive or Governor of the Corporation implements the policy laid down by the Board in the management and control of the operation.

Since the establishment of ASRCT, the activities have spread over a wide area of interests as permitted under the broad legislation. Of the total staff of nearly 400, the number of graduates classified as the scientific service officers is about 40 and that involved in research activities is about 120. Of the research category, about 20 are considered to be professionals with Ph.D and/or M.Sc. degrees with few years of practical experience. Thus the widespread activities of the ASRCT and thinly distributed professional staff have exerted considerable constraint on the planning, budgeting and operation of research of programmes. A need for concentrated efforts on limited lines of activity for effective results is therefore a necessity in the future plan.

Assistance from overseas mainly by UNIDO under the United Nations Development Programme, and some from other sources, has been provided to ASRCT during the past eight years. The assistance in the form of equipment and expert services has been of great value in these formative years while the resources and research capabilities of the local staff are limited.

Results shown by the examples in Thailand and in other countries and the general consensus of opinion today suggest that an institutional assistance by a well developed sister organization, coupled with facilities for co-ordinated training programme is by far the most effective means of establishing applied research capabilities in a developing country. It can only be hoped that more attention be given in this direction by the international aid agencies.

One of the major problems found at ASRCT is the inability to develop adequate manpower with skill in leadership in research and in development work. Results of laboratory research have therefore accumulated, awaiting development and productive transfer to application. In the absence of institutional type of assistance as stated earlier, an on-the-job training can only be acquired through arrangements with overseas centres preferably under aid programme. This remark further emphasizes the need to recognize that a realistic programme to build up research and development capabilities in local personnel is an essential part of any plan to establish a viable applied and industrial institution in a developing country.

B. Problems at the operation level

It is true to say that one of the preliminary steps in setting up a research organization to promote industrial development through consultancy service is to identify the needs of the industry. In a situation where industrial development is in the early stage and there are no national guidelines for the development as was the case of Thailand when ASRCT began, the task of establishing an institution with appropriate research facilities is not so easy. Furthermore, ASRCT was set up to serve both the Government and the private sectors. Hence, many of the research programmes initiated were of the in-house nature. The apparent lack of action to rationalize research programmes and to demonstrate effective results in tangible form has been one of the reasons which retard recognition especially by the Government sector, of the role of ASRCT in the application of science and technology to national development plan. Rationalization of research activities and strengthening of the development component, compatible with financial and manpower resources of ASRCT is imperative in the immediate future.

Receptiveness of the industry to new technology and practice has also been another problem. Bearing in mind that most of the industrial products are intended for the local consumption and as long as the manufacturers have to compete in price, not so much in quality, improved technology and practice based on both the criteria would always find it hard to get accepted. Thai industrial standards of quality now being introduced, import substitution of some products which require Government protection of some kind, and some export possibilities would in the years to come induce the local industry to accept modern technology and enjoy benefit in the services of ASRCT.

Some of ASRCT achievements

Remarks are often made by technologists that several years are needed to establish a research organization. This is highly comforting for scientists but not fully appreciated by many industrialists and businessmen. To a great extent such remarks may be true for the early days of development in the advanced countries. Developing countries today, however, have learnt to benefit from these early scientific discoveries and to adapt the foreign technology for local application. Thailand bears no exception to this general development pattern. In spite of the many shortcomings in the establishment of ASRCT, it has been possible to produce some results and a few may be cited.

One of the achievements is in the application of pulp and paper technology to develop an industrial project for the manufacture of pulp from kenaf, an annual crop grown widely in the northeastern part of Thailand. The project is designed to produce pulp of writing paper grade at a rate of 150 tonnes per day and is based on laboratory and mill test results and extensive economic feasibility study. The $20 million investment project which has been accepted by the sponsor and approved by the Board of Investment is now under financial negotiation for implementation. Although it has been known for several years that kenaf can be made into pulp and paper, the process has only been developed for an industrial scale operation for the first time by ASRCT. The national benefit of this project is expected to be about $10 million per year of import substitution.

Another example is in the area of food technology where an agreement has been made with a local company to apply the results of the laboratory work on evaporated milk product to industrial scale manufacture. This application of research findings is expected to save the country about $2.5 million per year of imported powdered milk.

