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D03865 – D03886

PROCEEDINGS OF THE INTERREGIONAL SEMINAR ON INDUSTRIAL RESEARCH AND DEVELOPMENT INSTITUTES IN DEVELOPING COUNTRIES

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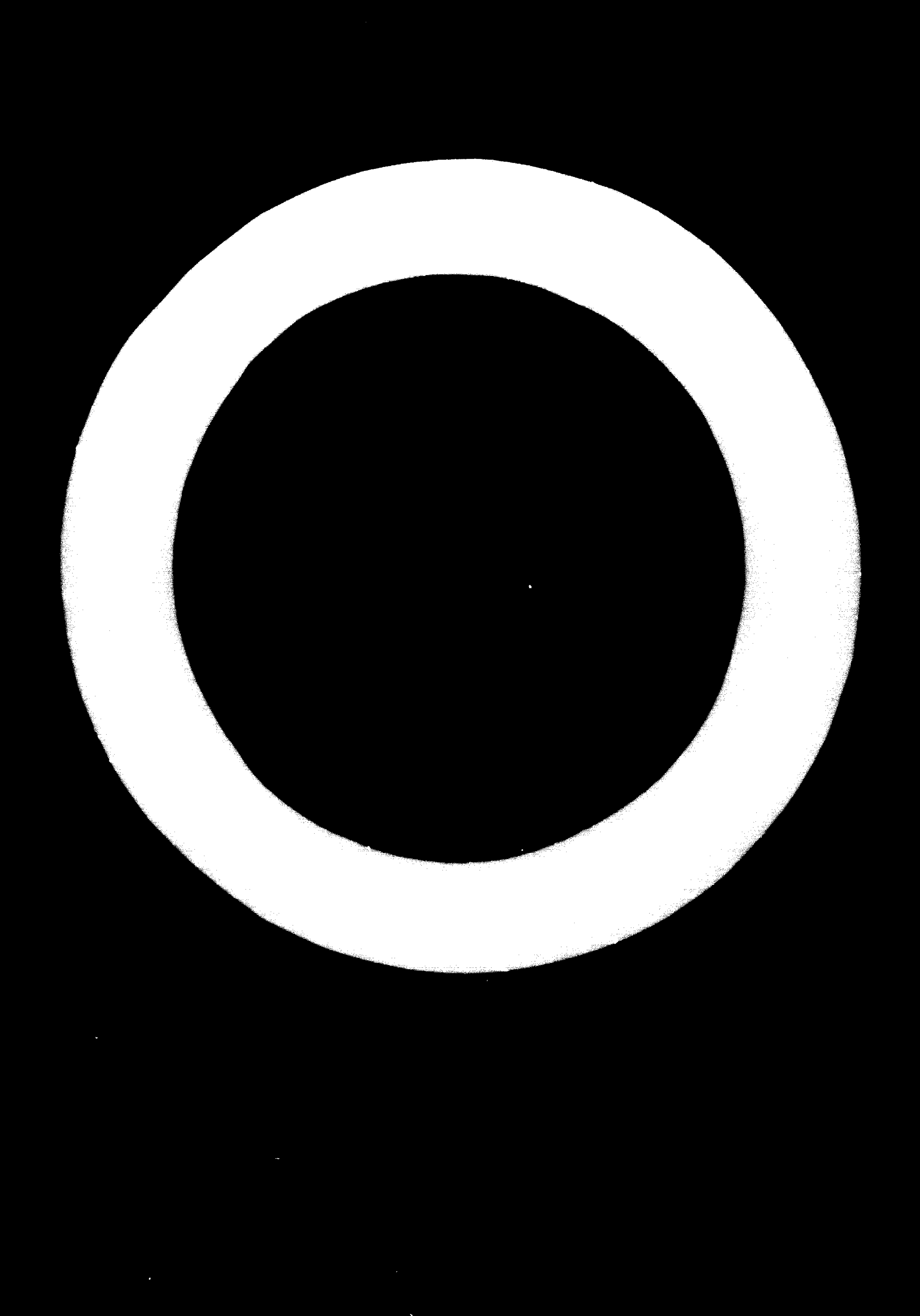
PROCEEDINGS OF THE INTER-REGIONAL SEMINAR ON INDUSTRIAL RESEARCH AND DEVELOPMENT INSTITUTES IN DEVELOPING COUNTRIES

Part One - Report of the Seminar

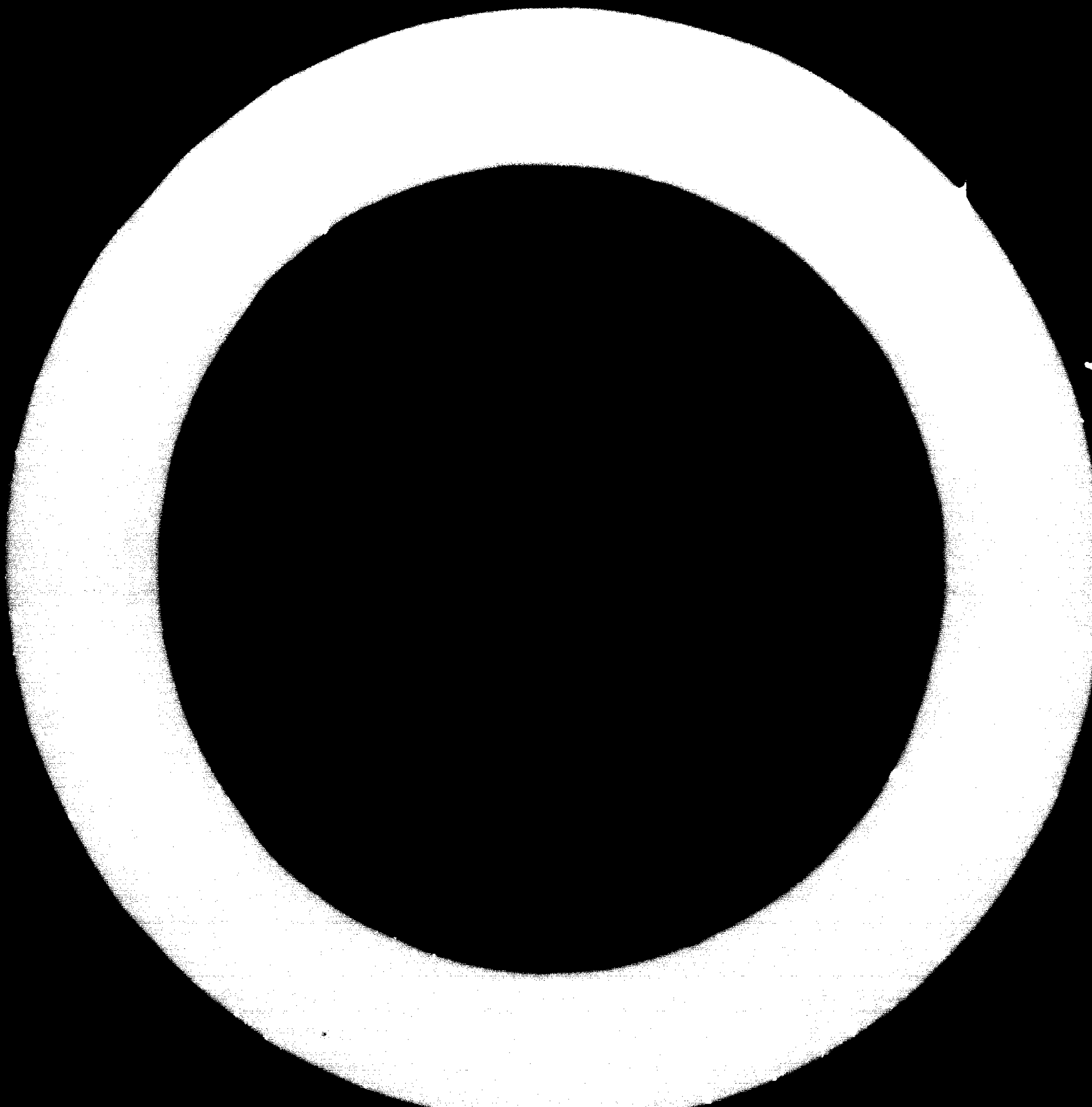
Part Two - Concept and objectives of industrial research and development institutes

Part Three - Industrial extension services

Part Four - Organizational aspects



Part Four - Organizational aspects



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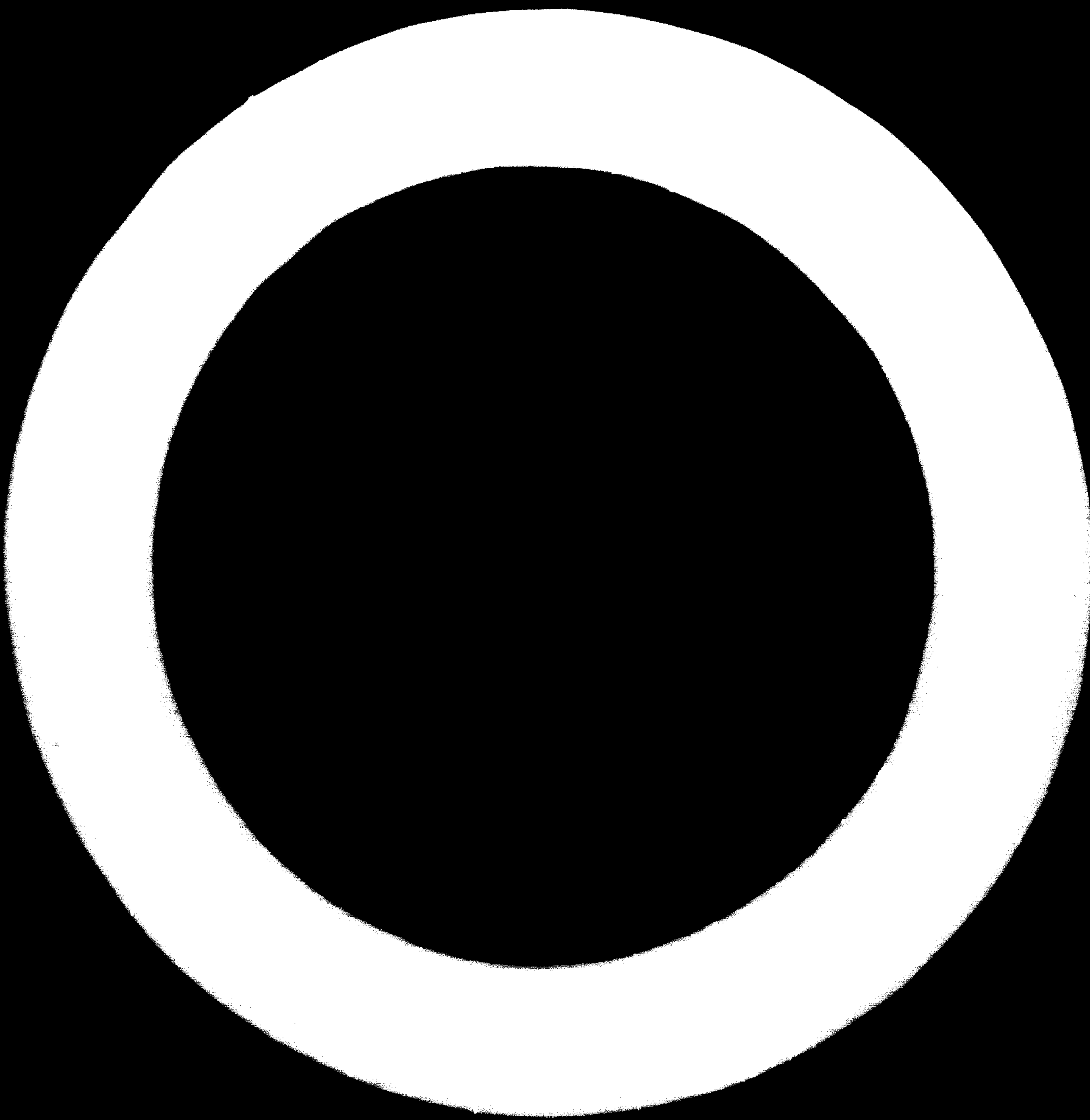

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I. ORGANIZATION OF INDUSTRIAL RESEARCH

Prepared by the United Nations Centre for Industrial Development

Introduction

1. The role of industrial research and development in fomenting industrialization has become increasingly preponderant. This subject is discussed in numerous papers. Industrial research activities have been undertaken by Governments, universities, industry, other concerns and individuals in varying intensity in different countries of the world. These activities differ in the way in which they are organized, in their sponsorship, in whom they serve and in their scope. They are organized in the form of governmental departments or institutes, autonomous institutes, private laboratories under a company, associations of industries in a co-operative form, university institutes, etc.

2. The organizations conducting industrial research activities are oriented in some cases to one specific field or to a specific industry; in others, they could carry out multiple industrial research and development activities for the Government, industries or individual firms.

3. The scope of this paper will be limited to a general survey of the different types of existing organizations of industrial research, illustrated by numerous examples from different countries. The paper also describes the ways in which funds are made available for research.

4. Much of the information used is based on a questionnaire on industrial research institutes sent by the Centre for Industrial Development in October 1963 to United Nations Member States. It has been necessary to use other reference material to fill in the gap since some of the questionnaires were not answered completely, as had been anticipated.

5. The purpose of this paper is to present information for the discussion of Part Three, Section A, paragraphs 28 and 29 of the Annotated Agenda of the Inter-regional Seminar on Industrial Research and Development Institutes in Developing Countries.

6. This paper presents the institutes classified according to their sponsorship under Government, universities or industry. This classification is not intended to be exclusive, as many institutes could be included in more than one of the categories established.

[illegible]. The role of Governments in industrial research

7. Governments have traditionally taken part in scientific and industrial activities either to support fundamental research or in matters related to national security. This traditional role dating back centuries in some cases, has been supplemented by the increasing role of Governments in the industrial research field with the purpose of assisting and accelerating the industrialization process. In countries with centrally planned economies, the task of supporting and performing industrial research is inherently taken in most cases by the State.

8. The importance of the government role in industrial research activities has been emphasized and requested both in developed and in newly developing countries.

9. In the United Kingdom, a White Paper entitled "Scheme for the Organization and Development of Scientific and Industrial Research" was announced by the Government on 3 July 1915. The preamble stated: 1/

> There is a strong consensus of opinion among persons engaged both in science and in industry that a special need exists at the present time for a new machinery and for additional state assistance in order to promote and organize scientific research with a view especially to its application to trade and industry.

10. Governments, in response to this need, which is clearly distinct from matters of national security, have undertaken numerous activities either directly or indirectly in the field of industrial research.

Industrial research institutes and organizations under the aegis of government bodies

11. Many countries have government bodies in charge of determining national policies for industrial research and financially assisting industrial research through grants and subsidies.

12. In the United Kingdom the responsibility for industrial research falls on the Department of Scientific and Industrial Research (DSIR), created in 1916. (*See* Proceedings of the Inter-regional Seminar on Industrial Research and Development Institutes, Part Two, IV, for paper presented by DSIR.)

13. The DSIR has two separate, though related, functions which are reflected in its titles. One is the support of promising research projects in science and technology, excluding medicine and agriculture, at universities and colleges, and of post-graduate training of scientists and technologists. This is the "scientific" research. The other function is support of "applied" or "industrial" research, which is likely to benefit industry and other users directly.

1/ Ronald S. Edwards, *Co-operative Industrial Research* (London, Pitman and Sons, 1950), p. 34.

14. In Belgium, the Government's activities supporting [illegible] a contributing factor to the rapid development of industrial research [illegible] twenty years. The special organization formed by the Government [illegible] of industrial research is the Institut pour l'Encouragement [illegible] l'Industrie et l'Agriculture (IRSIA). The subject is discussed in "[illegible] of Industrial Research in Belgium", by Dr. Louis Henry (see chapter II).

15. The general pattern of research in the British Commonwealth has followed that of the United Kingdom. In almost all cases, the initiative in industrial research has been left to the Governments. 2/

16. In 1942, an administrative Central Council of Scientific Industrial Research was formed in India with functions similar to those of the United Kingdom Department of Scientific Industrial Research. India has adopted the experience of other countries forming specific institutes with co-operation between them. "Organization patterns of industrial research and development activities in Asia and the Far East", presented by the Economic Commission for Asia and the Far East, gives illustrations of governmental activities in industrial research (see chapter XVIII).

17. In Australia and New Zealand, action was taken in 1911 to establish advisory councils for science and industry. In 1921, the Australian National Research Council was formed. "The task of the Commonwealth Scientific and Industrial Research Organization is to provide, through scientific research, knowledge which will remove limitations to industrial progress or present new opportunities for it." 3/

18. In Israel, the National Council for Research and Development is the body in charge of centralizing Government-sponsored research and development activities. A typical organization under its aegis is the Ceramic Research Association of Israel, Technion City, Haifa. Founded in 1950, it is governed by a board of directors composed of members appointed by the Ministry of Commerce and Industry, the National Council for Research and Development, and by election at the annual general meeting. The association is open to producing ceramic industries with full rights and to non-producers with limited rights.

"Autonomous" industrial research institutes under Government auspices

19. In the newly developing countries, some Governments have undertaken programmes for developing industrial research organizations.

20. For example, the Ceylon Institute of Scientific and Industrial Research was established by the Government after a draft bill was passed by the Parliament in 1955. The Institute began operations on 1 May 1955, and had transferred to it the entire machinery and equipment of the Rubber Service Laboratory, besides all

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2/ C.E. Kenneth Mees and John A. Leermakers, The Organization of Industrial Scientific Research (New York, McGraw-Hill, 1950), p. 7[illegible].

3/ Australia, Commonwealth Scientific and Industrial Research Organization, Annual Report, 1962-1963 (Melbourne, 1963), p. 1.

the technological equipment of the Industrial Research Laboratory of the Department of Industries and its entire technical library. The Institute's objective is to assist the industrial development of Ceylon rendering services to the public and private sector. These services include process research, resources studies, waste-material utilization, natural products research, standards testing, technical consulting, industrial project evaluation and preparation.

21. In Ireland, the Government's activities on industrial research were expanded in 1946 with an Act of Parliament creating the Institute of Industrial Research and Standards. The main purpose of the Institute is to encourage the use of science and technology in Irish industry in every possible way by serving any agency requiring technical information or laboratory service, including government departments, industrial associations and industrial establishments.

22. Another example is the National Research Centre in the United Arab Republic, which was established in June 1956, as an independent body attached to the Presidency. Its predecessors were the National Research Council established in 1947 and the National Research Institute. 4/ The scientific activities of the Centre are governed by a board with the Director of the Centre as chairman. The Centre's objectives are to carry out research in its own laboratories or under its auspices, both basic and applied, and especially in the fields of industry, agriculture and medicine. The Centre also maintains a Scientific and Technical Documentation Division and publishes a number of scientific journals. For further information, see chapter XXXII "Industrial Research in the United Arab Republic".

23. There are also organizations created under the auspices of provincial governments with the purpose of serving the provinces. Such is the case in Canada of the recently formed New Brunswick Research and Productivity Council, which is intended to develop the use of the natural resources already exploited by industry; and also of the Research Council of Alberta, founded in 1921. For a number of years after its establishment, the latter Council operated on a small scale within the University of Alberta, with much of technical direction provided on a part-time basis by faculty members. There is now little formal tie with the University, apart from the fact that its President is a member of the Council. However, there are a number of relationships at the working level. The work programme is broadly related to the evaluation and development of the natural resources of Alberta and to the encouragement of the industrialization of the province. The Council does not generally work on problems originating outside the Province of Alberta. This policy has arisen since the bulk of the financial support is derived from a provincial government grant.

Industrial research conducted by government departments

24. Governments acknowledging the importance of their role in fostering industrial research have also undertaken industrial research and basic research activities under institutes or departments functioning under a ministry or other government bodies. Although most of the direct activities of Governments in research are

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4/ United Arab Republic, National Research Centre, 1[illegible]1.

irected to support the national security. ... of this ... especially in developing countries is directed to accelerate the process of industrialization.

. In 1956, the Federal Institute of Industrial Research was established by the Government of Nigeria for the purpose of performing applied research and development work, including pilot-scale experimentation on processes developed in their laboratory, industrialization of the raw materials of the country, technical consultation to industry, and general testing and analysis.

. In Burma, the Union of Burma Applied Research Institute (UBARI) was established in 1955 as an outgrowth of the State Industrial Research Institute, established in 1947. UBARI is a public establishment administered by the Burma Research Board, which is a policy-making body under the Ministry of Industry. UBARI provides technical services to industries, universities, private corporations and the Government, including the armed forces. For further information, see chapter XVIII.

27. Another example of government departments conducting industrial research and development is the textile development unit of the Department of Industrial Promotion of the Ministry of Industry of Thailand. The unit specializes in textile technology and undertakes product research, process research, industrial consultation and studies of material utilization. It also conducts regular short training courses.

28. In Libya, the Research Department of the Ministry of Industry was established in 1962 and now has six sections: (a) geology and mining; (b) product research; (c) market utilization; (d) marketing; (e) statistics and conferences; and (f) industrial laboratories.