A local manufacturer of LPG steel containers also benefited by the technical assistance from ASRCT and has been able to export to a number of countries estimated at $1 million per annum.

In the pharmaceutical field, a process for the manufacture of rauwolfia tablets has been established based on indigenous rauwolfia roots. The process has been adopted by the Government Pharmaceutical Organization for commercial scale manufacture valued at $20,000 per annum.

These are some of the examples which ASRCT has been able to achieve in recent years. Last but not least is the ability for ASRCT to advise on numerous occasions to the Thai Board of Investment, Industrial Finance Corporation of Thailand, National Economic and Development Committee and other Government agencies.

## VIET-NAM

# INDUSTRIAL RESEARCH CENTRES IN DEVELOPING COUNTRIES AND VIET-NAM

by

Le Trong Muu and Phung Huu Tan

Recently, quality control of industrial products and industrial research have become important in developing countries and have been considered one of the basic needs for industrial development. Therefore, in parallel with capital investment innovation, developing of laboratories and industrial research centres should be strongly regarded in developing countries.

## I. The role and the problems of the research institute in industrial growth in developing countries

The industrial research institutes and applied research centres in developing countries are expected:

- To be aggressive interpreters and adaptors of technology needed for industrial development.
- To establish and maintain an institutional capacity to undertake a wide variety of technical problem-solving.
- To have the staff who will identify and anticipate industrial technological needs.

But, in reality, the research centres in developing countries have their own problems and difficulties. Generally, these problems are as follows:

- Shortage of modern research institute management skills.
- Shortage of scientists and advanced technicians.
- Limit of experience in acquisition and diffusion of available foreign technology
- Lack of internal project evaluation and fiscal controls.
- Lack of appropriate mechanisms for technical assistance to medium and small industry.
- Lack of future plan.
- Lack of promotion and development programmes.
- Operating only in a certain limited field.

Because of these defects, the research centres are usually incapable of pursuing the expected programme development activities, or prepared to evaluate those cultural, social, economic and political factors which are a necessary part of the technology transfer process.

In consequence, there is no close interaction between industry and research institutes. The attitude of national large and medium industries can be generalized as follows:

- Industry lacks confidence in the ability of research institutes to provide meaningful solutions to their problems in a reasonable time and a realistic cost.
- Industry believes that the research institutes are largely subsidized by government funds derived from industrial taxes, so it should not pay for the services provided by a research institute.
- Industry usually is afraid of the research institute-government relationship which could disclose potential patent possibilities, technical secrets, or management information to government agencies or competitors.
- Industry does not often evidence a genuine interest in the research results of an institute until production, economic and marketing feasibility of these results have been demonstrated and resolved.

In the face of the above, the co-operation among the institutional centres, the research institutes, the industries and the government is urgently necessary. To date, a variety of approaches are being used in an attempt to overcome these existing constraints and deterrents, such as:

- Approaches to stimulation of technological research by government.
- Innovative mechanisms for increasing interaction of research institutes with the industrial sector.
- Industrial Advisory Boards, consisting of local industrialists, government leaders, engineers, organized to become an enhancing link with the public and private sectors.
- Salary incentive plans to stimulate applied research.
- Integrating single-purpose research institutes into multi-purpose organizations in order to reduce expenditures and avoid duplication of equipment and facilities.
- Demonstration plant approach to join the industrial research institute to the industrial development process.
- Multinational corporations and adaptive research for developing countries in order to raise the general level of technical competence and of managerial skills in the countries where they operate.
- Support by foreign assistance agencies in developing research institutes, and stimulating the introduction of appropriate technology for developing countries.

The results of these approaches up to now have not been particularly impressive. However, a wealth of experience has been accumulated so that the effectiveness of industrial research activities could be raised in the future.

II. Laboratories and research centres in Viet-Nam

At the present time, there is no such research institute, nor industrial research centre in Viet-Nam, but only laboratories. The principal activities of these laboratories have been to provide testing, quality control and development of standards. All these laboratories are listed in the appendix.

As in any other developing country, the laboratories in Viet-Nam have its own difficulties. These difficulties are in general as follows:

- Poor facilities.
- Insufficient funds.
- Shortage of scientists and well experienced technicians.
- Lack of equipment.
- Unmonotonous supply of resources.
- Limited capabilities in qualifying things in a certain field.
- Use of different methods for analysing or researching.

For the purpose of solving these problems, the establishment of a corporation of these laboratories is in progress in Viet-Nam. However, it should start to plan now, before it is too late, industrial research institutes and applied research centres which was mentioned above as the basic need of industrial development. Being behind in establishing research centres, fortunately, it is an advantage for Viet-Nam to avoid the difficulties other developing countries have faced.

## A P P E N D I X

### Laboratories in Viet-Nam at the present time

1. Saigon Pasteur Institute Laboratory
   167 Pasteur
   Saigon
   Tel. 20.351

2. Public Health Ministry Laboratory
   200 Co Bac
   Saigon

3. Custum Department Laboratory
   74 Hai Ba Trung
   Saigon
   Tel. 91.737

4. Natural Resource Department Laboratory
   31 Han Thuyen
   Saigon

5. Phu An Material Research Institute
   P.O. 18
   Saigon
   Tel. 24.396

6. Saigon Water Department Laboratory
   Thu Duc

7. Agriculture Department Laboratory
   Saigon

8. Research Institute Laboratory
   121 Nguyen Binh Khiem
   Saigon
   Tel. 91.746; 91.061

9. Viet-Nam Rubber Research Institute Laboratory
   34 Thong Nhat
   Saigon
   Tel. 24.695

10. Saigon University Laboratory
    222 Cong Hoa
    Saigon
    Tel. 24.762; 91.097

11. Phu Tho National Technology Centre Laboratory
    Saigon

12. National Agriculture Centre Laboratory
    45 Cuong De
    Saigon
    Tel. 24.114

13. Military Supply Department Laboratory
    KBC-4118
    Tel. 50011/127

14. Laboratory of Army Maintenance Centre
    KBC-4199
    Tel. 30.272

15. Chemical Laboratory of Signal Corps Supply Centre
    KBC-4529
    Tel. 31.545

16. Supply Technology Research Centre Laboratory
    4 Don Dat
    Saigon
    Tel. 40.222; 40.966

United Nations Educational, Scientific and Cultural Organization (UNESCO)

# UNESCO'S ROLE IN THE FIELD OF TECHNOLOGICAL RESEARCH

by

F. Pala

UNESCO has a basic and very wide responsibility in scientific matters but this responsibility is, of course, not a monopoly. Both in theory and practice, science has become such an essential factor in modern societies, intimately linked with and diffused through all their aspects, that no one body could claim exclusive responsibili for it and, indeed, each of the organizations in the United Nations system must promote scientific research and the application of science in its particular sphere of competence if it wishes to carry out its mission effectively. UNESCO and its sister agencies within the United Nations system have therefore to reach agreement not so much on lines of demarcation between mutually exclusive fields of action as on differences in standpoints and functions which will enable the programmes of the various organizations in any given sphere to be linked together so that efforts in pursuit of shared or mutually related aims be harmoniously concerted.

UNESCO does not engage in or support industrial research directly - this is the area of competence of UNIDO within the United Nations system - but we do have activitie in closely related fields. UNESCO supports and implements extensive programmes in scientific and engineering research, both in universities and in pure and applied research institutions, and we carry out a wide range of activities in what might be termed the infra-structure for scientific research. This includes scientific information and documentation, data handling and processing, precision measurement and metrology, and instrument maintenance, calibration and repair. As will be readily apparent, these activities are cross-sectoral in that they provide essential supporting services to not only scientific research in universities and institutes, but also to medical research, agricultural research, industrial research and the full range of science-related activities. Since they are cross-sectoral scientific services, UNESCO, which is also cross-sectoral in this sense, takes major responsibility in these areas. Here it should be noted however that as we move towards the sectors (e.g. from standard as the term is used in precision measurement and metrology towards standards as the term is used in product and process specifications and control) we work in close collaboration with the appropriate agency, which in the example given is UNIDO.