B. Industrial research related to or conducted by universities

29. Although the main functions of universities and higher institutes of technology are teaching and conducting fundamental research, some universities have built up special organizations to undertake applied research. Many of these organizations, or institutes, have evolved into autonomous units, but have kept very close links with their universities; in other instances, " university department may 'manage' a government research establishment (e.g. The California Institute of Technology)". 5/

30. There is also a growing trend in the United States of America and in Europe for professors in universities and institutes of technology to undertake ad hoc applied research problems, occasionally because their interests are related to such problems, but often because they are a source of additional funds. In some countries, notably the Federal Republic of Germany, Denmark, Sweden and the United States of America, the technical colleges and technological institutes of university status have made important contributions to applied research and to industry.

5/ Organisation for European Economic Co-operation, The Organisation of Applied Research in Europe, the United States and Canada: vol. I, A Comparative Study (Paris, 1954), p.41.

Industrial research by university institutes

31. There are numerous industrial research institutes that originated as a university department and then became autonomous, although they maintain ties with the universities in many fields, such as the case of the Instituto de Pesquises Technologicas in Sao Paulo, Brazil, which was created in 1934 as a department of the Engineering School of the University of Sao Paulo and changed in 1944 to an independent institution. Prior to 1934, it was just one of the laboratories of the School, the Materials Testing Laboratory. At present it has 467 staff members. In Uruguay, the Instituto de Tecnologia y Quimico de la Facultad de Ingeniera was founded in 1952, to carry out training, technical assistance and research in the industrial field. In the Federal Republic of Germany, research is an integral part of the activities of the science research colleges. About two-thirds of all research is done in university institutes, which are mainly concerned with basic research. In the field of technology, however, members of university staffs are often urged to undertake research by outside sponsors, especially in industry.

32. Another example is the Instituto de Investigaciones Tecnologicas of the Universidad de Concepsion in Chile, which was founded in 1959 by the University. The Institute services industry throughout the country and conducts technological research.

Independent industrial research institutes related to universities

33. Industrial research institutes originated and closely related to universities - known also as sponsored research institutes, 6/ or as independent industrial research institutes - are a distinctive feature of research in the United States of America, principally. The oldest of these, the Mellon Institute at the University of Pittsburgh, was founded in 1913. It is an independent non-profit corporation, which grew out of an earlier organization originally established at the University of Kansas in 1907. The programme became a constituent part of the University of Pittsburgh in 1910 and continued as such until 1927, when the Institute was independently incorporated under the laws of the Commonwealth of Pennsylvania

34. University institutes which are sponsored also by outside organizations or by government bodies can be found in Sweden, where there are three institutes of technology in which a great deal of research is carried out, with applied research being favoured. The research is, in general, financed by the research councils and other foundations, as well as by contracts. These institutes are the Royal Institute of Technology in the Stockholm and Chalmers Universities (Institute) of Technology in Gothenburg, and one established in Lund in 1961. 7/

6/ *Ibid.*, p. 58

7/ Organisation for European Economic Co-operation, *The Organisation of Applied Research in Europe, The United States and Canada*: vol. II, *Applied Research in Europe* (Paris,), p. 143.

C. Industrial research organizations and activities sponsored by industry

35. Research in industry covers the whole field from fundamental research to applied research. While a good correlation between the type of industry and the type of research can be found, the size of the industrial unit has a great influence on the size and type of the research activities. 8/ It is only the largest industrial enterprises that can afford, from their own resources, the long-term investments in fundamental research.

36. Industrial research and development carried out by industry is conducted by the individual firms themselves under their own laboratories or in a co-operative way. The cost of research to the individual firm depends on the scale of efficiency with which it can be organized. The value of research to the individual firm depends on how it is likely to affect the firm's position vis-à-vis its competitors. The use of outside facilities for research will therefore depend on both these factors.

Co-operative industrial research

37. When industrial firms cannot afford an efficient research section, and although the great part of industrial research in all countries is carried out by the large firms, co-operative research arrangements have grown to meet the need. 9/ Co-operative research establishments have the advantage, which also applies to industries composed of large firms, of reducing duplication of staff and equipment, increasing the size of the laboratory and reducing overheads. Co-operative research may be classified in the following way:

(a) Unsubsidized co-operative research organized:

(i) Directly between firms;

(ii) Through trade and development associations;

(b) Subsidized co-operative research organized:

(i) Through universities and technical colleges;

(ii) Through government research establishments;

(iii) Through research associations.

8/ The Organisation of Applied Research in Europe, the United States and Canada: vol. I, A Comparative Study, p. 27.

9/ Ibid., p. 31.

38. In the Federal Republic of Germany in 19[illegible], a number of existing research associations, the Organization for European Economic Co-operation and the Federal Ministry for Economic Affairs, together founded the Arbeitsgemeinschaft Industrieller Forschungsvereinigungen (Council of Industrial Research Associations). 10/

39. The structure of the organizations affiliated to the Arbeitsgemeinschaft varies widely. They may be firms with a collective research centre (co-operative industrial research institutes, technical university research institutes founded by various industrial groups, etc.) or co-operative research societies with no institutes of their own. Most of the member associations possess their own research institutes (thirty-seven in all). Those with no institutes of their own give their research assignments to the institutes of fellow-members, or to the federal or regional establishments, science colleges, Max Planck Gesellschaft institutes or other independent research centres.

40. In the United Kingdom, industrial associations conduct research for their members, which are associated with the DSIR; and this pattern is closely adapted by several countries. (See Proceedings of the Inter-regional Seminar on Industrial Research and Development Institutes in Developing Countries, Part Two, IV.) A few associations serve highly developed industries and can undertake a good deal of elaborate or advanced work. At the other extreme, there are new research associations which must confine themselves largely to straightforward projects yielding early results of recognizable value to their members. It must be added that this type of organization is a continuously changing one, as, for instance, during the period from 1957 to 1962 one DSIR station was closed and a new one (the Warren Spring Laboratory) has been put into operation. The work of others have been reorganized to meet changing needs. Five new research associations went into the Government scheme and two existing associations amalgamated.

41. Most co-operative research organizations are in principle open to receive private contract work for individual member firms on a repayment basis, even where membership of the association is compulsory for all firms in the industry. 11/ In France several research centres set up to serve the industry concerned, have been in existence for many years. A law of 1901 makes provision for the creation of non-profit associations for the carrying out of research on behalf of member firms. The Co-ordinating Committee of Research Centres and Institutes was founded in 1950 for the purpose of ensuring and developing liaison among the research centres of French industry. The centres and institutes have practically without exception joined the Co-ordinating Committee. 12/

10/ Organisation for Economic Co-operation and Development, Country Reports on the Organisation of Scientific Research, "Germany" (Paris, 1963), p. 30.

11/ Organisation for European Economic Co-operation, The Organisation of Applied Research in Europe, the United States and Canada, vol. I, A Comparative Study, p. [illegible].

12/ Organisation for European Economic Co-operation, The Organisation of Applied Research in Europe, the United States and Canada, vol. II, Applied Research in Europe, p. [illegible].

Industrial research in industry's own laboratories

42. Industrial research activities carried out by industrial units are a function, as said previously, of the type and size of the firm.

43. In the Federal Republic of Germany, there were, in 1959, about [illegible]00 research institutes belonging to industrial concerns: 13/ Research divisions have a large degree of independence within the firm and can submit their suggestions and recommendations directly to the Board of Directors. Besides the scientific and technological development of new projects and products, they include feasibility studies and profitability of production methods.

44. In the United States of America there are more than [illegible],000 laboratories belonging to industry, of which 200 are of considerable size. 14/ From 19[illegible]0 to 1940, the growth of research in industry was from 300 laboratories to over [illegible],300. The uniform adoption of industrial research by United States industry as a whole, regardless of size of company, field of industry, or geographic location, was equally impressive. 15/

D. Other types of industrial research and development institutes

45. There are several types of autonomous institutes all over the world which conduct industrial research and development activities for a country or for a region. The institutes are sponsored by Government, industry and universities on a non-profit basis, or also could be organized as private organizations conducting industrial research and development for profit. Several examples of these institutes are given below.

Multipurpose institutes

46. Multipurpose institutes are applied research organizations which perform a wide range of activities, both technical and economic, for a great number of different industries. Institutes of this type which are associated or affiliated with universities are discussed in paragraphs 33-34.

47. A good example of the multipurpose institute is the Instituto Nacional de Tecnología Industrial (INTI) in Argentina. The Institute is developing a scheme similar to that of the United Kingom's Council of Scientific and Industrial Research (CSIR), with the difference that INTI organizes industrial research under agreements with universities and industrial institutions, instead of with associations consolidated under the sponsorship of a central council, as is the case of CSIR. For further information, see chapter XXVI. In the Federal Republic of Germany, a multipurpose institute of private non-profit category

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13/ Organisation for European Economic Co-operation and Development, op. cit., p. 36.

14/ Mees and Leermakers, op. cit., p. 121.

15/ C.C. Furnas, Research in Industry (New York, Van Nostrand, 1948), p. [illegible].

is the Fraunhofer Society for the Advancement of Applied Research, founded in 1949. Another multipurpose institute is the Instituto de Investigaciones Tecnologicas in Colombia, which is currently engaged in a programme of technical assistance to the small and medium-sized industries.

48. Multipurpose private consulting laboratories perform research and development services on a contractual basis for a fee. They are similar in operation to other service organizations. Research service is the major function and it normally can assure the undivided attention of a number of staff members to a research problem.

49. Many of the private consulting laboratories do not grow beyond the point where they can handle problems in more than one or, at most, several technological fields. 16/ But some have engaged in multiple fields. There is a consulting firm in the United States of America doing work closely associated with that of the Massachussetts Institute of Technology. 17/ This firm serves, in most cases, as a consulting laboratory for an industrial company rather than as a consultant on a particular problem or project.

50. The increasing cost in research costs has produced industrial pools in industrial research. Although the pharmaceutical industry is an industry with very specific research problems, small companies could not stay in the running without the products of research. This special situation has produced the creation of an "industry institute", which could also be classified as a regional institute. This is a private institution formed by seventeen pharmaceutical companies from sixteen countries, both highly developed and developing, and located in the Federal Republic of Germany, having the qualified sources of manpower and information at hand. The results of pooled research will be exploited commercially by each member in his own country. 18/

Institutes conducting research for specific industries

51. Some institutes are established for the purpose of serving one industry in particular. These institutes are supported by Governments or by industries themselves. Such is the case in India of the National Sugar Research Institute in Kanpur, the Technical Laboratory of the Indian Central Joint Committee and the Bengal Ceramic Institute (also under the aegis of the Council of Scientific and Industrial Research), as well as such institutes as the Central Glass and Ceramic Research Institute and the Indian Institute of Petroleum, among others. For further information see chapter XVIII.

52. Another example of the industry institute is the Textile Research Institute in the United Arab Republic. The institute is a public establishment intended to be the national scientific organization for research work for the textile

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16/ Mees and Leermakers, op. cit., p. [illegible].

17/ Organisation for European Economic Co-operation, The Organisation of Applied Research in Europe, the United States and Canada: Vol. I, A Comparative Study, p. [illegible].

18/ "Pooling drug research", Business Week, No. [illegible] ([illegible] October 1963), pp. [illegible].

industry; further information is supplied in "Industrial Research in the United Arab Republic". (See chapter XXXII.)

53. In Nigeria, the West African Institute for Oil Palm Research was created in 1951, "for the purpose of undertaking research into and investigation of problems and matters relating to the oil palm and its products, and for the provision and advice relating to oil palm".

54. In Ceylon, the Government's activities were oriented in fostering industrial research associated with particular industries, as was the case in other Commonwealth nations. For example, there are the Rubber Research Institute in Agalawatte, the Tea Research Institute in Talawekelle and the Coconut Research Institute in Lunuwila. There is also a Small Industries Service Institute in Moratwa.

55. The West African Fisheries Research Institute, founded in 1951 and currently (1962) Fisheries Division of the Ministry of Natural Resources in Sierra Leone, is engaged in process research, product research, pilot-plant studies and marketing for the fish industry. Other industry institutes are the Forest Products Research Institute in Laguna, Philippines, and the Building Research Institute of the Ghana Academy of Sciences, which do work for the Government, university, consultants (architects and engineers), contractors and manufacturers.

56. As can be seen, a wide variety of industries is covered by industry institutes all over the world. In the petroleum industry, the National Iranian Oil Company Research Centre was created following the precedent set by the major oil companies. Prior to its creation, the company relied almost totally upon the services of foreign consultants and laboratories.

Regional institutes and institutes with activities in other countries

57. Several industrial research and development institutes that were established for the purpose of serving national development have undertaken foreign activities in other regions. In Israel, the Technion Research and Development Foundation is engaged in extensive research in all fields of modern science and technology. These include chemistry, physics, building materials, soil mechanics, hydraulics, farm machinery, applied mechanics, aeronautics, geology, etc. Research projects are undertaken on behalf of local and foreign, private and public bodies, including industrial concerns and government departments.

58. The Industry Institute in Beirut is an institution that is of national character, but independent in operation and available to both public and private enterprises. It has currently undertaken contractual research and development work in the Middle East. The Institute was established in 1955 as an independent, non-profit corporate public organization granted by a presidential decree of August 1955. It is governed by an independent board of trustees.

59. Another type of institute established for the purpose of developing other regions is the Japan Consulting Institute, organized in 1955 with the powerful support of the Government. The Institute makes it its object to conduct business on a non-profit basis as a technical consultant, primarily in heavy industry, so that assistance can be rendered to the developing nations of the world in their

endeavours for industrial construction and expansion. Practically every one of the major industrial establishments operating in Japan has been enrolled on the list of its membership.

60. An institute that was primarily established to serve the development of a region is the Instituto Centro Americano de Investigaciones y Tecnologia Industrial (ICAITI). This institute also represents a major step in international co-operation. In 1955, the Governments of Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua jointly established ICAITI to carry out applied research to serve the region. For further information, see chapter X, "Organization of industrial research on a regional basis with particular reference to ICAITI".

E. Ways of financing industrial research

61. Industrial research funds are obtained or made available to institutes and organizations in several ways. The two main sources of funds are Governments and industry. Governments finance industrial research either by contracting research work, or by grants or subsidies. Industry finances research by contracts, grants, gifts, voluntary contributions, compulsory levies, through licences and payment of royalties, etc.

62. Institutes in all categories derive their incomes from several sources and in different ways, although most of the funds usually come from one main source. The INTI in Argentina, for example, receives most of the funds from a compulsory levy of .25 per cent imposed against the industrial loans of the Industrial Bank of Argentina. Other funds come from contractual work. A detailed report is presented in chapter XXVI.

63. The Institute of Chemistry and Technology of the School of Engineering in Uruguay obtains 90 per cent of its funds from the Government and 10 per cent from fees for services rendered. Other organizations obtain their funds from government grants and subsidies. The word "grant" has certain restrictions in different countries. In the United States of America, "a university is as bound by the conditions and terms of a research grant as by any contract. It cannot spend the funds for research outside the field specified by the grant, or for purposes other than for research, under another principal investigator than the one named in the grant. It must account for the monies spent, accept government audit of costs, submit reports as called for, comply with inventions and patent conditions, and so forth". 19/

64. The grant scheme introduced in the United Kingdom in 1934 is still the basis of contracts between the Government and research associations. The DSIR enters into an agreement, normally of five years' duration, with each association. This agreement provides that a block grant will be made each year on condition that the association risks for research a stipulated minimum income from industry. All the results of its work, including patents, belong to the association. The DSIR claims nothing in exchange for the subsidy with the exception of the right

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19/ "Grant vs. Contracts", Industrial Research, vol. 6, No. 4 (April 1964), pp. 48-57.

to inform other research associations of the titles of research reports and communicate the results to another home government department. 20/

65. The Government also subsidizes the operation of the Instituto de Pesquisas Tecnologicas in Sao Paulo, Brazil, and supplements the income coming from industry to the Forskningsinstituttet For handels Og industriplanter in Denmark, with 50 per cent of the funds. In many cases, the Governments and international organizations join together in financing the initial stages of research organizations. Such is the case of ICAITI in Central America, which derived income from the Governments and the United Nations initially and currently is complementing them with fees and contracts with industry and institutions such as the Inter-American Development Bank.

66. Several institutions obtain or have obtained funds through gifts and donations from individuals, industry, foundations, etc. The Battelle Memorial Institute in the United States of America was founded by Gordon Battelle, who bequeathed to it the fortune accumulated by his father, John G. Battelle, in the coal, iron and steel business. The will provided for the building and endowment of an "Institute for the purpose of education and creative and research work and the making of discoveries and inventions for industry".

67. The Stanford Research Institute established a special class of membership called "Instituted Associates" to designate individuals or corporations who have contributed funds to the Institute. Funds received through such memberships are used for the expansion of Institute facilities and the acquisition of laboratory equipment.

68. Many organizations derive their funds from contributions and subscriptions, on a voluntary basis, from other institutions or fellow members. This is a widely used method of providing the funds required to carry out research by industrial research associations. In France, the revenue of technical industrial centres comes mainly from subscriptions, either compulsory or voluntary, from the undertakings of the branch of industry concerned. These subscriptions are made either directly or through trade organizations. 21/

69. The exploitation of patents and inventions has been the purpose of creation of several institutes, although the majority of organizations derive funds from patents. For example, the Armour Research Foundation in the United States of America is financed by sponsored research contracts and income from patents. All employees of the Foundation are required to sign contracts in which they agree to assign to the Foundation any patent arising from their work; and, in accordance with the specific contract made with a research sponsor, all patentable inventions developed by a staff member become the property of the sponsor, while patents which the Foundation files in its own name are managed by the Foundation.

20/ Ronald S. Edwards, op. cit., pp. 40 and 41.

21/ Organisation for European Economic Co-operation, The Organisation of Applied Research in Europe, the United States and Canada: vol. II, Applied Research in Europe, p. 65.

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II. THE ORGANIZATION OF INDUSTRIAL RESEARCH IN BELGIUM

Prepared by Louis A.M. Henry*

Summary

At the outset, the author provides a definition of applied research, its place within the framework of general research, its role in industry and attendant risks; he then gives an outline of industrial research in Belgium.

In Belgium, state aid to industrial research is canalized through the Institute for the Promotion of Scientific Research in Industry and Agriculture (Institut pour l'Encouragement de la Recherche Scientifique dans l'Industrie et l'Agriculture - IRSIA).

IRSIA's mission is to stimulate, promote and encourage, by means of subsidies, scientific and technical research apt to ensure the advancement of industry and agriculture. IRSIA is a semi-governmental entity operating on a yearly grant from the Ministry of Economic Affairs.

Guided by the basic considerations of expediency, achievement and economy, the IRSIA has directed its activities towards stimulating the spirit of research in industry, encouraging team-work among industrialists (possibly in co-operation with universities), ensuring the dissemination of research findings through liaison channels and, finally, promoting and financing research likely to open new areas of operation to industry. Notwithstanding its modest budget (348 million Belgian francs in 1963), IRSIA's activities have proved eminently successful, as evidenced by various examples.

Industry is aware of the importance of research and is earmarking ever-increasing sums to it (some fr. 3 billion in 1963); small and medium-sized firms are willing to form groups in order to carry out research in common. Even the larger firms derive benefit from joint research through the comprehensive use of manpower and facilities in plants and at universities.

Introduction

1. Industrial research in Belgium has developed considerably over the past twenty years. Industry has realized its importance and is earmarking ever-increasing sums for its furtherance.

2. However, one of the important factors contributing to this development has undeniably been the Government's financial aid to applied research. The special organization formed by the State for the pursuance of research is IRSIA.

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* Director, Institute for the Promotion of Scientific Research in Industry and Agriculture.

3. The purpose of this report is to show how this policy of aid to applied research was implemented through IRSIA, and how it led to practical results of a most useful nature.

4. Before proceeding to a detailed study of the organization of applied research within the framework of IRSIA, it will be helpful to define specifically some considerations that have served as a basis for its activities:

(a) The meaning of applied research;

(b) Where it fits into the general concept of research;

(c) What its place is in the field of industrial activity;

(d) The element of risk in applied research;

(e) The meaning of the term new industry;

(f) The importance of continuity in research.

The meaning of applied research

5. Applied research is interpreted as any research, at times very elementary, directed towards the investigation of economically profitable application possibilities, whether at short or long term.

Where applied research fits into the general concept of research

6. Oriented research, i.e., the investigation of known facts with a view to deriving economical advantages from them, and non-oriented research, in other words, the study of known facts from a disinterested standpoint, are ever more closely related. Whatever the ultimate goal may be, the basic knowledge, the reasoning process, the work methods and the technical approach are always the same. The accelerated development of science and technology and the need to study increasingly complex and far-ranging problems are such that conventional sources of information no longer suffice to fill the basic data requirements of industry. Oriented research, while retaining its ultimate purpose of discovering application possibilities, is obliged to penetrate areas that were formerly the exclusive attribute of university research. As a result of this, applied research has become an important source of basic data opening new scientific fields. It has been instrumental in the perfecting of technical processes without which fundamental research could never have developed as rapidly as it has over the last few years. Let us consider, notably, radio astronomy, solid state physics and lasers.

7. Conversely, moreover, research of a seemingly purely speculative nature may help to resolve essentially practical problems. For example, one of the most brilliant investigations conducted in Belgium on the brittle fracture of steel is based on extensive studies relating to rock-salt crystal flaws, which at first sight seems far afield of practice.

8. It becomes more and more clearly evident that it is useless to attempt to establish a distinct boundary between oriented research and academic research. The two increasingly overlap each other.

The place of applied research in the field of industrial activity

9. Even if applied research is canalized at times towards very elementary investigations, practical application and the transposition of laboratory findings to an economic and profitable production level remain its ultimate objective and justification. Does such transposition still involve research?

10. In numerous instances - fortunately, it must be added - the transposition of discoveries or improvements originating in the laboratory is achieved easily and almost immediately.

11. As an example, in the chemical industry, the improvement of the manufacturing process of a product through the perfecting in laboratory of a new synthetic process permits, as a rule, easy transposition to the production stage.

12. However, generalizing this concept must be avoided. Often, and particularly where rapidly expanding fields requiring ever more elaborate refinements are involved, the transposition of research findings and their adaption to prototypes (whether a process or machine prototype) entail frequent additional laboratory studies. It even occurs that such new investigations, revealed to be essential in the application stage, are of a wider scope than the initial research. For instance, in the machine-tool field, improving the surface finish of milled parts on a high-speed lathe, i.e., replacing the ground finish with a lathed finish, seems offhand to be a rather easy problem to solve. The laboratory studies the machinability of the metals to be shaped, the cutting properties of the tools, the rates of advance and penetration, the optimum cutting angle, etc. However, the technical application of these new principles may reveal a number of difficulties that were certainly suspected at the outset but that it was impossible to pin-point. Their solution requires additional research, such as a study of phenomena like slippage, transmission of vibration to the frame and shaft heating. These new investigations may reach such proportions as to lead to an entirely different design of the machine. Thus research and technology constantly overlap each other up to the final stage of industrialization; it would be useless to endeavour to dissociate them.

The element of risk in applied research

13. The need to invest in research is now no longer doubted. But, research likewise means risk: the answer may be found, and then again it may not. In the case of applied research, this risk is particularly high: as a matter of fact, it is multiplied by the possibilities of failure at each stage towards production.

14. Let us take an example in the field of chemistry: a firm striving to produce a new polymer of well-defined chemical and physical properties (e.g., to be used as a textile fibre or film coating). This will, first of all, involve laboratory syntheses of dozens of new compounds. These syntheses will make it possible to arrive at most interesting conclusions regarding, for example, reaction

mechanisms and the laws governing chain linkages. Thus, the research is a success from a purely scientific standpoint. But it is extremely possible that among the dozens of new compounds investigated, none can be found with the properties required for possible practical application. Even if one or two of these compounds seem promising, it may then evolve that the reaction output is inadequate or that the outset products are too costly. Finally, if all these problems are solved, a final drawback may reveal itself in the last industrialization phase; e.g., a vestige of impurity accumulating in the course of continuous production would destroy the process. Such setbacks in sequence are not unusual. Fortunately, it is often possible to stop the work at an intermediary stage; but this does not alter the fact that investment in applied research is a highly risky one. Should research involve investing a large part of available resources, failure may, in certain instances, dangerously compromise the financial situation of a firm.

What is meant by new industry

15. The term in itself may lead to misunderstanding if it brings to mind new plants whose establishment site has been chosen in the light of economic and social factors. Such plants, set up by national or, contingently, foreign firms, are often merely evidence of the industrialization of a given region.

16. In the author's opinion, the concept of new industry must be applied solely to the creation of a totally new product, not yet manufactured in Belgium and extraneous to the line of activity of the plant that created it. This creation is the result of the amassed experience of the firm's research and production departments. The manufacture of magnetic recording tape is an example of this. The magnetic tape is made up of a thin film (originally of paper) bearing a layer of of magnetic iron oxide held by a binder. Magnetic recording techniques were developed during the Second World War; obviously, the tape manufacturing industry was non-existent in Belgium. On the other hand, there were firms with the experience required to enter this new field. There were specialists in the production of emulsion-coated photographic film at Gevaert's; specialists in the preparation and use of metal oxide powders at the Henricot plants; specialists in magnetic gaugings at the Electric Constructions Workshop of Charleroi; and, lastly, specialists in the determination of crystal structures and properties at Professor Dekeyser's laboratory in the University of Ghent. From the mutual experience of these various groups working as a team, a new industry was born in Belgium - the magnetic tape industry.

Continuity in research

17. Research cannot be undertaken without foresight. The era of the individual inventor seems definitely over. It is becoming more and more evident that research, in order to be productive, must be a team-work operation. The formation of an efficient research team with a nucleus of qualified people and the selection and training of assisting personnel, with university or technical background, takes time and involves considerable work. The formation of a good research team represents an important investment.

18. To break up research teams is tantamount to destroying an investment difficult to replace, reducing a production potential of great worth, and discouraging the men whose task it is to make long-range plans for the firm's future.

19. Research is the sole means available to industry to maintain and improve the level of quality of its production, and to discover new products of a highly technical nature; it is one of the factors that ensures satisfactory utilization of highly qualified workers. The firm that has undertaken research cannot slacken its efforts without losing ground.

20. One investigation necessarily leads to another, if only to guarantee constant improvement of quality. Moreover, favourable research results inevitably incite the competition to greater efforts. Thus, it is only through increased expansion of its research operations that a firm can retain the advantageous position it has established in foreign markets and preserve its maximum personnel utilization potential.

21. The subject proper of this report - the organization of applied research in Belgium within the framework of the IRSIA - is divided into four sections:

(a) The immediate post-war situation;

(b) How research activities were organized and what characterized this move;

(c) What the present situation is;

(d) The prospects for the future.

A. The immediate post-war situation

22. During the years prior to the Second World War, industry showed an increasing interest in research. A few industrial companies had well-equipped laboratories and evidenced a distinct willingness to expand their activities. This, however, did not prevent some of them from completely discontinuing all research work when circumstances were unfavourable. On the other hand, medium sized and small industries were barely becoming aware of the concept of research.

23. The Second World War and the occupation of the country put an end to this development and disorganized existing facilities. All research activities remained practically at a standstill for five years; production equipment was put to abnormal use. In 1945, Belgian industry was considerably retarded in comparison with those of countries where the war effort had required an extraordinary development of research, technology and production resources.

24. Nevertheless, Belgian industry showed its will to live by quickly resuming activities in a remarkable fashion. It applied itself to make up for lost time and to regain its position among the technically developed countries by undertaking ever-increasing research activities. The Government, on its part, took the necessary steps to encourage and back this movement by creating the Institute for the Promotion of Scientific Research in Industry and Agriculture.

25. The purpose of IRSIA is stated in its by-laws: "to stimulate, promote and encourage, through subsidies, scientific and technical research that may contribute to the progress of Industry and Agriculture".

26. Its activities may be directed on behalf of all fields of applied sciences, with the exception of the nuclear and coal industries.

27. From a legal standpoint, IRSIA is a public institution. Financially, it derives its operating funds from a yearly grant entered in the budget of the Ministry of Economic Affairs. The grant amounted to: fr. 255 million in 1960, fr. 235 million in 1961, fr. 283 million in 1962 and fr. 348 million in 1963.

28. Organically, IRSIA is managed by a twenty-one-member board and a director, assisted by a secretary-general and four scientific advisors. Consequently, the administrative structure is small, flexible and economic. (In 1961, administration costs absorbed only 3 per cent of the budget.)

B. How research activities were organized

29. The unfavourable conditions existing at the outset - limited resources in funds, equipment and research personnel, and the backwardness in relation to other countries - made it imperative that applied research be organized to meet three requirements: speed, maximum output and drastic economy.

30. Speed and maximum output implied using all skilled personnel wherever available, and the rapid training of an ever-increasing number of young researchers to bolster existing teams, as well as extensive co-operation between industry and universities.

31. Economy implied utilizing existing laboratories rather than constructing new ones, but at the same time updating their equipment to conform to the most advanced technical standards. Economy further implied the avoidance of duplications in equipment and particularly in research; hence the need for team-work, exchange of data and joint investigations.

32. Lastly, it was imperative to orient industry towards the investigation of new and future fields of activity.

33. It was by following these three basic principles that applied research was developed in Belgium. It is by following these same principles that it continues to progress; as a matter of fact, although economic conditions have not improved decisively in comparison with the post-war period, competition has now become so intense and technology has developed at such a rapid rate that these three initial mandatory conditions are still applicable.

34. This fundamental philosophy quite naturally had to lead to a very extensive development of joint research. This type of research is not an essentially Belgian innovation; just prior to the Second World War, the United Kingdom had research associations, and there are some in Belgium's neighbouring countries that group firms of a same industry for research purposes. But the characteristics that make the Belgian research association a distinctly Belgian institution are its wide scope, flexibility of operation, close relationship with universities and the fact that it brings together firms of extremely varied standing and at times of very diverse activity.

35. Its development has assumed such proportions that it warrants being viewed in greater detail. The grouping of industrialists for joint research purposes is identified in Belgium by a variety of names - centres, committees, etc.; its structure pattern is greatly diversified and extremely flexible. It may consist of several firms of a same industrial area grouped either autonomously - as the National Centre for Metallurgic Research (CNRM) - or the Government-recognized form of the "Centres De Groote" type - such as the Glass, Explosives and Construction Centre, and the Metal Constructions Centre (CRIF). It may also be comprised of a number of plants from different industries grouped to conduct comprehensive investigations of common problems (such as the Committee for Solid State Research and the Extrusion Committee). Two figures will suffice to illustrate clearly the rate at which these research associations have expanded: in 1946, there were eight; by 1962, fifty five were operating.

36. These research centres, associations and committees may be of a permanent nature, like the De Groote centres or CNRM; or they may be created solely to cope with specific problems and cease to exist once these are solved, or again be expanded with the utmost flexibility as the research work may require. Some of these research groups have been specially created by IRSIA to acquaint industry with new techniques, train the specialists required and open the way to new fields of activity. A few examples of this are given in a subsequent section.

37. Some research associations have their own laboratories: CNRM is an excellent example. But this is not necessarily the rule. Some of them entrust their research work to universities; others distribute it among plant and university laboratories. Such collaboration makes it possible, at no great expense, to enlist the services of the most competent researchers in the most varied branches. Joint research is advantageous to all firms, whatever their size. Even firms having large laboratories and numerous researchers derive benefit and constant increase of their scientific productive capacity from it.

38. But it is particularly the small firms that benefit by joint research. The majority of them do not have the material means required to set up a research department with minimum return potential. Therefore, joint research is the sole practical possibility available to permit them to develop from a scientific standpoint.

39. Joint research has purpose only if the circulation and application of its findings can be ensured. If plants that have their own laboratory encounter no difficulties, the same is seldom true in the case of small firms, particularly those that have not even one staff member with a scientific background capable of understanding and assimilating research findings.

40. This problem led to the formation of a corps of liaison agents. These are university or technical school graduates assigned to a research association, whose function is to visit plants and acquaint them with research in progress and its findings. In counterpart, they inquire about technical problems with a view to solving them or having them solved by association's laboratory staff.

41. The active policy of IRSIA has essentially been that of developing joint research. It has not always been an easy task to put this policy into practice, but industry came to realize that it could not progress by remaining aloof.

Success was achieved in having competing firms work together in the investigation of fundamental problems whose solution formed the basis of their development (the Committee on Applied Electronics serves as an example). Whenever an isolated firm applies to IRSIA for assistance, the Institute requires that its request be mentioned in the bulletin of the federation of which such firm is a member; the purpose of the research is outlined and any firm interested in the project (and proving, of course, its ability to carry it out) may participate in the work. This method had led to very profitable joint work.

42. There are some further fundamental aspects of IRSIA's activities that must be pointed out:

(a) Firstly, IRSIA intervenes solely in granting subsidies to carry out well-defined research programmes. In so far as industry is concerned, the subsidy granted covers, as a rule, 50 per cent of research costs. In practice, through elimination from the budget of certain expenses not directly and specifically related to the subsidized project, owing to a limit established in the schedules of some researchers, the subsidy covers at most 40 per cent (and sometimes less) of actual costs. In the case of agriculture, the subsidies granted originally covered practically the full research costs; at present, as a result of the "industrialization" of some agricultural regions, the subsidies cover no more, on an average, than 85 per cent of costs, and this percentage is still being reduced;

(b) IRSIA has no laboratories, but encourages and helps research associations to set up and equip their own laboratories. Notable among these are the laboratories of CNRM and of the Centres for research on glass-work, ceramics, paints and varnishes, explosives, high pressures, leather, roads and, before long, construction work and mechanical construction;

(c) IRSIA serves the function of liaison agent for the purpose of establishing close relations between industrial research groups and university specialists, or of helping small and medium-sized industries to define their problems and directing them to the laboratories capable of solving them;

(d) Finally, there is an essential aspect of IRSIA's activity that must be stressed: its role as initiator. IRSIA seeks to initiate the investigation of problems of importance for the future and persuades industrialists to take an interest in them. Mentioned at the beginning of this report was the creation of the magnetic-tape industry. An excellent example is that of the establishment of the Committee for Research in Solid State Physics.

43. Some fifteen years ago, the meaning of solid state physics was hardly known in Belgium. It was deemed essential to develop this field in view of its scientific importance and of its possible implications in numerous areas of industrial application. A research group was formed, headed by Professor Dekeyser of the University of Ghent, a specialist in the study of crystal flaws. Gradually, various industries became interested in its work, submitted problems, shared in the financing of the investigations and sent specialists to acquaint themselves with this new branch of science. There is now in Ghent a research group of some twenty persons of international renown, studying the fundamental problems related to the various areas of the physics of semi-conductors, such as surface effects in catalysis, brittle fracture, refractory alloys and ceramics, properties of non-ferrous metals, crystals with special properties for lasers and the crystallography of photosensitive substances.

[illegible] There are still other examples of research work [illegible] the investigations of the Committee on Computing Machines [illegible], the study of refractory metals and cermets, research in the field of [illegible] pressures, etc.

[illegible] The author will not review here the method of evaluation of research [illegible], nor the establishment of budgets, the control of costs or the regular [illegible] work progress. It is of greater interest to attempt to determine the results of this aid to research policy.

C. The present status of applied research in Belgium - results of the policy adopted

46. The criteria that permit the determination of the scope of research efforts and their results, particularly in industry, are varied and often difficult to apply: they might consist of an evaluation of the sums expended for research, either in absolute worth or as a percentage of turnover, of the number of scientists employed, and of the number and importance of the projects under investigation.

47. In the exact sciences, it is, as a rule, easier to gauge the magnitude variation of a phenomenon than its absolute value. Likewise, if it is sought to evaluate the development of research from the standpoint of time, it is more important to determine the increase in effort than its absolute magnitude.

48. The willingness of industry to expand its research efforts is clearly manifest on noting, for instance, that from 1958 to 1961 the steel industry increased its research costs from fr. 1.80 to fr. 4 per ton of steel produced, and that the percentage of turnover assigned to research by the chemical industry rose from about 2.5 per cent in 1961 to approximately 3.5 per cent in 1962.

49. There are specific data available on the budgets for research work conducted by Belgian industry with the assistance of the public authorities, said budgets corresponding to industry's share plus IRSIA subsidies. The analysis of the evolution of these budgets on a year-by-year, area-by-area basis is most interesting, for it explicitly shows the rapidly expanding branches of industry. These budgets increased from fr. 145 million in 1953 to fr. 477 million in 1962, providing for a staff of some 1,250 per sons, of whom more than 320 were university graduates. However, these budgets represent only a part of industry's research efforts, inasmuch as it conducts entirely at its own expense the research work in areas involving competitition and, in the majority of instances, covers expansion costs. The distribution of IRSIA subsidies to the various sectors of industrial activity over the last few years is itemized as follows:

	[illegible]
Iron and non-ferrous metallurgy	[illegible]
Chemicals	[illegible]
Metal production	[illegible]
Electronics	[illegible]
Civil engineering and roads	[illegible]
Textiles	5.[illegible]
Glass and silicates	3.3
Research of interest to various sectors	4.4
Other sectors	2.[illegible]
Electric production and distribution	0.3
Total	100.0

50. Agriculture (which absorbs about a third of IRSIA subsidies) is gradually becoming research conscious. As a result of its industrialization in certain production areas (gardening, flower growing, fruit growing and canning) its share in research cost is increasing little by little and has now reached approximately 15 per cent.

51. However, there is a simple criterion that permits determining the status of applied research: industry's vitality. This vitality is evidenced, naturally, by the continuous improvement of equality and output but particularly by the trend towards new products of a highly technical nature, by the creation of entirely new products in rapidly expanding or as yet little-prospected areas, by the sale or exchange of patents and by the establishment of plants abroad. Belgian industry of today furnishes numerous examples.

Improvement of quality and output

52. Research work on the sizing of cotton threads serves as a simple example in which the advantage derived from investigation could be unambiguously calculated. The problem was to improve the quality of the threads by rationalizing the sizing so as to reduce thread breaks on the loom.

53. The cost of research was fr. 1.9 million. A study of the application of research findings in two types of establishments shows an annual saving of fr. 2 000 per loom. Inasmuch as there are some 26,000 looms in operation in Belgium, the savings resulting from research are around fr. 50 million per annum. The costs of adjusting the sizing machines were recuperated in less than a year.

54. Another example showing figures is that of the investigation of the preparation of cyanamide from calcium carbide (Société [illegible] de [illegible]). Here the problem was to improve the nitrogenization [illegible] output, which came to only [illegible] per cent of the theoretical output. This output shortage resulted in a loss of about fr. [illegible] million per annum.

55. Research work cost fr. 4.5 million and made it possible to increase the output to 96 per cent, which made the operation financially profitable. Moreover, subsequent investigations permitted orienting manufacture towards high-quality products derived from cyanamide: ferro- and ferricyanides, and particularly melamine, the base product for the manufacture of high-grade plastics.

Creation of new products

56. Here again there are numerous examples. One of the most recent involves research work undertaken by the Magotteaux Foundries, specializing in the manufacture of balls for milling apparatus.

57. This medium-sized firm resolutely launched itself into research, equipping a fine laboratory and hiring a large staff of engineers (twelve for 200 workers). A yearly research budget in the range of fr. 2.5 million made it possible to perfect complex alloys of excessive hardness, high abrasion resistance and a much lengthier life than the cast-iron used in conventional balls. This firm, by undertaking the manufacture of highly technical products (necessarily high-priced because made from distinctly costlier raw materials), has assumed a leading position in Europe.

58. One may further cite in the field of metallurgy:

(a) The perfecting of cobalt alloys (Umco-50) presenting extraordinary properties at high temperatures;

(b) The perfecting of the LD-AC conversion process for steel which has been substituted for the conventional Thomas process, yielding products of a grade comparable to Martin steel; this process has truly saved the Belgian iron-works industry. An even more improved process, capable of leading to a wider range of steel compounds, is presently being investigated;

(c) The development of the metallurgy of tantalum and other refractory metals. The perfecting of methods of extraction and purification of the metal (notably fusion and final purification by electronic bombardment) has established Belgium as one of the major world producers of extremely pure tantalum;

(d) The production of high-purity or doped semi-conductor bodies.

59. Some years ago, the once flourishing machine-tool industry was very far from having resumed its hoped-for surge ahead. It was possible to persuade the Atelier de Construction Electrique de Charleroi (ACEC) and Progrès Industriel to work together in the study and design of numerically controlled automatic lathes. The investigations yielded distinctly positive results and, furthermore, led to other interesting developments, such as research on surface finish and on the elimination of machine vibrations. On the part of ACEC, the development of logical control components opened new fields of application in the domain of regulation and permitted the optimizing of industrial processes.

Research findings as a medium of exchange

60. Experience shows that research work and its findings constitute an exchange medium of great worth for industries wishing to conclude interesting agreements with foreign firms, whether it involves the sale or exchange of processes, or

production contracts. It is owing to their research potential and the results achieved that, among others, Hoboken succeeded in concluding an agreement with Fansteel and creating a new industry for the mechanical processing of tantalum; and that Progrès Industriel succeeded in entering into a contract with Jones and Lamson, thereby broadly expanding its area of manufacture and sales. Research has made it possible for various firms to sell new processes, production plants and know-how abroad.

61. The study of achievements through research is a fascinating one and warrants being pursued in detail. This paper merely cites examples in the industrial field; there are equally absorbing ones in the field of agriculture, where some production areas have expanded into actual industries. All these are tangible proof of the scope and value of efforts made in Belgium in the field of applied research.

D. THE FUTURE OF APPLIED RESEARCH IN BELGIUM

62. This consideration must remain uppermost in the minds of those who are aware of the importance of research as a factor of economic development and are concerned with the prosperity of the country. Belgium has reached a point where industrial research must be given new impetus and supplied with new facilities. Scientific and technical evolution is progressing at an ever-increasing rate throughout the country; industry must keep pace with it, or risk regressing and ceasing to exist. Industry must direct its efforts more and more to manufacturing products of high quality and a technical nature, and to planning for an ever more distant future. The special fields in which the country's vital industries - ferrous and non-ferrous metallurgy, chemistry, electronics and metal construction - must concentrate their research activities are known and well defined. These efforts must supplement those required for the normal development of production units.