Thus, our interest in and contribution to the field of industrial research under discussion at this seminar must be considered:

(a) From the side of training, since most industrial research workers get their initial exposure to research concepts and their preparation to engage in research in the course of their university careers and UNESCO is heavily involved in strengthening technical education programmes and facilities;

(b) From the side of scientific and technical research which is closely related to and often provides the base for industrial research;

(c) From the side of scientific services which are essential to industrial research as they are to all other branches of scientific research.

In the course of stimulation of industrial research activities in developing countries one must consider the full spectrum - since no one aspect can stand on its own - which is why UNESCO is particularly interested to be involved in this seminar.

During recent decades, a number of meetings have been held bearing on the application of science and technology to development and thus on industrial research. The earliest of the series was the United Nations Conference on the Conservation and Utilization of Resources in 1948. However, it was the United Nations Conference on the Application of Science and Technology for the Benefit of Less Developed Regions, held in Geneva in 1963, which gave UNESCO an opportunity to define in detail the goals of an international science policy related to problems raised by economic growth and social progress.

The Conference on the Application of Science and Technology to the Development of Asia (CASTASIA) was organized by UNESCO in co-operation with ECAFE and took place in New Delhi in 1968. This conference identified the basic considerations for the application of science and technology to development and resulted in a number of specific and general recommendations. Of particular interest are the general recommendations which outline:

1. Priority areas for action in Asia - with nine areas considered to be of particular importance, including the organization and promotion of international and regional co-operation, particularly in exchange of information and scientific personnel, co-operative pooling and use of scarce resources and transfer of appropriate technology;

II. Target for national expenditure on research and experimental development - in which a target of 1 per cent of GNP by 1980 at the latest was recommended;

III. Transfer of technology - in which it is recommended that technology and information centres be established, and that a comprehensive plan be drawn up covering the work by the United Nations agencies;

IV. Mechanism for regional co-operation - in which UNESCO was invited to study the ways and means and to take steps for the creation and functioning of such machinery.

CASTASIA was an action oriented conference, and its recommendations are being followed up. The major sectors of UNESCO's programme in Asia have been strongly influenced by these recommendations, as is evident by the series of seminars, training courses and meetings which UNESCO has held since CASTASIA (see Appendix, page 90).

As an outgrowth of the Conference of Asian Ministers of Science (CASTASIA) very significant steps are being taken which are expected to make a serious impact on the development of the region. Further guidance, stimulus and support from the highest level of the governments of the region can only strengthen this impact. By the same token, UNESCO may be able to provide information or assistance to other bodies working on application of science in Asia which will be of value to them.

The information provided further on in this note on UNESCO's programme will give some idea of the range and scope of its activities. It must be emphasized that in all of these activities we welcome the interest and support of other groups working in related fields.

## UNESCO's activities in the field of technological research

These activities come under the Department for Scientific and Technological Research and Education, consisting of two divisions:

- One for the promotion of research and training in the basic sciences including the development of basic science education at university level;
- One for the promotion of applied and engineering sciences, including the promotion of engineering education and the education of technologists and higher technicians.

To assist in the planning and execution of its programme the UNESCO Natural Sciences Sector has under its jurisdiction a network of five Regional Field Science Offices. A major part of the work of the Field Science Offices has so far been

concerned with the promotion of inter-communication between scientists, technologists and research workers throughout the world, the carrying out of surveys, and the organization of regional training and refresher courses, seminars and symposia for the training of scientific and technical personnel. The most important of these activities related to technological research are listed in the attached Appendix.

UNESCO's programme for the promotion of research in the engineering sciences can be divided in two inter-related groups:

- Activities for promotion of international co-operation

  These are to be considered as "catalytic" activities.

  They are mainly financed under UNESCO's regular budget.

- Activities concerning direct assistance to individual member States

  For strengthening their institutions and training of manpower, these activities are to a large extent financed by the United Nations Development Programme.

International co-operation

Whereas international co-operation has had a long and fruitful tradition in UNESCO's activities in the basic sciences, it has been more limited in the applied sciences, particularly in the engineering sciences. For this reason activities in the engineering sciences will be increased.

In 1970, UNESCO held a consultative meeting on its activities in the field of engineering sciences and research to examine the "State of the Art" in most fields of engineering. The meeting identified gaps in international co-operation in research and outlined four fields of engineering research as requiring concentrated attention and international support:

- Rheology - the behaviour of materials under stress,
- Heat and mass transfer,
- Measurement and instrumentation, and
- Solar energy and its applications.

The research carried out in the first three of the above fields will largely benefit the developing countries through the process of the vertical transfer of technology, as elaborated by UNCTAD; the implementation of this process will call

for the co-operation of UNIDO. Research in solar energy, on the other hand, requires the use of soft technologies and may therefore be started and carried out in developing countries.

UNESCO will embark upon these programmes in the period 1973-1974 in a relatively modest way during which period it is planned to hold symposia and publish a state-of-the-art survey. The activities will be expanded in the period thereafter and will be carried out in consultation with the United Nations.

A co-operative programme of research and training in the above fields will be launched in selected international centres such as:

- The International Centre for Mechanical Sciences, Udine, Italy, and
- The International Centre for Heat and Mass Transfer in Belgrade, Yugoslavia.

Under its Regular Programme UNESCO will give support to these centres for research and training programmes and the centres will make available their training and research facilities for the organization of annual courses, seminars and research projects in selected fields of rheology, bio-engineering, ergonomics, pattern recognition, heat and mass transfer problems including the aspects of air and water pollution, heat transfer in fire prevention and control and in agriculture. The centres will also assist in the preparation of annual surveys in these fields. Extra-budgetary funds will also be sought for these activities.

Furthermore, in recognition of the increasingly important role of engineering in the protection and enhancement of the environment, an expert meeting will be organized by UNESCO in collaboration with the World Health Organization, the United Nations Industrial Development Organization and other interested organizations to consider the need for international co-operation in research and development in various fields of environmental engineering. The meeting will also make recommendations on the inclusion of up-to-date environmental studies for the training of engineers. The proceedings of the meeting will be published.

Several studies have confirmed that links between sciences, technology and production in the developing countries of Asia are weak or even non-existent. Recently the University of Singapore in co-operation with a number of industrial firms held a seminar on "University and Industry Partners in Progress". It is of interest to mention here that UNESCO is organizing a seminar to be held in Manila in 1973, on

a similar subject, namely; University-Industry Co-operation in Engineering Education and Training. This seminar is envisaged to coincide with the inauguration of the Association for Engineering Education for Southeast Asia, which is being sponsored by UNESCO. The Association issues a Journal and Newsletter which is directed to all concerned with engineering education and industry in the region. The September 1972 issue of the Journal contains an outline of UNESCO's programmes for the promotion of education for engineers, technologists and higher technicians.

Speaking of publications, it is of interest to mention that UNESCO publishes a series of "Engineering Laboratories" as guide for developing countries. For the creation of modern laboratories in various fields of engineering.

Under the United Nations Development Programme (UNDP) UNESCO is responsible for the implementation of several Special Fund and technical assistance projects dealing with the establishment of engineering laboratories for research and training purposes. Some of these laboratories are already nearing completion, others are being equipped and it is expected that UNESCO will be associated with further projects in developing countries as the need for them arises and countries request assistance from UNESCO. Although each of these projects is designed to meet the specific requirements of the country concerned, there are a number of common components and characteristics. This is the main aspect stressed in the surveys published in the "Engineering Laboratories" series. Recently the fourth volume in these series appeared. It is devoted to a survey on Applied Thermodynamics laboratories. The survey was prepared at the reques of UNESCO by the Institute of Mechanical Engineers, London, and covers teaching and laboratory practice in a number of countries. Efforts were made to secure a variety of information by choosing establishments of different sizes, character and backgroun

These series of publications will be continued in the period 1973-1974 by one volume on material science and one on energy science.

Assistance to member States

The emphasis in this group of activities is on the training of specialized personnel in the engineering sciences needed by the developing countries, through the organization of specialized post-graduate courses in collaboration with universities and research institutions. Under its Regular Programme, UNESCO is providing assistance for the continuation of existing courses or for the establishment of new courses, as follows:

Chemical engineering in Tokyo, Japan;
Chemical engineering in Karlsruhe, the Federal Republic of Germany;
Petroleum technology in Bucharest, Romania;
Petroleum technology in Milan, Italy;
Research techniques in chemistry in Sydney, Australia;
Metallurgy in Buenos Aires, Argentina;
Structural engineering in Ouro Preto, Brazil;
Electronics in Eindhoven, Holland;
A new course dealing with material and system engineering sciences;
A new course on solar energy.