63. There is no stopping point in the field of present technical expansion; whoever stands still falls back, and research is one of the progress factors of capital importance.

64. Belgian industry assigns slightly more than fr. 3 billion to research and development; there is, however, a limit to the efforts that can be expended, and many firms, even among the leading ones, appear on the verge of having reached it.

65. The need for increased aid to applied research on the part of the public authorities is no longer a matter for discussion - it must be met. In all industrialized countries, in whatever form the firms are established, the Government sets aside ever-increasing sums to help industry in research work at all levels. To overlook research would be tantamount to dooming industry to retrogression and to the loss of its position on the European market, with all ensuing social consequences.

66. Over the last few years, the public authorities have taken important steps to help research. The amount of sums assigned to research in general has more than doubled over the last five years (from fr. [illegible] billion in 1959 to fr. 4.5 billion in 1963).

[illegible]. It is important, however, that in the Government's assistance to [illegible] a balance be established between broad research and oriented [illegible] harmoniously apply to the cultural and economic development of the country.

[illegible]. Science cannot survive through vain efforts for prestige: a country [illegible] above all live and prosper.

[illegible]. Government aid to industrial research may assume very different forms in other countries. This report on research activities in Belgium is intended merely to illustrate what has been achieved with relatively restricted financial means, but making use of all available resources.

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III. INDUSTRIAL RESEARCH INSTITUTES FOR SERVING MANUFACTURING INDUSTRIES

Prepared by P.C. Trussell*

1. Since this Seminar is concerned with "industrial research", it is appropriate to define the term in a general way. Any research, basic or applied, which produces results of value to industry can be classified as industrial research. Certainly all applied research depends on scientific knowledge acquired through basic research. However, for the most part, industrial research is applied research, or "end-product research", in which the end results are of more concern than an understanding of the means or the theory. Ideally, the results should be produced quickly and cheaply. The user, the industrialist, frequently is totally uninterested in the research part; his interest is only in the exploitable results.

A. The research institute in relation to the industrial environment

2. It should be clearly understood, from the outset, that the establishment of an industrial research and development institute does little in itself for the setting up of industries in a country. For the industrial development of a country three ingredients are essential: capital, sound management and skilled workmen. The presence of natural resources is a valuable asset, but is not always essential (for example, Switzerland and Japan), and the amenities of climate and a stable government are highly desirable. Markets, either internal or external, are of course essential for the success of any industry. Although many scientists and engineers would like to believe that industrial research and development is responsible for initiating industries, it has been the evolutionary pattern in areas undergoing industrial development in recent times that industry comes first; later, and generally only when competitive and sociological forces demand changes, industry turns to scientists and engineers outside their plants for assistance. This does not mean that no new industrial developments result from industrial research and development each year, but that these new developments are arising in highly developed industrial areas where the demand for the new processes, equipment or products is high. It is also in these highly industrialized areas where most extensive basic research is done.

3. Since it is the industrialist who is intended ultimately to use the services of an industrial research institute, the first consideration in the planning for institutes must be the industrial and economic environment which the institute is to serve. This environment must predicate the forms of the scientific assistance to industry if the institute is to be useful. This will mean that the services useful for one area or country will differ from those of another. Also, the methods of scientific assistance useful at one stage of a country's development will have to be extended and added to as the industrial environment (and its demands) change. Thus, the structure and services of a scientific assistance institute should be adequately flexible to meet the industrial changes.

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* Director, British Columbia Research Council.

In practice, this means that the institute should ideally begin simply in structure and operation and become progressively more complex to meet the increasingly sophisticated demands of industry.

4. From this preamble it can be appreciated that no fixed recommendation can be made for a technical assistance institute for any particular country or section thereof. Certainly the tendency in many cases has been to provide an institute that is too elaborate for the immediate demands of industry. The subsequent effect has been one of annoyance when industry seemingly does not take advantage of all the services being offered. At this point, research people seem to feel that industry should be catering to their demands, rather than them catering to industries'.

5. In the more highly developed countries of the world industrial research is, to a large extent, predicated on reducing the cost of labour in manufacturing processes or in protecting or extending the market of one commodity in competition with others or potential substitutes. These research outlooks may have no part in countries at lower levels of industrial development. Very often there has been a glamourizing and exaggeration of the need and application of research far beyond what is realistically required in a new industrial environment. Certainly in countries with little modern industry, the establishment of institutes to carry out complex industrial research is an unnecessary expense. Such institutes are apt to become the havens of highly educated scientists who have returned to their native country and wish to continue undisturbed the basic research programmes of their post-graduate training. Any industrial significance of these programmes is completely incidental.

6. For countries embarking on a programme of industrial development, the first need is to establish skills in their people - skills at performing tasks related to the conversion of their natural resources to products of value in the world's markets. That the most efficient labour-saving methods are not employed is not too important; in fact, a high involvement of labour at the outset may be advantageous. In the course of time, however, the cost of labour will become an increasingly important factor as the national standard of living increases and labour costs go up. This will call for manufacturing techniques to be as efficient as those in the established developed countries.

7. Skills for industrial manufacturing are of no value without capital for establishment of industries. Whether the financing comes from private or government funds, or both, is of no great moment as long as the money is effectively and efficiently spent. Human nature being what it is, the greatest efficiency usually derives where the money is being invested by the private sector, although the industrial exploitation, without controls, may not always be in the best public interest.

8. In the early stages of industrial development, the technical need exists in the form of advice and information. Governments are advised to establish scientific secretariats to advise the current Government on technical matters bearing on the development of the country. A director of the secretariat and his assistants should not be political appointees but permanent civil servants (contingent upon technical ability and performance). In addition, a technical information office, set up as a separate institute from the Government, but initially and completely financed by the Government, fills the need of supplying technical information for the industrial and urban development of the country.

This institute should establish liaison with [illegible] information offices in other countries and should have a staff of [illegible] who would have the duties of obtaining the technical information and [illegible] contacting parties within their own country for whom the information is intended.

9. The first industries to establish in a [illegible] country should be those for which the research has been done and for which technical information exists - food processing and preserving plants, pulp- and paper-mills, mining and smelting operations, fish canneries and freezing plants, hydro-electric installations, oil drilling and refining, textile industries, building materials, sewage-treatment plants and so forth.

10. The establishment of a technical institute with laboratories should be delayed until the time when technical problems within the country are not being adequately met by the existing information facilities and by the technical staffs of the industrial firms. Although the laboratories may be planned with the object of industrial research, initially they would be used for testing and trouble-shooting serving both the private and public sectors of industry and urban development. The technical information service should continue to be financed entirely by the Government; where the laboratories are used to solve problems presented by private industry, the cost of the work should be underwritten by private industry.

11. As the industrial development of the country proceeds, the time would finally be reached when the institute would move into a third phase, that including applied research. Very possibly, at the early stages, the institute itself would be required to establish the areas of applied research and this period would have to be underwritten by Government funds. If the areas of research had been judiciously selected in relation to the industrial development of the country, industry would become interested, as time goes on, in those programmes which showed commercial promise and would underwrite their cost.

B. Twenty-year history of an industrial research institute

12. The operation of the British Columbia Research Council (BCRC) during the first twenty years of its existence is briefly described below. In giving this account, it is the author's object to relate the Council's mistakes as well as its successes, so that planners of similar organizations may profit by them. It should also be noted that the mistakes which have been made have not been so much those of an individual, but rather of a group of people not being sure how to do something they had not done before.

13. The Council was established as an industrial research institute to assist and further the industrial development of British Columbia on 29 May 1944, and was registered under the Societies' Act of the Province of British Columbia. By constitution it was given a policy-making group, the Board of Management, comprised of seventeen men appointed from industry, the University, the Federal and provincial government services (technical), labour and the National Research Council of Canada. The Board is self-perpetuating and each member can serve a maximum of two three-year terms consecutively.

14. Under the Board of Management are the Technical Director and his technical staff, all of which are responsible to the Board of Management. In practice, the Board of Management confines its attention to policy matters, such as the

approval of staff appointments, staff salaries and [illegible] and formulates broad policy matters. The technical [illegible] of [illegible] is left to the Director and his staff.

15. At the time BCRC was established, two or three private firms had [illegible] research facilities within the Province of British Columbia, but no research facility, either public or private, was carrying out scientific work [illegible] on a confidential basis. However, agricultural stations and laboratories, fisheries and forest-products laboratories (all under the Federal Government), were operating in the Province. These agencies, together with the Department of Mines in Ottawa, were carrying out research programmes on a longer-term basis, instituted by the organizations themselves. One tie-in with research did exist in the Province, that of the Technical Information Service of the National Research Council at Ottawa. This was comprised of one man and a secretary.

16. In 1944, the primary industries of the Province were forestry, agriculture, mining and fisheries, in that order. Secondary industries were not highly developed and, except for ship-building during the years of the Second World War, manufacturing of secondary products was relatively small.

17. The first important decision that had to be made was whether the new organization was to limit its operation to canalizing technical inquiries and providing information to meet these - or whether laboratories should be part of the operation. Probably, in the enthusiasm to launch the new organization, the structure was too ambitiously conceived. This is not unusual. The name selected was the British Columbia Scientific and Industrial Research Council, a mouthful in words and intent. The name was shortened to British Columbia Research Council a few years later, but in point of fact, it did very little research for many years, and the best research it has done has not been related to the provincial economy. These and many other mistakes have come about mainly through inadequate planning. At this point it should be emphasized that research organizations should be given just as much purposeful direction as business operations that must stand on their own feet financially.

Mistakes in planning and operation

18. Some of the Council's failures through the years are outlined below.

Too ambitious structure at the offset

19. The technical information branch, with one or two men visiting industrial firms, was sound and the liaison between the British Columbia Research Council and the University (library and staff) and with the National Research Council (Technical Information Services Division) was productive and meaningful. But rushing into laboratory work in chemistry and physics was not. The first stage of the institute should have included only the Technical Information Service Division and senior technical men for areas of physics, chemistry, biology, engineering and industrial economics. Only after these men had received demands for technical work from industry, or had set up research programmes directly related to local industrial problems (the solution for which existed a strong industrial demand), should additions to the technical division have been permitted. Failure to follow this rule has meant that a large number of able technical men have entered and left the organization over the years, simply because these men did not have a specific job of work to do when hired.

20. This pitfall can be avoided by [illegible] programme and then hiring the men - not hiring the men and [illegible] upon the programme.

Unsuitable selection of men for senior positions

21. The men themselves were of high calibre, but their interests were academic rather than industrial and therefore they were very inappropriate choices for the intended role of the institute.

22. The research personnel of an industrial research institute must be carefully selected, not only in respect of technical ability, but also with regard to personal interests in applied research. This is particularly true when the institute is small, when there is no place for a scientific "prima donna" who is unwilling to mix with the mud and the mire of an industrial problem - who hesitates to have first-hand acquaintance with industrial problems as they exist. In short, industrial research is not an ivory-tower pursuit, either physically or technically.

23. Another feature that is essential in the early stages of a technical institute is the technical versatility of its senior staff. Problems arise from a great variety of quarters, and these must be dealt with by relatively few people. Thus, the senior positions call for men with sound judgement that are technically well-grounded, versatile in the application of their basic knowledge, able to advance practical solutions to industrial problems and capable of preparing concise, accurate reports.

Too complex an organization

24. After BCRC had been established with divisions of physics, chemistry and engineering, and with technical personnel standing ready for action, committees were set up to recommend areas of research - committees on forestry, fisheries, agriculture, mining, roads and highways, and so forth. These committees proved of little value; often they were used as a spring board for people with pet ideas. Substantial amounts of monies were spent fruitlessly on research programmes that were poorly conceived, poorly directed and had no practical industrial value.

25. What all this proved was that the responsibility for organizing the research programmes lies with the director and his senior men. To try to shift this responsibility to someone else means loss of time, money and often valuable personnel.

The introduction of "star players"

26. A further outgrowth of the lack of senior personnel to accept the planning responsibilities described in paras. 21-23 has been to bring into the organization men who are highly qualified researchers but who are specialists in areas bearing no relation to the industrial economy, in fact, people having little or no interest in industrial applications of research. There have been two cases where such men have established successful teams of scientists, only to leave when the limitation of our organization, as a [illegible] research institute, is realized. The teams and programmes have, of course, disappeared with them.

27. A man is only good if he is [illegible] for the institute and for fulfilling its purposes. The responsibilities of [illegible] the [illegible] environment in which

the institute is located, and in formulating the programmes to [illegible] responsibilities that must be invested within the institute itself [illegible] onto the shoulders of outstanding scientists and engineers brought in from the outside. True, these scientists and engineers will set up research programmes, but they will be their own and any connexion between the institute and the industrial environment will be merely incidental.

More over-organization

28. In addition to the advisory committees, the Council of the British Columbia Research Council was established under its Constitution; this was a group of about 200 businessmen, scientists and engineers in the community who were intended to give support to the new institute. It was intended that this group would cause industrial research demand in the community to expand. However, industrial research demand does not expand through friendly conversations; industrialists create the demand for financial reasons and the best means the research institute has of appealing to the industrialist is by demonstration of results. This demonstration may be in the form of an expeditious piece of contract work for an industrial client or by coming up with a sound piece of practical research as a result of in-house programming.

Failures in programme selection

29. A short survey of the industry by half a dozen senior personnel when the Council was newly established would have revealed that a demand for technical information and for trouble-shooting existed in local industry; that the economic development of the industrial environment would not support a research programme financed by the local industry; and that any research would have to be carefully planned by the institute staff with an eye to gaining financial support of the programme by industry when industry could see their practical value. This approach would have eliminated many programmes which aborted before fulfilment.

30. Over the years many attempts have been made to utilize waste from the local forestry industry. Much of this waste arises in the lumber mills. Looking back at this time, research into methods of obtaining a higher percentage of lumber from the logs, thereby reducing the waste, would have been a more practical approach than trying to find uses for the waste itself. As it is, methods were developed for the production of gas from wood, a hardened floor-tile, a hardboard for walls and charcoal. All of these processes, some of which are quite sound, still have no industrial application at the current time.

Solution of problems of programming

31. The Council's answer to research programming has been to consolidate its efforts in relatively few areas - at present its largest technical division is working on only three projects: marine borers, biological oxidation of metal sulfides and industrial-waste treatment. All these areas of research are related to the industrial development of the immediate area. Initially, almost without exception, these projects were financed completely as in-house programmes. At an appropriate time, dependent upon research success on a project and the timing in relation to industrial demand, industry has been induced to undertake the financing of each programme. One of the more recent programmes handled in this way relates to the bacteriological leaching of metal sulfide ores. This programme began as an in-house research study in 1955 and it was not until mid-1963 that

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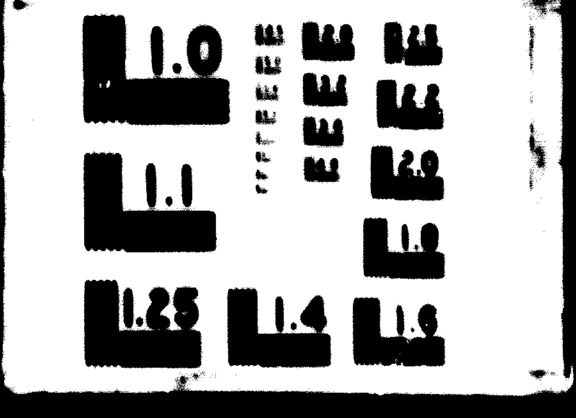

[illegible] financing [illegible] support [illegible] for two reasons: first, BCRC [illegible] in the field [illegible] [illegible], the [illegible] market was [illegible] to invest in research of this type. During [illegible] pledged support of 75,000 Canadian dollars per annum to support [illegible]. Only four of these companies have offices in British Columbia, [illegible] others are undertaking exploration and development programmes within the [illegible]. As in many other BCRC research programmes, the potential returns from [illegible] will find application not only in the Province of British Columbia but [illegible] in the world. The Council realizes that there are no geographical limits [illegible] application of research industrially, and in so far as the results of its research [illegible] to have application and benefit to the local economy the Council feels that the programmes are justified.

32. The technical information service, sophisticated testing, trouble-shooting and research programmes requested by industry are all included in the Council's present operations. But now the main emphasis is being placed on the longer-term programmes that are integrated into areas of interest to British Columbia's industry. These programmes are intertwined within the organization and carry on from year to year; they do not disappear if any senior personnel should leave. These programmes are constituting the areas in which the Council is gaining an international reputation for achievement and to which industry is turning and paying for an increasing volume of technical aid.

Financing of research institutes

33. In environments other than those having a well-developed secondary industry, financing in the initial stages must come from the Government. Once the annual grant has been set, the institute should budget its expenditures and strive to set aside reserves for meeting contingencies and for expansion. Accumulated reserves should in no way cause the Government to fail in its obligation to continue its support. There is a tendency in Canadian government departments and in academic institutions to return unspent surpluses to the general fund at the end of the fiscal year or to appropriate [illegible] money [illegible]. This practice discourages economy and interferes with long-term planning. [illegible] that money spent on equipment and especially on personnel (certainly the most costly item) can be metred on a fiscal basis. The institute should [illegible] to operate with a surplus and to show responsibility and maturity in the [illegible] aspects of its operation.

34. The BCRC commenced with an annual grant of $40,000 in 1944 and this rose quickly to $160,000 by 1948. In the following years the grant increased to $[illegible]60,000 (1964), but during this time the salaries increased 2.6 times so, since salaries constitute 75 per cent of the cost of operation, the dollar value of the grant in terms of 1948 is currently about $160,000. From this it can be seen that the effective government support rose very rapidly during the first years and then levelled off.

35. In its operation BCRC is [illegible] rewards through its operation do not [illegible] that [illegible] in its offices for individual [illegible]

cover the complete cost of the work. No charge [illegible]
information given verbally or in letters or short [illegible]

36. The rate of charge is based on the direct cost [illegible] carrying out the work, plus 110 per cent to cover [illegible] incidental supplies and general operating costs. In [illegible] operation, all projects, including those originating in the [illegible] are given individual project numbers and all personnel [illegible] charging their time against these projects. In this way the [illegible] established each month for each project and invoices are submitted [illegible] projects. The dollar volume of industry-sponsored work [illegible] until by 1957-58 it matched the government grant. The Council [illegible] operating with an annual income of $1 million and 75 per cent of this [illegible] from sponsored work, mostly from industry.

37. How is the government grant money used? Briefly, expenditure falls into the following divisions: (a) technical information service; (b) subsidizing small projects, particularly for small companies; (c) carrying credit for people or companies whose new businesses are not currently returning money; (d) new equipment; (e) financing "in-house" projects and developing new areas of competence; and (f) expansion of buildings.

38. Because the demands for money for all the above items are not consistent, the annual carry-over of a surplus is necessary, as mentioned previously. BCRC is currently carrying a total surplus of about $350,000. Much of this will be used for building expansion, which will cost about $1 million.

39. Currently only two research institutes in Canada operate on a basis of partial government support, the Ontario Research Foundation and BCRC.* Four other provinces in Canada have research councils and most of them have laboratories, but all of these are financed entirely by the Government. It is the author's considered opinion that industrial research organizations operate more efficiently when a part of their funds is obtained from private industry. When the progress and development of an industrial research institute are dependent upon industry, the institute is obliged to keep the interests of industry uppermost in its planning and operations. The institute also has to think twice before it commits money for research programmes. This is good, as research is an extremely expensive operation. It requires very expensive personnel and costly equipment with a high obsolescence rate on jobs that have very speculative chances of success. In short, a good research organization represents the most profitable expenditure of money. Support of poor research is one of the fastest ways to waste money.

C. Organization at the technical level

40. For purposes of organization, divisions based on scientific disciplines are necessary. BCRC has divisions of applied biology, chemistry and chemical engineering, engineering, physics and technical services, which include information service, operations research, market research and feasibility studies. However, in the performance of projects, either testing, trouble-shooting or research, integration of the disciplines is essential. If this is not done, one of the main virtues of having such diverse talents under one roof is lost. However, in having a team approach on projects the responsibility for the project

[illegible]

[illegible] BCRC has found that one of the most difficult [illegible] at both the intermediate and the senior [illegible] is the [illegible] accurate, concise reports. Since all projects are finalized [illegible] the importance of reporting cannot be over-emphasized. [illegible] one of the most difficult and rare qualities [illegible] original creativity, the very core upon which the organization depends. The author [illegible] way of finding men with this quality.

D. Operation in relation to other groups

42. At the technical information level, BCRC has had very close liaison with the National Research Council in Ottawa. The National Research Council not only contributes to the technical information service group at BCRC, but also pays the salary of an industrial engineer whose full time is given to assisting local industry on a no-charge basis.

43. The Council's location on the campus of the University of British Columbia has both advantages and disadvantages. Among the advantages are the proximity to the large technical library of the University, the exchange use of technical equipment and the convenience of consulting with scientists and engineers on the University's staff. One of the main disadvantages is that industry tends to mistake BCRC for part of the University and is inclined to consider its function academic rather than industrial.

44. During the earlier stages of its operation BCRC did a substantial volume of contract testing work, particularly in chemistry, engineering and physics. The Council has followed a policy of encouraging local industrial firms to expand their facilities to accommodate this demand and now passes to them as much of this testing work as possible. For over ten years BCRC's laboratory undertook the Canadian Standards Association approvals testing on electrical fixtures for industry in western Canada. In 1963 a branch laboratory was set up to do this work under the head office of the Canadian Standards Association at Toronto, and BCRC was pleased to withdraw from this testing work. Currently the Council is handling the Canadian Gas Association testing on gas-burning equipment manufactured by [illegible] industry, but is looking forward to the time when this service also [illegible] carried on by another testing facility.

45. For many years BCRC undertook some projects on a joint financial basis. [illegible] might cover half of the anticipated cost, the Council the other [illegible] this was the agreement in effect. Generally, these split arrangements have been found unsatisfactory, as BCRC has usually ended by paying [illegible] the cost. Today the Council prefers to have the projects financed in [illegible] by the client, or [illegible]

[illegible] does not exc[illegible] [illegible] This has [illegible] particularly in the fields of economic research and operations [illegible] applied research programmes, it is also entering into [illegible] agreements with private firms in Canada and elsewhere, [illegible] exploitation of processes it has developed and patented.

E. Conclusion

47. In conclusion, the author would like to set forth the following [illegible] for consideration in the establishment of industrial research institutes [illegible] their operation:

(a) The industrial environment must first be assessed as to its technological needs;

(b) Initially, the institute would be a technical information supply-plant, making use of the results of research done elsewhere. This function should be more than a question-and-answer system; it should engage technical people who visit industrial operations and who supply information on up-to-date processes, equipment and products associated with the operations;

(c) Laboratory facilities should be provided to fit the industrial needs. Initially, these would probably be limited to testing, quality control and trouble-shooting;

(d) When areas of applied research related to the industrial development of the country have been assessed and decided upon, research programmes in these areas should be established. Programmes having early industrial value should be given priority;

(e) In selecting personnel, it is mandatory to have sound technical people with broad interests and with backgrounds in industrial research to fill the senior positions in the early stages. Although men with intermediate levels of training are suitable for testing and quality-control work, higher positions in research require senior men with more specialized training, assisted by skilled technicians;

(f) During the formation of the institute, care should be exercised to avoid over-organization. To ensure a good esprit de corps, all positions in the institute should have a real function and purpose;

(g) The director of the institute and his senior technical men should bear the full responsibility for the technical and administrative operation of the institute. It is particularly essential that the long-term research planning should be done by this group of men;

(h) The need for eventually establishing areas of research competence associated with the main industries of the country should not be overlooked in the day-to-day handling of service and test work;

(i) The institute should be free from political interference;

(j) Financing of the institute would have to be carried out mainly by the Government at the start; private industry should be required to pay for work done to meet its particular needs. Even after [illegible] substantial, however, government support should be maintained [illegible] research into new areas of industrial development [illegible]

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IV. ORGANIZATIONAL FOR[illegible] INDUSTRIAL RESEARCH A[illegible] IN DEVELOPING COUNTRIES

Prepared by Francis [illegible]*

Summary

The various methods of organizing industrial research and development facilities are examined critically from the standpoints of: (a) the need to make most efficient use of limited resources and trained personnel, and (b) the importance of providing realistically the range of practical research and technical services on which factories and industrial investors of a developing country may depend.

In practice, most of the technical problems encountered cannot be handled adequately by laboratory research alone, but demand a combination of closely interdependent services which are therefore best provided together. While the individual problems vary from country to country, the types of service required for them are much the same and include feasibility studies, vetting of investment projects and their redesign when indicated, pre-project planning and pro forma costing, applied scientific research (on new or improved products, by-products, raw materials, cost reduction, adaptation problems, etc.) plant location, factory layout, materials handling, standardization, testing and quality control, trouble-shooting, production costing systems, library and information services, and the full modern spectrum of production engineering and technical management counsel.

To be wholly effective, these services must be readily available locally and fully identified with the local interest. For this reason, among others, regional institutions serving groups of countries are less likely to meet the need adequately than national institutions.

National facilities in operation today range from the broad multi-purpose institutes of some countries - which provide all the services working together in concert like those of a first-class medical clinic - through a variety of [illegible] function patterns of others often requiring partial help from several different institutions on the same problem, down finally to the extreme fragmentation represented by ad hoc assortments of narrowly specialized institutes, each interested in a very limited field or perhaps only a single industry or product.

It is shown that to provide the same over-all service, moving progressively down this series towards the more specialized institutions, increases costs, duplication of facilities and total numbers of trained staff required. The [illegible] integrated institutes permit the greatest benefit from the modern interdisciplinary

* United Nations Special Fund Project Manager designate, [illegible] Industrial Research Institute.

[illegible] or [illegible], [illegible]
[illegible] personnel, [illegible]
smaller, limited-[illegible]
the most expert and [illegible]
interest institute of [illegible] kind.

Proper planning [illegible] industrial [illegible]
with small details than with [illegible] direct
effective service possible. The important elements [illegible]
and hold the most competent personnel [illegible]
financial and operating procedures [illegible]
and (c) confidence of the business community that [illegible]
manufacturing secrets will not become public information [illegible], these
competitors. Although the Government usually [illegible] directly,
three basic requirements are especially difficult to meet in an operation
administered by the Government under its established rules. In successful practice
to date, the customary solution to this dilemma is to establish the institute as
an autonomous non-profit corporation under its own governing board.

Generally, government financing help is needed for such an institute's original
capital investment and also for much of the early operating expenses. [illegible]ecial
services offered free in the public interest logically should be supported by the
Government. But on the whole, both government and private enterprises should pay
fair charges for technical services rendered, for the services are [illegible]
profitable to the user. Moreover, free service is seldom valued [illegible] and is more
likely to be wasted.

Close working relationships between such an institute and an industrial
development bank are advantageous to both, and an interlock at corporate board
level is useful. However, this is perhaps the only case where such a direct tie
is justified in practice; with other technical institutions the natural informal
relationships at professional working level are quite effective, and there is no
particular need for any official co-ordination between them. Although sometimes
suggested for certain supposed advantages, merging the functions of an industrial
research institute with a university is not successful, and every attempt has
eventually ended in separation.

As far as industrial research is concerned, high-level national co-ordinating
councils and inter-institutional committees are of little use, as the work must be
determined mainly by the clients themselves and much of it is confidential
anyway. If the object is to avoid wasteful duplication, any effective
co-ordination must be preventive rather than corrective: the aim must be to
control the independent efforts and enthusiasms of various agencies so as to
prevent the creation of needlessly overlapping projects and institutions in the
first place. It is in every developing country's best interest to maintain its
own powerful control [illegible] to exercise this function, preferably through the
Ministry of Finance where the purse-strings lie, if [illegible] waste of
the country's limited technical resources.

Introduction

[illegible] research
and development [illegible], even
[illegible]
[illegible]

2. The questions are timely, [illegible]. For [illegible] the 1964 Beirut International Seminar, the United Nations Centre for [illegible] Development deserves commendation for such a comprehensive effort [illegible] it. Already nearly a score of the developing countries, together with [illegible] and agencies, are investing in institutes of one sort or another, all [illegible] to perform for industrialization the role stressed by economists [illegible] a pre-condition for take-off: "To get the rate of investment up some[illegible] the society must be able to manipulate and apply - and in a closed society they must be able to create - modern science and useful cost-reducing inventions". 1/ But the methods differ, and since the limited technical resources seldom permit trying several ways at once, at this stage each country is largely dependent upon whatever type of institutional instrument it may have selected. Whether in each case it truly fulfils that role - or is even capable of it - is important to know.

3. The money spent on the institute itself is the least of what is at stake. The more important concern, along with the allocation of scarce technical personnel, is the allocation of function: in other words, the gamble that the country has selected the right type of institution. One has to reckon the cost to the country's economic progress if even a few industries fail or fall behind, or a few potential new ones fail to materialize, chiefly for want of the technological insurance or catalysis that a fully effective institute might have provided.

Background

4. This discussion does not concern the scientific and technical work by itself, but, rather, its organization for a very specific purpose. It may come as a surprise to some that this Seminar is dealing with a comparatively new field, not only for the developing nations but for all countries. True enough, the applied researcher or inventor gave the world the stone hatchet, the wheel, the industrial revolution, the telephone, the airplane and the zipper. But one honours individuals, not research institutes, for these and most of the other scientific leaps that have altered people's lives up to recent times. Organized industrial research, as it is currently known, was still in its infancy no more than fifty years ago; in fact, most of its phenomenal institutional growth in the major industrial nations has occurred since the mid-1930's, when the broad mixed-group approach began to take hold.

5. In the developing countries, it is mainly within the last dozen years that general industrial research institutes have begun to be introduced at all. Some published national development surveys recommended them as early as 194[illegible]. 2/ and at least one promising independent start was made at about the same time in Sao Paulo, Brazil. Probably the first to operate on the present-day pattern was launched voluntarily by a visiting research team in Mexico City in 1947, and soon afterward another was organized by the private industrialists in Monterrey, Mexico. But despite these prototypes, little more than a decade ago the role of such institutions as industrial growth catalysts had not yet been recognized by public development agencies or technical assistance organizations. In this the turning point came only in 1951, with the first of a series of recommendations by World

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1/ W.W. Rostow, The Stages of Economic Growth (Cambridge, Cambridge University Press, 1960).

2/ F.W. Godwin, J.A. Hopkins and J.A. Shellenberger, Technological and Economic Survey of Argentine Industries (Buenos Aires, Corporacion para la Promocion del Intercambio; Chicago, Armour Research Foundation, 1943); F.W. Godwin, M.E. Nelson and R. Villasenor, Technological Audit of Selected Mexican Industries (Banco de Mexico, S.A.; Chicago, Armour Research Foundation, 19[illegible]).

[illegible] economic survey, which [illegible] institutes in a number of countries [illegible] industrialization. 5/

6. Thus, in the matter of institutions [illegible] to some extent. [illegible], that [illegible] improvement of technique, [illegible] blue print to fit all developing countries [illegible] more than this, because of [illegible] technically advanced areas, it has been [illegible] successful transplanting of this rather complex [illegible] countries of origin - a field of endeavour [illegible] profession in itself. Considering, however, that [illegible] and that all efforts to date are available for critical study, [illegible] true that every new venture in this field must be regarded as a [illegible] experiment. There is more to learn, but practical experience is [illegible] body of basic principles through which needless retracing of [illegible] can be avoided.

7. Some of these principles will be noted in what follows, although space permits only brief discussion of a few of the more prominent aspects. [illegible] is written from the professional point of view, to contribute some thoughts and findings on the introductory question, clearly the purpose would not be served by a mere studiously impartial catalogue of the various alternative institutional approaches tried. A more useful, positive contribution at this stage, it is felt, must offer something as helpfully decisive as available experience will allow, and must therefore contain elements of considered professional opinion and observation.

A. The job to be done

8. Since organizational form and operating method are likely to depend upon exactly what an institution is supposed to do, it will simplify matters if this question is reviewed first. The over-all aim is to further the development of industry through the medium of research and technology, but how? What specific services are to be undertaken, and for whom? [illegible] programmes differ everywhere.

9. If one asks instead what is needed, one is on firmer ground. Special local conditions notwithstanding, all developing countries are seeking essentially the same thing in their industrialization programmes: more local manufacturing, greater diversification of products, more efficient production, better competitive position. All are seeking to mobilize more financial capital for the purpose, and want to make their investments go as far as possible. Likewise, in the fulfilment of Professor Rostow's technological pre-condition, all developing countries at this time face essentially the same handicap and for the same reasons, any differences being mainly in degree. On the whole, therefore, the [illegible] to be filled is also similar.

5/ International Bank for Reconstruction and Development, Report on Cuba (Baltimore, Johns Hopkins Press, 1951), pp. [illegible] to [illegible]; The Economic Development of Ceylon (Baltimore, Johns Hopkins Press, 1953), pp. [illegible] to [illegible]; The Economic Development of Nigeria (Baltimore, Johns Hopkins Press, 195[illegible]), pp. [illegible]; The Economic Development of Malaya (Baltimore, Johns Hopkins Press, [illegible]), pp. 451 to 4[illegible].

10. [illegible] for the particular [illegible] industrial investors (including Government [illegible] countries, fortunately, [illegible] identified in country after country [illegible] direct examination and inquiry of count[illegible] authorities, private investors and [illegible] practical "consumer-demand" experience [illegible] and similar agencies already operating [illegible] absence or inadequacy actually retard [illegible] make a sizable list.

11. From idea to finished product, the need[illegible] services [illegible] technical and market feasibility studies, examination [illegible] industrial investment projects and their [illegible] planning and pro forma costing, applied scientific research [illegible] products, by-products, reduction of costs, use and adaptation [illegible] materials, adjustment of processes to special local production [illegible] economic plant location, efficient factory layout, handling [illegible] standardization, testing and quality control, technical [illegible] production aids, production costing systems, technical information [illegible] services, and the full modern spectrum of production engineering and [illegible] management counsel.

12. Wherever determined by expert study at the source, this list [illegible] technical needs is always virtually the same - for it is not governed by local policy, but only by what it takes to develop and operate modern industry successfully anywhere, and by the natural shortage of these specialized technical resources, that invariably characterizes a country in the early stages of industrialization. It has been uniformly found, furthermore, that all these services need to be readily available locally, quite irrespective of the fact that some of them can also be obtained from abroad for particular assignments from time to time. The reasons for this last point are too numerous to detail here, but chief among them are immediate professional familiarity with the local scene, an unquestionable identity of interest with it, elimination of costly delay when the services are needed, and the assurance that their competent presence gives to the very prospect[illegible] industrial investor. The point is made clear if one thinks of this complex of technical [illegible] as the "research hospital and general medical services" responsible for the health and growth of local industry - and the analogy can be carried quite far in other directions as well without being very wrong.

13. In applied research, incidentally, the need is as much for the [illegible] of unpredictable original ideas generated by the research [illegible] as for the prosecution of work requested or selected by others. [illegible] in the latter category, much of the needed research is on problems to be encountered [illegible] to an institute by the industries themselves, who are generally in the best position to know what they are hoping to do or what seems to be troubling their operations. As a rule, this leaves only a smaller number of the research problems [illegible] may need be, or for that matter should be, pre-selected for an industrial research institute by its founding or controlling authorities; such problems, [illegible] logically tend to be ones of broad application and most often constitute Government-sponsored research projects.

14. In such pre-selected work there is somewhat [illegible] real justification for emphasis on certain much-discussed types of research [illegible] For example, one aim, plausible enough [illegible] often [illegible]

uses for local materials". [illegible] reflect [illegible] nations need, first of all, a diversity [illegible] of industrial production that may be feasible [illegible] market. Second, [illegible] opportunities [illegible] through a disproportionate diversion of the limited [illegible] spectacular attempts to invent [illegible], [illegible] newsprint from corn husks, or plastics from temporary surplus crops. [illegible] uses for local materials are well worth looking for, but seldom [illegible] a country's early industrialization depend on finding them. Some of the effort might be better employed in bringing the existing industries [illegible], or in solving [illegible] immediate technical problems that may stand in the way of manufacturing locally certain commonplace products now imported.

15. It is worth emphasizing that the need for technical and techno-economic help in examining the soundness of proposed industrial schemes implies a no less important need for help in reshaping them when indicated. Experience of industrial development banks shows that many proposals, particularly those of the smaller companies, require a great deal more work before they can properly be considered for financing. 4/ If there are no competent technical facilities for this, the bank's own effective contribution to development is reduced; for, as they stand, there is little a bank can do with such proposals but reject them, although at the core some may actually be sound enough. Others that are unsound, and quite properly rejected, may be capable of revision into something a little different and bankable. A developing country cannot afford to dismiss summarily such potential entrepreneurial ability if there is any way to salvage it.

16. These, then, are the outlines of the role to be filled by an industrial research and development institute, or some equivalent, in a developing country. Those to whom the services need to be made available in most countries include government offices, State-owned factories, private industrial firms and investors, development banks and other lending agencies; they may also include various special bodies like public utilities and autonomous regional development agencies, or others to whom such services can be useful at times. Here is the job to be done, however each country may elect to go about it.

B. The choice of institutional pattern

17. Not surprisingly, the recent experimental years have seen in various developing countries, more or less simultaneously, a diversity of approaches to the task. The relative importance assigned to the several services needed - even their recognition or omission - has in each case been influenced in the beginning by local concepts, by how thoroughly the problem was studied beforehand, by the concepts and differing central fields of interest of the various specialized technical assistance agencies and, inescapably, by the breadth of the individual backgrounds of expatriate advisers often involved. Some local institutions have been roughly patterned after operating [illegible] abroad, which, themselves, may

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4/ International [illegible] Development, [illegible] Policies and Practices of Development Banks [illegible] pp. [illegible]-101, [illegible] 19[illegible].

actually represent different past stages or recessive theories in the [illegible] evolutionary advance of modern research organization. In some countries, parallel but unco-ordinated efforts of different agencies have yielded both duplications and unfilled gaps. In others the situation is more favourable. The [illegible] wide assortment of institutions variously designed and administered, serving either a broad or restricted clientele, and offering either all or [illegible] some limited portion of the needed services - sometimes appended to other activities outside the scope of the present discussion.

18. These institutions are also known by a possibly confusing variety of names, but here this paper will avoid fine semantic distinctions and discuss them in terms of actual function. From this standpoint, it is immaterial whether a technical service organization is called an industrial research institute, a productivity centre, an industrial development institute, an industrial extension service or something else. Although in some ways the implied operations are not always identical, they overlap to a large degree, and in practice there are no universally accepted definitions or boundaries for any of them. For example, in this field it is seldom practical to regard "extension service" as a distinct, separable activity, since it is so much an integral part of the regular staff work in applied research as well as in the advisory services. Likewise, "productivity", a broad term sometimes inaccurately appropriated for a narrower meaning, is obviously one of the most fundamental concerns of the entire technical role expected of any such institution, whatever its type.

The broad industrial research institute

19. A complete single institution to discharge this role competently will provide all of the listed services working together, like a first-class medical clinic, bringing to bear on the problem of each "patient" whatever combination of them may be required for complete diagnosis and solution - and fully prepared to deal at once with any unexpected complications that may have set in. There are already a few such institutes in the developing countries; in leading industrial countries there are many, with almost the same list of services (certain services being less needed because of the wider national dispersion of experienced technical personnel). Although, strictly speaking, their work is not entirely research, to the industrial and business world they are most often what is meant by the term "industrial research institutes", since they have become the best-known form of institution using the term. In United Nations parlance, they are sometimes referred to as "multipurpose institutes", to distinguish them from the several more limited types.

20. Such an institute not only offers all the services, but undertakes work for all kinds of industry and in all the pertinent branches of science and technology. It therefore maintains a wide range of physical facilities and a highly diversified staff, which permits it to make the most of the interdisciplinary team-work principle in solving problems, and also makes a more comprehensive array of equipment economically available to each individual problem. These are tremendous advantages, both in finding solutions rapidly and in doing so at the lowest cost; and this in turn, in a developing country, produces the secondary advantage of inducing more voluntary use of the needed technical services by industries not previously accustomed to this form of expenditure as a normal business cost.

21. A factor that has contributed to the growth of this type of institute is that seldom does an industry's problem lie wholly within one field. It is rare, in fact, that even a purely scientific problem lies entirely within a single field of science, and even if it does there is no assurance that the specialist in that field will always be the one to have the first idea for its solution. But in a developing country, especially, it has been found in practice that the greatest number of industrial problems involve a composite of several of the listed services, and their contributions are very interdependent and often indistinguishable. Many times the industry is not even aware of several of the contributing aspects until they are pointed out, and if the institute's knowledge or interest is confined to one field it is likely to miss them too. The importance of a composite technical service to investors is, if anything, more quickly apparent. To be of any practical service to an industrial development bank, an institute examining a proposed loan project obviously must be equally competent to deal with its scientific and its cost and production management aspects.

22. Anything offered as a broad technical service naturally must have, even at the outset, a certain critical mass of staff whose combined training covers a range of fields. For a country having a severe scarcity of trained technical personnel, this means putting quite a few of the best ones into one project. On the other hand, far from depriving other undertakings, their services thus become available to all and can be more equitably shared by those who need them - with much less likelihood of their under-utilization through narrow assignment or miscasting. And it is a well-established principle in this kind of work that the output of such a mixed group, using the team approach under good leadership, considerably exceeds the combined output of the same men working separately or in narrowly specialized groups. When one compares the broad industrial research institute with its alternatives - any of which must involve multiple institutions to do the same job - it is evident that the broad institution can make the most efficient use of scarce personnel. Not only is the potential output per man higher, but it takes fewer people to staff one institution well than to staff several at all, including the multiple administrations and other unavoidable duplications.

23. There are various other advantages to the multipurpose institute, only a few of which need be mentioned. One is that the local staff receives well-rounded in-plant training, and acquires a more balanced concept of modern industrial technology. Another is the greatly improved chance to discover the line in which the individual staff member can do his best work. In the physical plant there is far better use of costly equipment, since many of the same laboratory and pilot-plant pieces are required for problems in different fields, but are actually used only for limited periods on each job. Moreover, the broad institution, with its pooled support, can generally afford superior facilities which would be difficult for any one of a group of smaller or narrower institutes. As a notable illustration, one comprehensive reference library of industrial technology with a single unified card catalogue is infinitely more useful (and cheaper too) than a scattered assortment of smaller ones.