The number of these courses will be increased from seven to nine in 1973-1974, to eleven in 1975-1976 and to twelve in 1977-1978. More centres of advanced studies in member States will be added in order to strengthen the world network of centres of excellence for the development of scientific and technological research in critical and fast-growing fields.

A small amount under UNESCO's regular budget is earmarked to provide assistance in the form of short-term expert and staff missions to member States at their request, to advise in promoting the development of research in the applied sciences, the strengthening of individual institutions, and the creation of appropriate professional bodies concerned with the engineering sciences.

Furthermore, under the United Nations Development Programme, assistance can be provided by UNESCO, subject to request by member States and approval by UNDP, in the field of the engineering sciences and research. National and regional projects leading to the development of technologies of interest to developing countries will be supported from these funds (e.g. the Centre of Belgrade, Yugoslavia, dealing with the heat and mass transfer problems and the Centre of Udine, Italy, dealing with local, natural and transformed materials and also other regional programmes for the training of research staff.

Aid to technological research has been benefited largely from UNDP assistance. In the past decade UNESCO has already been responsible for executing a dozen large-scale projects, covering a variety of fields from power station technology and mechanical engineering research to the manufacture of precision instruments and the construction of a mathematical model for the development of the Mekong River basin.

Also, the support to the establishment and strengthening of several national scientif: documentation centres may be mentioned here.

At present UNESCO acts as executing agency for the following three large-scale projects concerning technological research in this region.

| | |
|---|---|
| India: | Mechanical Engineering Research and Development Organization, Durgapur (1969-1973) |
| Khmer Republic: | National Hydraulic Laboratory, Phnom Penh (1969-1973) |
| Syrian Arab Republic: | Industrial Testing and Research Centre, Damascus (1968-1973) |

With the advent of UNDP country programming it is expected that the number of projects under which UNESCO will provide assistance to laboratories and centres for technological research will be substantially increased.

## APPENDIX

### Some recent activities related to the promotion of research in engineering sciences, organized by the UNESCO Field Science Offices for South and Southeast Asia

**Scientific Documentation**

Training seminar on Scientific Documentation, Tokyo, July-August 1970, sponsored by the Government of Japan.

Preparatory work on the establishment of a Regional Science Information Centre related to the UNISIST.

Survey of Scientific Journals in Asia as a first step towards forming an association of science journals.

**Science Teaching**

Workshop on Integrated Science Teaching, Manila, August 1970.

Pilot projects in Science Teaching - regional follow-up on chemistry pilot project and introduction of materials from physics pilot project.

Science Material and Equipment - preparatory work for a project designed to develop science equipment for the region and stimulate local manufacture.

**Technological Education and Research**

Seminar on New Approaches to Engineering Education, Kuala Lumpur, March 1970.

Meeting on the Formation of a Permanent Committee on Engineering Education in Southeast Asia, Djakarta, October 1971.

Journal of Engineering Education in Southeast Asia.

Survey of Continuous Education and Retraining Facilities for Engineers and Technicians, 1970.

Survey of Research Facilities in Science and Technology in Asia, 1966-1967.

Survey of Basic Physical Standards of Weights and Measurement (metrology) available in government, university and industrial research centres in Southeast Asia, 1969-1970.

Support to the Asia Electronics Union.

Seminar on Scientific Instrumentation in Asia, Chandigarh, India, 1967.

Seminar on Multi-Disciplinary Research Activities in South Asia, Bangalore, India, November 1969.

Seminar on Multi-Disciplinary Research in Southeast Asia, Manila, October 1970.

Seminar on Transition from Laboratory Research in Industrial Application, Poona, India, December 1970.

Seminar on Computer Technology, Tokyo, October-November 1970 sponsored by Government of Japan.

Seminar on Wind Effects on Buildings and Structures, Manila, 1971.

Natural Resources Research

Seminar on Integrated Surveys, Jodhpur, India, September 1970.