24. The foregoing refers to certain advantages of one kind of centralization. Most debate about the relative merits of centralization and decentralization stems from the fact that either can be overdone. The greatest advantage is usually realized at some optimum point, and in the present matter one finds no exception. The effectiveness of a multipurpose institute increases with the

breadth and completeness of its services, and even with sheer [illegible] yet there is a level - not of completeness but of size alone - beyond which productivity drops and overhead costs go up sharply. Since these tendencies can also be induced earlier by such contributory circumstances as an unfortunate choice of administrative method, this optimum level varies.

25. The problem is one that need not trouble any of the developing countries, however; so far it has not, unless for reasons other than size, because normally it is not encountered except when such an institution becomes very large. The truth is that the secret of its success, the mutual exchange and cross-fertilization of ideas resulting from men in many complementary fields working together, is effective only with close, informal day-to-day contact. It takes a very ingenious administration indeed to preserve this asset if an institution grows so large as to begin to acquire the familiar departmental barriers, intramural formalities and red tape that go with bigness. Bureaucracy is the mortal enemy of creative research - an enemy that must be kept in check even in a small institution. The team approach, above all, is a personal human thing that cannot be replaced by official channels of communication and inter-departmental co-ordinating committees. Happily, it has been observed that the problem seldom occurs until a research institute's staff grows to around 400-500, or several times the size likely to be reached in the coming years by a fully operating institute of this kind in any of the developing countries.

26. It is never really necessary to reach this problem stage. If and when indicated, a single institute can successfully introduce a degree of decentralization by operating a branch or two in strategic locations, each fairly broadly staffed, and with a certain amount of interchange of special work, equipment or staff for best service and economy. This is feasible within the reservations of the preceding paragraph, which implies that such a branch must be competently headed and allowed a fairly loose rein or the purpose will be defeated. Alternatively, when a country's rate of industrial development warrants more service than can conveniently be provided by one broad industrial research institute of workable size, there is no reason why it cannot have two or more, operating independently, again strategically placed in the areas of greatest industrial activity. Either solution involves duplication, but not wasteful duplication in these circumstances.

Dividing the functions

27. Some countries have developed a pattern of what might be called medium-breadth institutions, no one of which attempts to offer as complete a service as those just discussed, but whose respective fields are more or less complementary, so that when taken together they may cover all or at least the greater part of the needed services. In one or two cases, they may have been planned that way from the beginning. More often, it must be acknowledged, these patterns have simply grown piecemeal by the progressive appreciation of still-unfilled needs.

28. Typically, perhaps, the first step may have been the establishment of a general industrial research institute, but one designed in the confidence that the most urgent industrial requirements could be met almost entirely with a programme of scientific laboratory work. After some years of operation it may have become clear that neither the industries nor the industrial banks and investors were always able to get quite what they wanted, particularly on practical techno-economic questions and the business technology of production planning, and this may have led to the creation of another institution for this kind of

assistance. Later, with the appearance of another gap, there may have been a separate project to develop standards for industrial products, and perhaps yet another for something else, and so on. The pattern may or may not have been built in precisely this order in every case, but it has usually started with the laboratory functions.

49. An interesting point is that the piecemeal process is also just about the way the modern multipurpose institute first developed - except, of course, that at each stage the further related services were merely integrated into the original applied research institute structure instead of creating separate new institutions for them. In fact, to the extent that the integrating process was first carried out in certain of the large industrial nations, where the broad research institute originated, most of the services subsequently added in those areas were already separately available from consulting firms, and still are, but were found to be needed also in closer conjunction with the applied research work.

50. This paper does not speculate as to any country's possible reasons for having chosen the divided-function pattern. Doubtless they have been good ones under the particular circumstances, possibly compelling enough to override considerations of efficiency. The system is workable, and while for most developing countries it is less to be favoured than the multipurpose institute, it is probably the next best - so long as the divisions are few and do not dismember any of the principal categories of service. In such cases, it is essential that the separate medium-breadth institutions be in a position to work in close collaboration and very often on the same problem, which, of course, questions why they should be separated in the first place. There is some loss to each; the applied research suffers the most, as its direct link with the realistic business aspects of industry is weakened, and its work commonly tends to become a little less practically oriented. There is also a natural tendency for each separate institution to attempt to solve an industry's problem by the means available in its own field, and to avoid calling in the other except <u>in extremis</u> - a matter of pride which is not conducive to the most complete solutions and occasionally may even produce a wrong one.

51. A division of work now more rarely seen than in times past involves a separate, physically isolated institute for each different field of science: one for chemical problems, one for physics, another for metallurgy, etc. This has its roots in the academic approach, especially of an earlier day when the demarcation lines between the sciences were thought to be far more distinct than they are today. Traditionally, it is more closely associated with fundamental research, where it may persist longer, although the mixed-team approach is just as useful here and it is doubtful if in this age any important chemical research institute, for example, can operate successfully without its staff complement of physicists, engineers, microbiologists and others.

52. For applied industrial research and development, at any rate, a pattern of separate institutes for the different sciences cannot be recommended. One may safely predict that where such institutes already exist, each will gradually be forced to expand into the fields of the other until eventually they become a set of parallel broad research institutes serving their respective geographical areas. As mentioned earlier, experience has shown that the problems encountered in industrial research scarcely ever lie entirely within one field, especially if they are carried through to the point of practical production. Even if this were not so, a developing country seeking to accelerate its industrialization

could not afford to sacrifice deliberately the acknowledged advantage of the interdisciplinary team-work principle. Considering that this team-work advantage can be lost within a single institution if day-to-day personal contact is merely impeded, it is useless to expect it to be achieved between the staffs of separate institutions miles apart, regardless of any supposed co-ordinating mechanism.

33. One further form of medium-breadth institution of which there are a number of operating examples is a type designed to serve only industries below a certain size, but usually without restriction as to their nature. In this group there are some known as small industry research institutes and others called cottage industry institutes. The meaning of cottage industry is fairly well understood. The term "small industry", on the other hand, is at best a relative and arbitrary one; what one country classes as a small industry may look large in another.

34. So far as concerns the particular list of services discussed above, basically there is little to differentiate the technical needs of small, medium or large industrial enterprises. All can be, and are, served successfully by the broad industrial research institutes, and from this standpoint there seems to be scant justification for creating a separate institution to serve the small ones. The most distinguishing general characteristic of the smaller industrial undertakings is not that their problems are so different, but that they are less aware of them. Since most small industries are hoping to become larger, it is probable that they can be helped better by an institution equally familiar with operations of the next size up the scale, rather than by one specializing only in smallness.

35. Cottage industry institutes are virtually outside the present discussion. Any laboratory research, development of equipment, or technical advice needed by or for the benefit of cottage industries can indeed be supplied just as well if not better by a more general applied research institute, and very often is. However, a cottage industry institute frequently devotes the larger share of its programme to promoting, organizing and teaching cottage industry skills, assisting in the sale of products, and similar activities unconnected with the foregoing list of technical services, and these are its principal justification. Ordinarily, when a developing nation encourages cottage industry it is for such purposes as reducing village underemployment, augmenting substandard farming income or the like; it is not viewed as part of the industrialization programme. At the risk of over-simplification perhaps one should say it is not industry at all in the current sense, but largely handicraft - more of a return to what was done before modern industries were invented. For certain objectives cottage industry has its own stop-gap value, in other words, but it is not undertaken as a direct road to industrial development and therefore need not be of concern here.

Narrow specialization

36. Finally, one must consider the type of research institute whose interest is limited to the problems and development of one particular industry, one product or local raw material, or at most a comparatively narrow group or category of industrial activities.

37. Ever since industry first awakened to the importance of investing in research (not such a long time ago, by the way) these specialized institutes have been fairly common throughout the world. In the industrial countries, at a time when many of the most progressive enterprises began to instal research departments

of their own, the competing member firms in one line of production chose instead to associate themselves in jointly supporting research of mutual interest to all members. A few industries have done both; but in the more typical instance the specialized institute has represented an old, conservative industry, slow to adjust to changing economic patterns, whose members were still hesitant to spend very much on anything so new as a research department. Some other industries have chosen joint research because it was the only way open to them: industries made up of many small enterprises, like laundries and dry-cleaners, each too small to support a substantial research programme or private laboratory of its own.

38. New institutes of this kind are still formed in the industrial countries now and then, for the same reasons. However, they show a growing tendency to avoid their former isolation, in recognition of the advantages enjoyed by the broader institutions, and the increasing complexity of facilities needed for modern research. Some of the newer specialized institutes build no laboratories of their own, but are merely paper organizations which contract with one of the large multipurpose institutes to carry out their selected programmes of research and development studies. Alternatively, some others have arranged to build their own laboratories directly on the ground of one of the broad research institutes, to work in close contact and to share certain major facilities on an agreed basis. Private problems of individual members may then be handled either by the specialized institute or, if more convenient, by the affiliated broad institution.

39. It will be seen that the specialized institutes are, in purpose, only a step removed from the private research departments of individual enterprises. It is a fairly large step, however, for in practice they have encountered certain common difficulties quite apart from those caused by isolation from related work in other fields. Having to satisfy all members simultaneously for their main programme support, they usually run into internal political friction if they attempt to give much of their attention to the special problems of individual member factories; some institutes even find it necessary to exclude such private service. Yet to the individual producers concerned, these problems are likely to be the most urgent ones. At the same time, interest in the institute's broader community programme tends to be diluted, so that when it has developed some technical improvement of general benefit to the industry, there is often much difficulty in persuading the individual producers to adopt it. During an information tour of a series of these specialized research institutes operating in one of the older industrial nations, this last was one of the most general complaints heard.

40. In the newly developing countries, the narrowly specialized institute needs to be very cautiously considered in each proposed application, for there are times when it is genuinely called for and many other times when it is definitely to be avoided. Against any argument favouring such an institution (and it will be shown that occasionally there are compelling ones) must be weighed the undeniable fact that it is the least economical, not only in physical investment and operating cost, but in the use of highly trained personnel, both technical and administrative, of which no developing country possesses any to spare. As a good working rule, one may say, therefore, that in such a country no narrow institution of this kind with its own separate research facilities should be established unless the particular circumstances permit no satisfactory alternative. The corollary is that under no circumstances should such a country attempt to meet its over-all need of industrial research and development by a planned mosaic of such narrowly specialized institutions, each for a different type of industry.

41. Yet with good justification, [illegible]
at least one or two such institutes, [illegible].
related to the traditional pre-development [illegible].
familiar historical economic dependence [illegible]
of one or two main raw products - [illegible] -
both the Government and the producers [illegible]
welfare of these critical commodities, [illegible]
from blight, their wider use and increase [illegible] [illegible].
the needed research may be partly industrial, but [illegible]
large part agricultural. The latter portion, at least, [illegible]
crop grows; but each main commodity may [illegible].
Thus, however desirable it might be to combine such research in a central institution, in these special circumstances it may be impractical for some of it, and at the same time the volume of work to be done on such a major product may amply warrant a geographically separate research organization. Even so, if there is also a broader industrial research institute available, it often pays to let it handle certain of the more transferable problems on a contract basis because of its more comprehensive facilities.

42. Inherent in this situation is a dilemma that every developing country must solve for itself. On the one hand, the importance of the one or two main products which may still be the life-blood of the economy would seem to justify a proportionately heavy research and development effort on these commodities, even at the expense of other uses for the limited technical resources. On the other hand, this utter economic dependence upon its traditional main products is precisely what such a country seeks to end, through industrial diversification as one means. If the main products are allocated a greater share of the research, will this not tend to increase their dominance instead of reducing it? In the long run, should not such a country's industrial research be aimed more broadly at diversification into new fields, instead of being apportioned on the basis of the unwanted status quo?

43. In any event, while the distinct climatic demands of tea grown in the mountains versus rubber from the lowlands might justify specialized research institutes in a country mainly dependent on these products, one fears that no equivalent defence can be offered for the unlimited variety of such institutes so often proposed and sometimes created in developing countries. Both local study and technical assistance produce many an expert field survey of the prospects for some specific local industry or some incidental local raw material, and it would be remiss if the findings failed to stress the importance of further research in the subject; but - to be honest - it would seem to be a rare report of such a study that does not recommend the establishment of a separate, special research institute for the purpose. Perhaps it is not unnatural that a highly qualified specialist in any one particular product, his attention focussed narrowly and intently on his subject as it must be, should see its problems in somewhat magnified proportions. Yet the mere need for research in a given line, however, important, does not of itself mean that a separate institution is required, nor even that it is the most advantageous way to handle it. In most cases it is not, in fact, but certainly the proposer may be excused for not knowing this, for the best expert on palm jaggery or coconut fibre might not also happen to be a specialist on research organization.

44. Keeping this in mind, a developing country will be better advised to view its industrial research and development plans first as a whole, just as it would

its fiscal [illegible] *[illegible]* [illegible]. [illegible] the very least, it would [illegible] more [illegible] to accommodate any new fields of [illegible] research [illegible] whenever possible, for [illegible] within [illegible], [illegible] later [illegible] separating them into special [illegible] the actual [illegible] experience [illegible] its work made it seem [illegible]. Otherwise, [illegible] proliferation of special institutes [illegible] overlapping and duplication - and, by a sort of Gresham's law, can also injure the country's prospects for development of the more useful broad industrial research institutes needed for promoting diversification of production.

Regional institutions

45. From time to time, someone suggests that instead of each country building up its own technical facilities, the needed services might be supplied to the industries of the developing countries from a few strategically placed, jointly administered regional research institutes, each serving a group of countries to avoid duplication. The scheme seems so plausible at first glance that its logic must be examined more closely.

46. One must not become so obsessed with avoiding duplication that one forgets the main object, which is to provide locally available technical services immediately, that is, services which are intimately familiar with the local industrial scene and directly identified with the national development effort. To avoid duplication, a regional institution serving a half-dozen countries obviously has to be situated in one of them, and not in the other five. Could it not maintain branches in the other countries, adequately staffed and equipped for effective local service? Yes, it could - and as these would then be equivalent to national institutes, the regional administration would be little more than an international complication and needless expense. But if there is only one institution, industries in the other five countries must, in effect, get their technical service from "abroad". If they are content to do that, they can already get it from existing institutions, of very high competence indeed, in the large industrial countries; with jet travel the difference is only a few hours. The point is, remoteness is exactly what should be avoided.

47. Moreover, just as a man cannot serve two masters, a regional institution cannot exert its fullest efforts for the individual development of each country. It is still a competitive world, and interests are bound to conflict. Country A, importing its clay roofing tiles from adjacent Country B, wants the institute's help to manufacture its own of better quality; but this will injure the trade of Country B, which has asked the institute to help find new outlets for its clay products. Both support the institution. To whom is loyalty owed? Yet if the regional institute avoids this type of problem to concentrate on work of mutual interest only, it will leave an important part of the job undone, and the industries will have to turn elsewhere for help. In the same vein there are numerous other problems of policy, multilateral administration, *pro rata* staffing and *esprit de corps* which create no difficulty in an institution that can use today's nationalistic enthusiasm as a driving force rather than a hindrance.

48. But probably the most useful answer is that one such jointly administered regional industrial research institute has already been in existence for nearly a decade. It has operated under conditions perhaps more favourable than could be

found in almost any other world region, since it serves a compact area of five quite small and progressive Central American countries sharing a common language and many other mutual interests. It has managed to turn out much excellent work, but it has also had its share of problems. With this best of practical tests, it may reasonably be felt that on balance any demonstrable superiority of regional institutes over domestic facilities, as a policy for other parts of the developing world, should have become evident by now.

C. Comments on organization

49. The requirements for a successful industrial research institute are basically the same whether it is organized under private or public sponsorship. In the developed countries, except in purely socialist economies, most of them are initiated by private groups and incorporated as non-profit public service institutions. This has also been done successfully in a few developing countries, but seldom is the business community of a newly developing area so well organized or able to muster the necessary resources. Thus, in such countries the initiative is usually left to the Government. Under the conditions this is an advantage in some ways, as there is need for outside technical assistance, public funds, and often special legislation to pave the way for effective service.

50. Because of the Government's involvement and its frequent unfamiliarity with this type of undertaking, the established customs of public administration often influence the planning of such a project along lines well-intended, but somewhat mistaken in emphasis. Much premature attention may be given to organization charts, department designations, officer-titles, staff cadres, specific research topics and even detailed lists of equipment to be ordered - an approach more suited to the planning of a routine operation. Partly it is a misunderstanding of function, for a glance at the list of services discussed earlier should show that for an industrial research institute, too much advance planning of these details is neither necessary nor desirable; they will fall into place better under capable administrative judgement as the work proceeds. The real planning should focus instead upon laying a broad, sound foundation for an effective institution, for which several basic elements are more important, but are frequently understressed and sometimes unrecognized.

Staffing

51. Unlike research organizations in many other fields - where mediocre work is hard to measure and may not be detected for a long time - an industrial research institute works under a spotlight. It cannot bury its mistakes and display only its successes. Serving business-minded bankers and industrialists who risk large investments on its findings and advice, its output is evaluated constantly and accurately in cold profit-and-loss statements. If its performance is mediocre, its help is considered a dangerous gamble and is seldom wanted, no matter how pretty its laboratories. Accordingly - and here is what is not always appreciated - there is no room for compromise: half-good is not half-effective; only a first-rate institution can be effective at all.

52. What makes a first-rate institution is a first-rate staff, and nothing else will do it. The money spent on buildings, books and apparatus merely equips the staff with the necessary tools. Not even the largest electronic computer ever has an original idea. The useful output of a research and

development organization depends wholly on the vision, competence and ingenuity of its personnel, and these attributes are measured in intensity rather than volume. That is, low levels of ability cannot be offset by larger numbers; if one man's training and ability are inadequate to cope with a problem, giving him a dozen helpers of the same or lower level will not solve it either.

53. Although a developing country normally sees some overseas technical assistance in starting its institute, a handful of temporary expatriates do not suffice to make a first-rate staff. The local personnel constitute the majority from the outset, determine what even the expatriates can accomplish, do the largest share of the work, set the tone of the institution, and eventually have to carry on by themselves. They, as well as the expatriates, must be in contact with the industries and give them help and advice. The institute cannot function with a local staff any less competent than those employed by the industries it seeks to advise, for such a condition cannot be concealed and technical counsel will not flow uphill. Therefore, it is most essential, in planning such an institute, that it be enabled by whatever means necessary to attract and hold a local staff of the highest calibre that can be found in the country.

54. This usually means matching the salaries they can obtain elsewhere, although the personal satisfaction of such interesting work is often worth something. For applied research, the best candidates are usually of a venturesome, self-reliant type to whom security and pension are not the first considerations. They are more likely to respond to open horizons and to opportunity for advancement strictly on their merit and value to the organization, since their talent is less of an asset to them where promotion is mainly by seniority. An eventual chance for further study overseas is also a drawing-card. They are self-starters, skilled at doing things themselves and intolerant of red tape. Congenial working conditions, efficient supporting services and senior officers for whom they have respect are absolutely necessary to hold such men. Later, when the institution has earned a reputation, the pride in working for an organization of recognized competence and efficiency is not to be underestimated as an attraction.

55. Special skills of all kinds are naturally scarce in a newly developing country, and it is useless to utter counsels of perfection. But the need for competence, at least to the best level obtainable locally, is just as great in the other echelons as in the top technical staff. The work of an industrial research institute depends heavily upon the supporting services of its machinists, welders, pipefitters, electricians and carpenters in the experimental workshops; on its laboratory assistants, electronics and instrument men, glass-blower and other skilled technicians; on the efficient service and knowledgeable maintenance of stocks in the supply room; on the ability and initiative of its professionally qualified technical librarians; and on the competence of its office and clerical staff. Poor workmanship and slow delivery from the supporting artisans can make successful experimental work all but impossible. A carelessly typed report can destroy the accuracy of the best experiment, and furthermore, as it is often the only thing the client receives, it will be taken as a probable indication of sloppy work throughout the institution. A research institute should hire the best available in all these occupations and, if this is still short of excellence, undertake or arrange for supplementary training as well.

56. A common misconception is that a broad industrial research institute must be staffed with experts in each of the many industries to be served. Actually, for applied research, the need is for men of good basic training and experience in a

variety of useful fields, which [illegible] likely to be encountered, but a highly [illegible] of greater value than previous intimate [illegible] fact, as many prominent research directors [illegible]. last thing wanted, because: (a) he does not [illegible] it would not require research; and (b) he [illegible]. On the other hand, some of the advisory functions [illegible] practical business experience - but again, not so much in the [illegible] as in the principles of industrial planning, management [illegible].

57. It is questionable whether a country should attempt to [illegible] institute, even with outside technical assistance, unless [illegible] a nucleus of technically trained local counterpart staff. [illegible] be better to delay the project for a few years [illegible] overseas. However, experience indicates that most developing countries [illegible] possess more trained personnel than are at once apparent, and [illegible] will turn them up in the most unlikely places. Official sources may [illegible] them working for the Government. Many a graduate engineer, trained overseas at family expense, is managing his father's plantation or importing business through [illegible] a properly rewarding outlet for his training. If a small nucleus of staff can be found, perhaps a start can be made while more are sent for advanced training.

Administrative procedures

58. By its nature all research is difficult to plan ahead, but the work of an industrial research institute is especially unpredictable. In addition to the uncertain course of each investigation, there is no way of knowing from day to day what new problems will be brought in by its diverse clientele. Of necessity, through the years this has led to the development of various special methods for budgeting, costing, accounting, purchasing of supplies, expediting, assignment and handling of personnel, etc. Among the many successful institutions these procedures are generally similar, and are familiar to any professional specialist in this field. Appropriately flexible to meet the unusual requirements, they have been worked out through experience to permit rational planning and best service to the clientele, and especially to avoid wasteful investment, unnecessary operating cost, loss of valuable staff time and the frustration, if not eventual loss, of the most capable technical personnel. Thus, in planning a new institute it is wise to take advantage of what has already been learned the hard way, and to ensure the administrative discretion to adopt such techniques in the most suitable form.

59. Particularly where the Government must sponsor the institution, it must be recognised at the same time that the ordinary established governmental requirements and procedures in these matters are designed for the totally different needs of general public administration, and have been shown to be singularly unadaptable to the practical operating requirements of an industrial research institute. Universally it has been found that where standard government regulations apply to such an institution they seriously impede the work. As a rule, however, there is no existing provision for creating a new department or direct agency of the Government without making it responsive to these established regulations, and therefore some other way must be found.

Confidential service

60. A third fundamental requirement for an effective institution is that it must be in a position, psychologically, to perform the full services for which it is intended. If one of its functions is to help industrial production in the private sector, it must be able to satisfy the business community that their private affairs can be treated confidentially and will not become public information or be shared with competitors. This is a fair demand, for in many of the most urgently needed services competent help cannot be given without knowing all the pertinent facts, and this often requires confiding to the institute future business intentions, internal financial records and similar private details; research entrusted to the institute may involve a firm's production "secrets", or patentable new inventions; and a factory having trouble with its quality wants the problem corrected, not published.

61. For these reasons, businessmen everywhere are instinctively reluctant to impart their most critical problems to a government-administered institution, since it is undeniably a part of the public domain despite any assurances that may be offered. The result is to be readily seen where such institutes exist, particularly in some of the developing countries: support of the private sector is disappointing, the help requested tends to be more of a routine nature, and the larger part of the work becomes limited to broad, general problems of less certain impact while an opportunity for service on many other problems is denied. Some may choose to attribute the situation to special local conditions, yet there are instances where it has been spectacularly changed by removing the psychological stigma of a government operation.

Operating autonomy

62. The accepted way for the Government to overcome these difficulties is to establish the institute as an autonomous non-profit corporation, broadly responsible to the Government for the successful discharge of its over-all objects, but for this purpose empowered to determine its own appropriate operating policies, procedures and employment conditions, select its own staff in accordance with need, execute contracts with its clients for confidential services, hold or assign patent rights, and generally manage its own affairs and finances within the terms of its charter. 5/ When guaranteed this degree of genuine operating autonomy and headed by a business-oriented board, this organizational form is distinguishable enough from an ordinary government agency to satisfy the psychological problem of the private industrial clientele, and it is the form of those institutes which have had the best success to date in the developing countries. In order to embody certain desirable provisions not customary for ordinary commercial corporations, it has usually been found best to create the corporate institute by special legislative act, preferably drafted with expert assistance well experienced in this type of research undertaking.

5/ United Nations, First Expert Working Group on Technological Centres, 1954 (United Nations publication, Sales No.: [illegible].II.B.[illegible]), para. 102; United Nations, Bureau of Economic Affairs, Establishment of Technological Research Institutes in Under-developed Countries, Industrialization and Productivity Bulletin No. 2 (United Nations publication, Sales No.: [illegible].II.[illegible]), pp. [illegible].

63. The governing board should be small (eight or nine at most) and its composition is important. Naturally it will have some government members if the institute is government-financed, and the institute's Director should always be a member; but it should also contain a good weighting of industrial, business or banking people, for the board members should be chosen primarily to contribute their practical experience and judgement in guiding the institute's policies and financial affairs along business-like lines. It should not be a "representative" board composed of spokesmen for each of the many agencies, institutions or special bodies who might have some kind of connexion or interest in research: such a group tends to pull in different directions, and often to misinterpret its purpose. It is not the function of the board either to choose research problems or to solve them: the first is done by the clients, the second by the staff. Executive authority, under policies laid down by the board, should of course be delegated as fully as possible to the chief executive officer, the Director of the institute.

Relationships with other organizations

64. A persistent scheme, for all its disappointing attempts in practice, is that of merging the operations of an industrial research institute into an existing university. It is often suggested that this will avoid duplication of facilities, permit the teaching staff to double as industrial research experts, and give the students valuable practical experience. Unfortunately, the idea is illusory, and every marriage of this kind has eventually ended in divorce. A library can be shared well enough, but of the limited percentage of equipment that might serve both purposes, its scheduled use by inexperienced students cannot be reconciled with its need to be free and in controlled adjustment for urgent research work. As for staff, it has been found generally that the experience and interests of an academic career are not the same as those of the applied research man, and in any event the industrialist with a production problem that is losing him money each day is not satisfied with part-time technical service whenever convenient between classes. The involvement of students in work that is both critical and confidential simply cannot be accepted by those seeking the most competent technical help. A university should be provided with adequate research funds of its own, but not as a substitute for the industrial technical services discussed here.

65. On the other hand, if a developing country has established an industrial development bank, a close working association between it and an industrial research institute can greatly extend the effectiveness of both. They deal in complementary and very interdependent aspects of national industrial development; the clients of one are the clients of the other, often on the identical project. It is a good practice for the institute's board to include the industrial bank's manager, and in at least one country the director of the institute is also on the board of the industrial bank. The natural symbiosis between the two institutions is at once apparent.

66. This is perhaps the only case where such a close tie is justified in practice. However, the industrial research personnel normally maintain appropriate contact with their professional colleagues in universities, other research organizations and similar institutions. They visit and consult, use each others' libraries, exchange emergency supplies from their stockrooms, and even borrow equipment now and then. Often the institutions contract to perform [illegible] services for one another. These relationships at working level are generally [illegible]. There [illegible]

67. Occasionally there is a proposal for a developing country to set up a complex high-level technical council or network of inter-institutional committees to co-ordinate, supervise and control all technical and scientific work. Such ambitious overcentralization has little in its favour and many faults. Certainly so far as industrial research and development services are concerned, it is difficult to see what such a body could really contribute except interference and unnecessary overhead cost. The work of an industrial research institute must be mainly what is asked of it by its clients, and much of it is confidential anyway. If it is a corporate institution its remaining affairs are the responsibility of its competent board, which should not need another body to usurp or duplicate its functions in the name of co-ordination.

68. On this recurrent theme one must grant that, when all is said and done, more is said than done. If the purpose of co-ordination is to prevent wasteful duplication of facilities and functions, not much useful co-ordinating can be accomplished after the duplication has already been created. It must be done beforehand. In many developing countries, there is still a serious unfilled need for a single co-ordinating office, at authoritative ministerial level, whose job it is to see that the independent efforts of so many departments and international assistance agencies do not dissipate the available resources in duplicate, overlapping or conflicting projects in the first place. Countries that already have such an office have usually put it directly under the Minister of Finance, where effective control can be exercised through the purse-strings, and they are able to make much better use of their limited technical resources than could be achieved by any belated symbolic attempt at corrective co-ordination.

Financial aspects

69. Services rendered free of charge are seldom valued highly and are often a waste of effort. Industries use technical services in order to make money, and therefore they can well afford to pay for them. In a country where they have not previously done so, it may take some object lessons and public relations skill to convince them, but this is part of the job. An industrial research institute should charge fairly for its work, on some adjusted cost basis, from the very outset. Furthermore, it should charge the Government the same as it does other users, keeping things on a business-like basis; any arrangement that, in return for general government support, allows the Government to call for unlimited or unaccounted free service makes sound management and planning impossible.

70. As a rule government money is needed for the institute's initial capital investment in buildings and equipment, and also for a large share of the operating expense in early years (possibly with some international agency help, of course). So as to let the institute manage its development efficiently, it is most satisfactory to supply these funds as outright cash grants, with few strings other than general accountability for their use as intended. Where the institute is created by legislation, it is best to include statutory provision for such grants to be paid in stated amounts over a period of years. This guarantees a level of support on which the institution can base a long-term development plan, instead of the uncertainty of a newly argued government appropriation each year.

71. It is quite feasible for such an institute to become self-supporting eventually through its charges for service, but it takes time to build up the clientele. During this period a large part of the work must be for the Government's

account, and the Government may wish to include in the annual [illegible] an agreed sum earmarked to cover the charges for such work. The Government should also plan on a continuing grant to support certain desirable activities of the institute which are not paid for by service charges. These include potentially useful research initiated by the institute itself, free advisory services to very small producers from whom it would be impracticable to expect payment, publications, lectures and demonstrations, general technical information services, operation of a modern library of industrial technology and similar public services which can be especially important to a developing country.

D. Concluding observations

72. Obviously no paper of this kind could cover even briefly all the aspects of organizing and operating an industrial research and development institute. It is doubtful if a document of any length could do so, for apart from the fact that fully this much could be said on any one of the topics merely touched upon here, most professional research directors will agree that there is also a certain amount of art in it. If, so, this part would be no easier for any of them to put into words than to describe how to manage a complex business or to write a successful novel.

73. Unquestionably, therefore, the essential first step in creating such an institution is to get the most competent expert assistance, and to get it at the earliest pre-planning stage. Previous first-hand experience in organizing such facilities under comparable conditions should be sought especially, since the job is rather different from doing it in an already industrialized country. Help in this special field can be obtained through the United Nations Technical Assistance Organization, and sometimes through other types of organizations. Whatever the source of help, of course, the applicable experience to be judged is not that of an organization but of the selected expert himself, for in such a matter the required skill can be stored only in the individual and never in any organization's filing cabinets.

74. Finally, it must be recognized that many new things are still being learned, about such a young field of work. The experienced professionals are still far too few, and as they work all over the world, they seldom enjoy such an opportunity as this Seminar to exchange their observations in a group. What is offered in this paper is drawn from one body of experience, and it will be most useful if on some points this occasion brings forth differing experiences to strengthen the over-all knowledge of this important field which can mean so much to the future.

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V. INDUSTRIAL RESEARCH IN YUGOSLAVIA

Prepared by Br[illegible]*

1. In recent years plenty of evidence has been disclosed [illegible] significance of scientific research for economic development of the contemporary world. In the well-known United Nations Educational, Scientific and Cultural Organization study on the current trends in science, it was estimated that research activities were being doubled nearly every ten years, which represents a rate of growth four times as rapid as in all other human activities. It is true that this impressive growth of science cannot be explained by economic considerations alone, for research is also undertaken for social, cultural or military motives, but without doubt, the economic effects of science have contributed the most to its outstanding position in modern society. While this important role of science has gained wide-spread recognition, there still remains much to be understood about the different factors and their quantitative measures which determine complex relationships between scientific research and the economic development. There is an urgent need to study these problems in all countries, but especially in those which are undergoing a process of economic and social development. It should be borne in mind that most reports of the rather extensive research in this field tackle the problems arising in highly industrialized and developed countries. Obviously, their findings cannot apply equally well or even serve as a broad outline in tracing national scientific policy in developing countries in which economic conditions are less favourable and scientific tradition poorer. For many reasons, the question in these countries is not whether they should or should not concentrate to develop their own research capacities, but how to make them to bear in the most efficient way on accelerated economic development.

2. There is no doubt that the United Nations Centre for Industrial Development is performing a very useful service in preparing this Seminar and in bringing together the representatives from a number of developing countries to exchange their experiences and to discuss such important topics as the institutional pattern of the industrial research in different countries and the organization of the independent institutes serving industry, as well as the research laboratories inside the industry, their operation and financing, to mention but a few of them.

3. Probably, as in many other countries, the most important issues of Yugoslav scientific policy have been lying at the core of these problems during the whole period of the accelerated economic and social development after the Second World War. For this reason, it seems to the author of this paper that it might be of interest to discuss some problems of scientific development as they appeared in Yugoslav experience. But in doing so, he is quite aware of the fundamental limitations of this method, for the problems and objectives of research development as experienced in one country depend to a great extent upon the existing natural conditions for economic development and the specific social environment.

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* Professor at the University of Belgrade.

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4. After the Second World War, when the process of industrialization was begun in Yugoslavia, the prevailing conditions were not very favourable for either rapid economic growth or scientific development. The pre-war economy of the country, based primarily on agriculture and handicrafts, had been almost completely destroyed during the war and the same was true of the scarce research institutes and university laboratories. In such circumstances, there were not many alternatives to decide upon as to the first steps to be taken in order to create the indispensable basis for further development of scientific research. Apart from the insufficient financial means, the main obstacle to both industrial or research development was a rather critical lack of scientists, engineers and other trained personnel. This was especially true in the physical and engineering sciences, which, in earlier periods, owing to the undeveloped industry, were nearly completely neglected. To open this bottle-neck, serious efforts had to be made to expand greatly the whole system of higher education.

5. Quite a number of faculties in different fields of engineering, economics and physical sciences were established, and in only a few years, student enrolments at these faculties outnumbered those at the faculties of art, law, agriculture and other traditional subjects. Although the number of degrees given in technology and in science has not yet reached the necessary level to meet the increased needs of the rapidly developing industry and the whole national economy, the results so far achieved can be considered quite satisfactory.

6. The great expansion of the higher educational system added considerably to the creation of the necessary conditions for starting research work in many branches of technical and physical sciences, as the newly established university departments and laboratories provided facilities not only for practical training for students, but also for research activities of the teaching staff. In addition, a certain number of other institutes in technology and physical sciences, attached to academies of sciences or with the status of independent organizations, were founded. Among others, three institutes of physics and nuclear sciences were established and attributed with research facilities and sufficient funds to develop research activities in electronics, automation and feed-back theory (upon which computing machines are based), chemistry and biology, apart from their main orientation in physics and nuclear sciences. They were to play an important role in the later stage of scientific development not only by their own research capacities, but also in supplying universities and other scientific institutes with quite a number of experienced scientists.

7. However, it seems appropriate at this stage to go more deeply into the problem of erecting the institutional basis for conducting research in developing countries and to comment on some points, which, at least in the author's opinion, might be of essential interest for the whole topic of creating the most effective system of engineering research. First, it is a question of setting up a proper balance between the funds for economic development, on one side, and those allocated to the training of scientific and technical personnel and to the expansion of research activities, on the other. It appears that the needs of these latter funds are nearly always underestimated at the initial phase of industrial development, simply because they do not offer an immediate economic return. Nevertheless, these investments are as economically feasible as any other and they often yield an even

better economic return [illegible] takes much more time to develop [illegible] this is overlooked when the decisions regarding [illegible] future economic development of the country [illegible].

8. The second point concerns even more [illegible] an efficient instrument in the process [illegible]. [illegible] posed as to whether some special incentives [illegible] in order to bring into being as close a cooperation [illegible] institutes and industrial undertakings from the very beginning [illegible] development. For at least two reasons, the answer to this [illegible]. On one side, in the early phase of development the manufacturing [illegible] depends in its production on imported technological knowledge [illegible] often started simply by assembling the imported parts into final products [illegible] proceeding step by step in mastering the whole skill of production. [illegible] instances, the processes and products are such that they call for [illegible]. This fact, as well as the pronounced shortage of highly trained personnel [illegible] largely responsible for the quite insufficient influence that the [illegible] industry is able to exercise on the orientation of the research activities of the university and other scientific institutes.

9. On the other hand, if all the national research capacities were to be confined to the university departments and laboratories and to a number of the institutes created and operated by academies of sciences or even by the Government, there is a real danger that they might become too academic and tend to dissociate themselves from the supporting work for the benefit of industrial development. Traditionally, much of the fundamental research has been accomplished in the universities all over the world. It is also true that this kind of research is of great importance for economic development, for without advances in basic research, as has been said, industry would be doomed in the long run to the continued application of existing knowledge. Finally, in these days, when the quality and not only the number of the engineers and other specialists employed in industry is of great concern, the vital importance of the link between basic research and teaching cannot be over-emphasized, if the universities are to supply all sectors of economy with well-trained and able specialists. Therefore, the author is not going to profess that further efforts should not be made in encouraging and strengthening basic research in a developing country, especially at the universities. But he cannot help thinking that, unlike the situations encountered in the countries with highly advanced economies, applied research and development (versus basic research) are not given their fair share and support in the less developed of the developing countries. While in highly developed countries more than [illegible] per cent of the total national expenditure for conducting research is devoted to applied research and development, one must fear that almost the opposite is true in many countries which need to advance.

10. Of course, the necessary proportion in the allocation of funds among the various stages of research, such as basic, applied and development work, cannot be the same in different countries. This is a matter of rather complex considerations and much additional work is needed for the enlightenment of the different problems involved. But if the targets set up in planning industrial development are to be achieved, a much greater emphasis should be put on applied research and development. The experiences accumulated in Yugoslavia during the period of the rapid economic development show invariably that difficulties in getting research institutes fully

[illegible]

[illegible] of the institutes [illegible] the results [illegible] industry. However, the [illegible] to bring the [illegible] industry and the other sectors [illegible] industry was extensive [illegible] economic growth and [illegible] were set up by the Chamber of [illegible] for financing, under contracts, research [illegible] ensuring progress in industry and agriculture. [illegible] derived from the [illegible] by the Government on the industry. [illegible] this new system of financing was introduced, [illegible] institutes in technology were to derive their revenue partly [illegible] contract research for industry. University departments were also encouraged [illegible] on a contractual basis. But in view of the danger that [illegible] might be tempted to do so much work for industry that they [illegible] to their teaching duties, these later contracts were [illegible] subject to the prior approval of the faculty council. Several positive consequences [illegible] these measures, among them notably, a growing interest of scientific institutes in applied research and in establishing closer relation with the economy.

1 . However, [illegible] the initial process of strengthening industrial research had to be faced with many difficulties and was immediately followed by at least two unfavourable outcomes. On one hand, the scientific [illegible] institutes which were doing a lot of contract work, tended to [illegible]. In many instances, the industrial firms were not ready to finance [illegible] long-range research, but were primarily interested only in [illegible] solutions of their short-term practical problems. [illegible] carried out by the institutes were often more [illegible] work. [illegible] quoted as saying: "I fear we are doing much contract work, but not much contract research". On the other hand, the research institutes, which resisted these temptations and were more critical about the scientific [illegible] of the projects, found it increasingly difficult to [illegible] without which a first-class staff cannot be attracted [illegible].

1 . It is also noteworthy that the industrial enterprises were not satisfied with the assistance they received from the institutes. They complained steadily that the institutes were not flexible [illegible], that their research programmes were not attuned to the real needs of the [illegible], that the services the institutes were expected to provide were [illegible] slow.

1 . [illegible] expect everything to be [illegible] making industry

more research conscious. All the difficulties [illegible] the end of developing industrial research [illegible]. [illegible] least some of them could have been avoided [illegible] insufficient financial means available for the [illegible] development. Greater supporting funds [illegible] research institutes and industry to continue [illegible] an adverse effect on the scientific achievements.

15. As a further step, the Federal Council for Scientific Research [illegible] the Law of 30 June 1957 and was entrusted with the task of [illegible] and co-ordinating research activities and [illegible] required to promote research activities and to ensure the application [illegible] results in economic development. The membership of the Federal Council [illegible] by the Government, consists of eminent scientists, representatives of industry [illegible] other sectors of economy, and of the chairmen of the [illegible] Research Councils of the National Republics. It is presided over by a member of the Cabinet. Assisted by its Advisory Councils for different fields of science and technology, the Federal Council undertook a comprehensive study with the aim of formulating [illegible] scientific policy. This investigation resulted in two laws, [illegible], regulating the operation of the Federal Fund for Scientific Research and the financing technique to be applied to the scientific institutes and development laboratories in industry. Both of them were of great concern to further development of industrial research.

16. As a matter of fact, the Federal Fund for Scientific Research was established in 1957, but it was not until 1960 that its tasks were drawn up on far stricter lines. The Federal Fund was charged with providing financial support to research projects of broader economic or scientific interest in all branches of science and technology, and with awarding capital grants or loans to research institutes for special apparatus and other research facilities. Special provisions were made to permit the Federal Fund to encourage industrial enterprises to establish their own research laboratories by assigning them, on request, long-term loans for research facilities at a reduced rate of interest. Such loans were offered on the understanding that at least an equal proportion of the entire capital expenditures would be supplied by the recipient enterprise. It is worth mentioning that of the total outlays of the Federal Fund for Scientific Research in recent years, the major share has gone to industrial research projects and to setting up new institutes for industrial research and development laboratories in industry.