Training Seminar on Geochemical Prospecting (in co-operation with ECAFE), Colombo, Ceylon, September 1970.

Regional Seismological Centre for Southeast Asia, continuing preparation work for establishment of the Centre in Manila.

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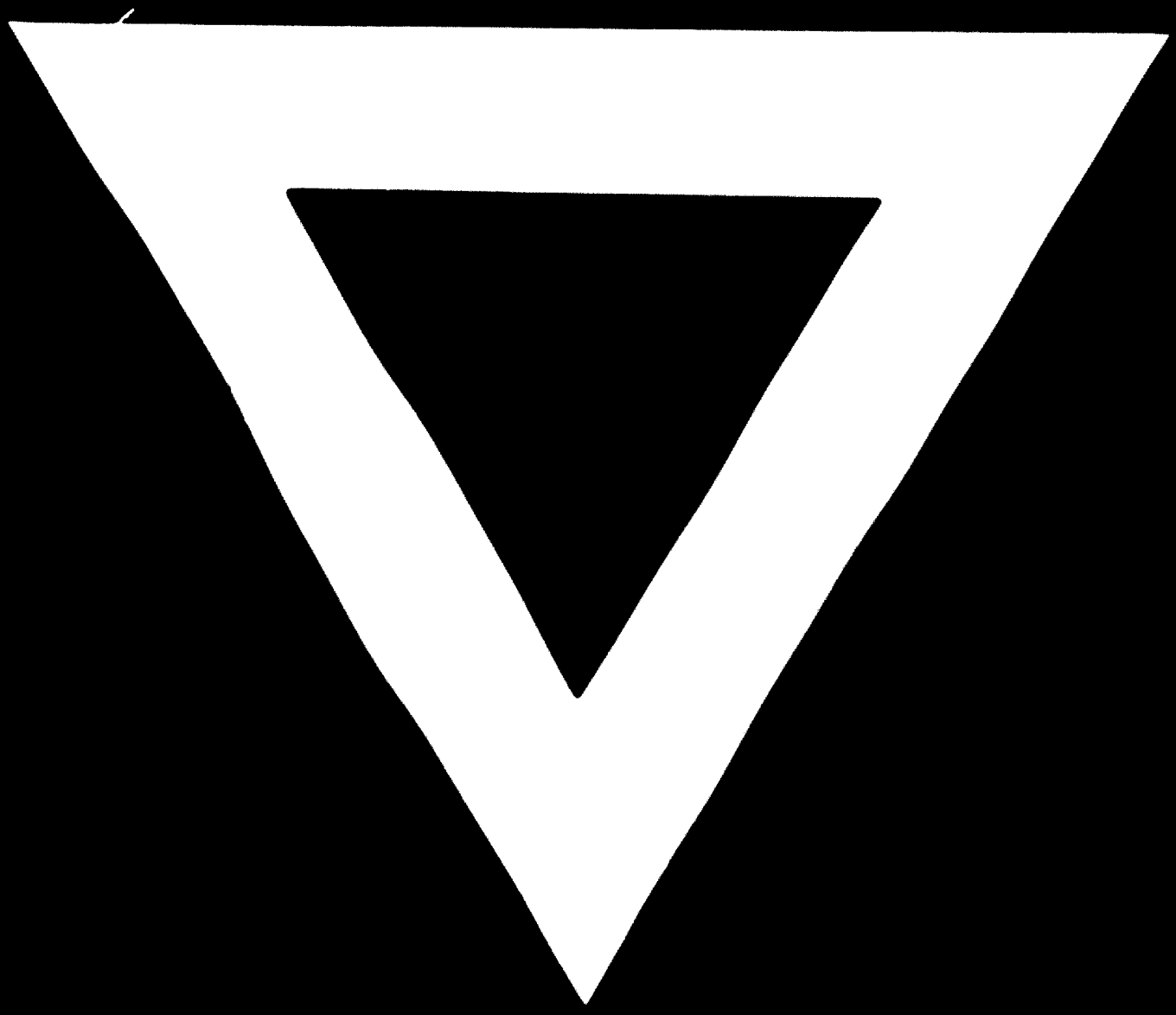

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