17. The second law, relating to the financing technique employed in running research institutes, was even more important for further development of industrial research. New fiscal measures were introduced which practically led to the exemption of any kind of taxation for the investment and other research expenditures made by industry. It applies regardless of whether research is carried out within the factories' own research departments or laboratories, or as research and development work contracted by industrial enterprises to outside scientific institutes. Similarly, research institutes, which derive their income by doing contract research, are exempted from any kind of taxation on the condition that they establish their own research funds amounting to the taxation due and an additional 5 per cent of the total income. These funds are at the disposal of the institutes for financing basic research projects and scientific training of their staff. The institutes are expected to report on and to account for the use of their own research funds.

[illegible] in the belief that scientific [illegible] in economic and social development [illegible] research were not [illegible] broadly based, so [illegible] of research institutes and different types of research [illegible]. In this respect, it seems particularly important to emphasize the role of development laboratories and of the more general type of industrial laboratories within the enterprises in making the whole system of industrial research more effective. These laboratories are a logical link between research institutes and production departments in plants, without which there can scarcely be any practical mechanism for converting scientific achievements into new technological processes and products. This is a generally accepted philosophy in most advanced countries, but, in the author's opinion, it is equally true for countries undergoing the process of economic development. For even when there can be no question of producing completely new technological knowledge, these laboratories can render an extremely important service to industry in bringing a new, more scientific outlook to the whole art of industrial production. Also, it is easy to realize that the existence of such laboratories in the factories would greatly facilitate the upgrading of the scientific level of the sponsored research work in the outside scientific institutes, for without doing research by itself, the industry can hardly be able to formulate the real research problems it could confide to other scientific institutes.

19. Along with the fiscal measures and other incentives set up under the two above-mentioned laws, the Federal Research Council and the trade associations have been doing a lot of work in recent years in creating a "science climate" and in trying to make the competent bodies of industrial enterprises more aware of great economic consequences of science and of industrial research, in particular. At the same time, the Research Councils of the six National Republics have been made responsible for establishing new institutes in those fields of science and technology which were deficient in scientific establishments.

20. All these actions have proved to be successful and although the present state of industrial research in Yugoslavia leaves much to be desired, it is a great encouragement owing to its relatively rapid progress.

B. Industrial research establishments

21. It can be seen from the previous section that there are three main types of research institutes in Yugoslavia doing work for industry, i.e., development laboratories and research institutes within the industry, independent institutes outside the industry and university research establishments. In addition, there is a rather interesting pattern of the research institutes which are closely affiliated with the university but which derive their working philosophy mainly, though not entirely, from the idea on which research associations are based. It should be recognized that the problems emerging from the existing differences in economic or technological development of various sectors of industry influence the entire structure and operation of industrial research in each particular branch. This structure of industrial research is also dependent on the former history of development of scientific work and, consequently, on the available scientific and technical manpower in different fields of science and technology. It is, therefore, proposed not to dwell on a specific example of industrial research institute, but to proceed further in discussing freely research problems of organization, financing and operation, as well as the different techniques adopted by the institutes in serving industry, as they are experienced in Yugoslavia.

22. The special [illegible] tax treatment of research expenditures in industry and the greater support by public funds seem to have been a strong inducement for

larger industrial enterpr[illegible]
development laborat[illegible]
been growing most rapid[illegible]
the chemical, electr[illegible]
differ markedly in [illegible]
of course, in the typ[illegible]
establishments of this type [illegible]
relatively smaller proportion of [illegible]
more strictly classified as research [illegible]
processes. Much of their [illegible]
existing technology, improvements [illegible]
of raw materials or components for the [illegible]
the production technique to the existing [illegible]
quality control methods, etc. However, [illegible]
of their directors and other decision-making [illegible]
the future research programmes of these institutes. [illegible]
the fact that these institutes are only [illegible]
that they are still suffering from a rather great shortage of [illegible]
and other specialists. Of course, many laborat[illegible]
even expect, by reason of the cost, to enlarge greatly their [illegible]
embark on a larger research project, at least not in the [illegible] future. [illegible]
is not a cause for worry, however, because they are [illegible]
important service to industry.

23. It is worth mentioning at this point that any research [illegible]
given the favourable tax treatment as applied to [illegible]
the legally imposed condition that it be registered with the [illegible]
This registration is made on the recommendation of the Adv[illegible]
which estimates whether necessary conditions are met for carrying [illegible]
on any significant scale. All registered research institutes and [illegible]
laboratories are legally treated as independent [illegible]
whether they are founded by the Government, by a university, [illegible]
enterprise. They all are doing sponsored research work [illegible]
institutes closely attached to the university, they [illegible]
proportion of their total income from contract [illegible]
establishments, set up by industrial enterpr[illegible]
their founders only, so that the contractual [illegible]
more than a mere formality which has been worked out [illegible]
fiscal technique. But it is fairly obvious that the [illegible]
having their own research facilities, can benefit much more from [illegible]
than smaller or medium-sized firms which cannot afford to have [illegible]
establishments of their own. On one hand, it is quite probable that [illegible]
medium-sized firms, especially in chemical industry, are [illegible]
could have been exempted from taxation, if these firms had [illegible]
establishment. On the other hand, there is not always [illegible]
what is considered development work and some services [illegible]
particularly true in developing countries where, [illegible]
flexibility should be exercised when using definitions of research and development [illegible]
work in industry. The large industrial enterprises, running their own research
institutes, often use them also for such services as routine [illegible]
and tooling, or routine product testing.

24. Although there were strong incentives [illegible]
establish their own research facilities, [illegible]

[illegible] the results of research [illegible] to their [illegible] institutes, they have found it [illegible] convenient to [illegible] the contract research institutes [illegible] the industry. [illegible] that the results of research done under contract for the industry [illegible] confidential and cannot be disclosed to anyone without the sponsor's permission. That is why these enterprises came to think that by contracting for research and development with outside organizations, they might take the advantage of the [illegible] in research which existed in contract research institutes. They were also prepared to help the institutes to enlarge their research capacities on the understanding that some arrangements could be made in order to secure preference and priority for the sponsors' research and development projects.

5. This scheme was deliberately fostered by the Research Council and some provisions were made to permit industrial enterprises to become co-founders of some research institutes established by the Government. The conditions on which industrial firms were permitted to become co-founders were in every specific case worked out by negotiations. Perhaps one or two examples might help to clear the whole picture. A factory, which happens to be the chief producer of electric cables in Yugoslavia, became a co-founder of an electrotechnical institute by providing the financial means to erect a new laboratory for research on cable technology. The same institute was awarded another capital grant by an enterprise manufacturing electrical apparatus, to establish a special laboratory for research in the field of high-voltage phenomena. But such capital grants are not always concerned with providing specific research laboratories to meet the sponsors' individual needs. They can also be in the form of a general contribution, for example, to help provide new buildings or to equip different departments with more powerful scientific instruments.

6. In the capacity of a co-founder, the industrial enterprise can nominate one or more representatives as members of the council of the institute, which is a policy-making body, but without executive responsibilities. One half of the members of the council is elected by the staff of the institute and the other half is nominated by the Research Council of the National Republic and by other co-founders. The director of the institute, to whom the executive responsibilities belong, is the member of the council ex officio, but he cannot be the chairman of the council. In some larger institutes, the director shares the executive responsibilities with a governing board, consisting of elected representatives of different units of the institute.

7. It may be noted in passing that this is a legally imposed scheme of organization which applies to all research institutes, except for the fact that the industrial enterprise, exercising its founder rights, can nominate up to three quarters of the membership of the council, while only one quarter of the membership is elected by the staff of the institute.

8. This technique prevents any particular industrial enterprise or even a group of them from taking over the total control of the institute. This is a point of vital importance [illegible] two reasons. First, the institutes must cover a broader field of scientific [illegible] research projects of national interest. [illegible] knowledge in their respective [illegible] otherwise, they [illegible] development

work. Secondly, contract research institutes [illegible] primarily aimed at providing an adequate scientific [illegible] sized enterprises that cannot afford research facilities of their own. [illegible] rights must be preserved and, even more than that, it should [illegible] main objectives of science policy in developing countries to [illegible] look much more for services offered by research institutes.

29. However, it would be an over-simplification to assume that [illegible] quite sufficient for keeping a proper balance between such different tasks as development work, short-term and long-term applied research and last, but not least, basic research in scientific institutes. The real and most important influence on research policy always stems from the financial means allocated to different tasks. If an institute derives its total income from contract work for industry, there is a high probability that short-term development projects will occupy the most prominent place in its activity, to the detriment of larger, long-term research projects of far-reaching economic consequences. The problem is all the more difficult as the industry, by reason of its structure, does not have ample scope for financing larger research projects. This is exactly where public funds for scientific research can play a very important role and ensure that the proper balance in scientific activities of the institute is not disturbed. In spite of their rather insufficient financial resources, the Federal Research Fund and the respective funds in National Republics have done and are still doing a very useful service to this end.

30. Finally, a question can be raised concerning the relative virtues of different patterns in conducting industrial research, as they are experienced in Yugoslavia. In the case of smaller enterprises, there has been no alternative to branch institutes serving many firms under contract. By its very nature, this problem is the same as that encountered in more advanced countries, but with greatly increased difficulties in making smaller firms science-minded. On the other side, large enterprises have brought to bear on two different patterns of performing research and development. It was pointed out earlier in this discussion that some of them are running research institutes of their own, while others find it convenient to utilize the services of outside research organizations. Both schemes have proved successful in many respects, but some short-comings have also been brought to light.

31. At the current stage of development, large research establishments inside industry, having better research facilities than can be found elsewhere, show a tendency towards autarchy. This might be harmful to the efficiency of their work and their total scientific output, especially in view of the marked shortage of scientific personnel in these institutes. On the other hand, large enterprises that contract for research and development to be performed by outside institutes are always faced with difficulties in transferring laboratory prototypes of new products, worked out by the institute, into production. The technique of transition from the later development stage to production is dependent on many factors, but it always calls for close co-operation between the development team and the production department. In this, as well as in many other respects, nothing can replace the development laboratory within the industry. Therefore, it seems to the author that further efforts should be made to broaden the network of development laboratories in industry and to make them an efficient link between research institutes and production departments.

3. University Institutes Serving Industry

52. Although a rapid expansion of research work in industry and in other non-university research establishments has recently taken place in Yugoslavia, the universities have been and still are key factors in the entire scientific development in the country. This is as it should be, for in this phase of development the most important task is to increase the number of scientists and technologists. The universities can fulfil this task only if they are given full encouragement and financial support to promote their research activities, which are, as is generally recognized, essential and an integral part of the system of higher education.

53. However, it is beyond the scope of this paper to discuss in any detail various problems of the organization of research work at universities and, therefore, further attention will be focused on one point only, that concerning the relationship between universities and industry. A technically advanced country can afford discussions about whether it is advisable for universities to undertake industrial research as a part of their activities. It appears that for many countries, undergoing their economic development, the answer to this question must always be positive, for if some important services to the industry are not done by the universities, they will not be done at all. The real problem is to what extent university research establishments can be engaged in research and development so that it does not interfere with their other tasks. Of course, as the economic and scientific development of the country progresses, their function may change to meet the needs of a changing situation, but in Yugoslavia it is still felt that in some fields of technology university research institutes have to play an important role in promoting industrial research.

54. As mentioned in the foregoing sections, some years ago university professors were encouraged to undertake research for industry on a contractual basis. Following the same line, a new institutional model has recently been created, being somewhere between the research association pattern and the contract research institute, but closely affiliated to the university. It might be useful to explain this type of institute through a concrete example. In 1961, the Institute for Machine Tools and Tooling in Belgrade was set up by the Government, the Faculty of Mechanical Engineering of the University of Belgrade, the trade association of machine-tool builders (Masinounion) and the trade association of cutting and other tool manufacturers (Alat), whose members represent well over half of the total manufacturing output in this branch. The Government provided for the building and for research equipment. The rate of subscription for each individual member-enterprise was determined to be 0.5 per cent of its annual turnover, on the understanding that during the formative period of three years the Institute should use the total amount of subscription fees for completing its research facilities. Currently, apart from the subscription fees, the Institute derives about 60 per cent of its income from contract work for member-enterprises, while the remaining 40 per cent is obtained from public funds. Professors and other members of the Faculty of Mechanical Engineering are part-time personnel and, currently at least, they greatly outnumber the full-time research staff of the Institute. As the Institute is separated from teaching departments, there is no evidence of its interference with the educational objectives of the Faculty. On the contrary, it provides an essential service by offering to post-graduate students research facilities which would not otherwise exist.

D. Conclusion

35. This paper is limited for the most part to reporting on the Yugoslav scientific policy relating to the development of [illegible] conducting industrial research. Other fields of scientific [illegible] activities that are a great concern to industrial research have been left untouched. It cannot be questioned that in the whole structure of [illegible] research a very prominent place is occupied by various disciplines of social sciences and especially by the science of economics, for the most important decisions to be made in industrial development, as well as in planning research work for the benefit of industry, are economic in nature. More descriptive than analytic, and not exhaustive in any sense, the foregoing discussion is still believed to provide a picture of the scientific policy that has pushed to the fore industrial research in Yugoslavia during the past several years.

36. This policy can be briefly summarized by stating that science can be made an efficient instrument of economic development of the country only if research is integrated with each sector of economy and if, in the given circumstances, special emphasis is put on applied research and development. This is the underlying philosophy of all the measures, ranging from the exemption from taxation of research expenditures to different forms of direct financial support of industrial research provided by public funds, that have been designed in order to induce industry not only to take over a greater share in financing research work at universities and other outside institutes, but also to set up research facilities of its own.

37. Judging by the number of the newly established research laboratories in industry, as well as by the enlargement of research activities of other institutes in the field of technology, this policy has proved to be a success. Since [illegible]0, the outlays for industrial research have been increased progressively and it can be anticipated that this trend will continue for years to come.

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VI. THE MANAGEMENT CONSULTANT AND THE INDUSTRIAL RESEARCH AND DEVELOPMENT INSTITUTE

Prepared by J.L. Mooney, Jr.*

Introduction

1. The industrial research and development institute has been an important contributor to the economic growth and improved standard of living in both developed and developing nations.

2. Of equal importance in this development of modern economies has been the contribution of the management consultant. He has helped in setting up well organized and properly financed research facilities. He has found new products to be technologically developed by the research institutes; he has then found markets in which to sell these newly developed products. He has improved the science of management, so that product and distribution costs could be lowered, thus allowing business to grow and employment to increase.

3. The achievements of industrial research institutes can be measured in direct proportion to their alliance with management consultants. The institute is best qualified in technological fields, the management consultant in business. When the two are properly combined, there are no limits to their industrial development achievement possibilities.

4. Each of the developing countries that either has or plans to set up such research institutes would do well to enlist the services of a good consulting group at least on a retainer basis, if not full time.

5. The discussion that follows will describe the management consultant, his relationship to industrial research, and how best to utilize his services.

A. The Management Consultant

History

6. Several thousand years before the dawn of history the first evidence of management took place when two Neanderthal men joined their efforts to perform a task which neither man could perform alone. This task might have been the moving of a heavy rock from the face of a cave. Management was necessary and self-evident, for only with management could prehistoric man first determine a need, communicate this need to his fellow man, direct the method of accomplishment, and co-ordinate the performance of work to effect the desired result. Thus, management itself has been here for many thousands of years.

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* J.L. Mooney Associates, United States of America.

7. It took the industrial revolution, however, to [illegible] evolution. This latter took place many [illegible] after the industrial [illegible] itself already become part of history.

8. As is so often the case in the evolutionary development of [illegible], the science of management was initially forced upon the world. [illegible] resort to managers because they, as [illegible] professionals, could [illegible] owners; instead, industry and commerce grew so large that the typical owner [illegible] more than he could effectively oversee. He therefore was forced, if he wanted to grow and acquire additional wealth, to seek others to look after his interests.

9. This great transformation from owner-manager to professional manager had its largest impetus from the demands of the First World War and from the great move toward mass production that occurred earlier in this century.

10. Concurrent with the growth and stature of professional management has been the growth of the management consultant.

11. The importance of the management consulting profession is evidenced by the fact that almost every new technique in the field of scientific management has been developed jointly by the consultant and by his working counterpart in industry. For example, each of the following have been developed not only by operating industrial personnel, but also by the management engineer (as he is often called): time-and-motion study; employee incentive plans (for both labour and management); work methods and standards; the principles and practices of organization and administration; market research; product development analysis; budgetary control; and a thousand others.

12. Thus, this important industry - the management consulting industry - has made major contributions to the operating efficiences of all segments of modern society, in all parts of the world. This industry, which had its beginning fifty years ago, currently has, in the United States of America alone, over 30,000 consultants (2,500 consulting firms; 24,000 employed consultants and 6,000 individual consultants) and does an annual volume of about $US1,000 million.

What a management consultant does

13. Briefly stated, the management consultant solves problems for management. In the words of the Association of Consulting Management Engineers (ACME), "Management consulting is essentially an organized effort, by specially trained and experienced persons, to help management solve managerial problems and maximize economic opportunities, through the application of objective judgement based on specialized knowledge and skill and systematic analysis of facts".

14. In the sphere of commerce and industry, the consultant is most often confronted with the solution of a problem that will directly improve the profit performance of a business enterprise; sometimes the problem is only indirectly involved with profits. Professional management, which includes management consultants, has long recognized the fallacy of the archaic belief that ownership or management could improve profits by exploiting workers. Quite frequently the consultant is called upon to suggest a work-improvement method which will ultimately improve profits through more effective utilization of available manpower. The consultant,

from personal experience and from the analysis of overwhelming statistical evidence, has come to acknowledge the fact that those industries which have the highest profits are the same industries that have the highest employee earnings. Thus, the solution of management problems almost invariably results in improved earnings and working conditions for all employees - management, white-collar and labour.

Who he is

15. The management consultant has many qualities; he is objective, impartial, experienced, educated, faithful, comprehensive and persuasive. To do his job properly, he must possess each and every one of these characteristics.

16. Most consultants have received university training in some technical specialty (i.e., engineering, marketing, economics, accounting, psychology, etc.). They have then gone into industry where practical experience has been added to theoretical training. Frequently their experience has included employment with more than one employer, and this has in itself given a broader point of view in their own particular technical endeavour. The experienced technician then joins a consulting firm, having himself achieved adequate theoretical and practical training in a specialized field to allow him to solve the problems that others encounter in this same field.

17. After the consultant has worked on projects for many different companies, he should be fully qualified as an acknowledged expert to act as project manager in planning and supervising similar jobs for other companies.

18. The management consulting profession has a similarity to the medical profession. In this latter there are general practitioners who handle general problems, but who usually refer more difficult problems to the specialist (i.e., pediatrician, dermatologist, ophthalmologist, etc.). There are consultants who handly general management problems, and then there are dozens of specialists. For example, there are men who are consultants in hospital administration, others who specialize in the administration of civic groups, and specialists in banking administration, corporate administration, or perhaps the administration of research and development bodies. There are also specialists in general management, administration and marketing finance. As in medicine, sometimes the general practitioner can properly diagnose and prescribe a cure for general problems concerning any part of the body; sometimes he realizes the problem is too complex and suggests a specialist. This happens in consulting in the same way.

How he operates

19. The management consultant assumes a passive role in obtaining clients. Because he has gained professional standing in a certain field and has therefore been accepted as a recognized authority, clients who have a need for his type of experience will seek him out, for it is the client who first recognizes a need, just as it is the patient who first feels a pain and therefore seeks a physician to make a diagnosis and recommend a cure.

B. Management Consultant [illegible]

Industrial research as seen by the consultant

20. The economies of the countries that have industrial research and development institutes have moved ahead at a far greater pace than th[illegible]. It must of course be said that merely having such an institute [illegible] promote economic growth and a better standard of living. It is only through the proper utilization of the industrial research and development institute that a country's industry can be materially assisted. This assistance, [illegible] through more effective utilization of assets (both human and material resources) applies equally to the largest and to the smallest countries.

21. There are innumerable examples in the United States of America of industries that have grown as a result of developments by the industrial research and development institute. Well-known examples of this are seen in the Xerox Company, whose "dry" copy machines were developed by the Battelle Memorial Institute; before this new product came on the market the Xerox Company employed only a few hundred people and was a relatively insignificant factor in the office-copying-machine industry, the company now has a dominant role in the industry, employs many thousands of people and operates all over the world. Thus, employment has been given to many thousands of people through this one product development. Another example is the tape recorder, for which Armour Research Foundation (now called IIT Research Institute) has held practically all the patents on both magnetic tape and recording heads and has licensees throughout the world.

22. On the other side of the size spectrum, the Industrial Research Center at the National Institute of Science and Technology in the Philippines has developed a new low-cost method for turning the country's coconut crops into processed components instead of merely exporting raw copra. This has changed the country's position in the coconut trade from just being a raw materials producer to opening up a whole new agriculturally based industry.

23. The management consultant sees the special value of the industrial research and development institute to the developing countries. Quite frequently there are not only economic limitations to industrial programmes, but also limitations of personnel and know-how. It is in this general area that the industrial research and development institute can be most useful to the developing economy, for problems that no individuals or companies would ever know how to approach or would have sufficient funds to solve can be solved economically at the institute.

Research capabilities and limitations

24. Research can make many conquests; research can cause many defeats. It is most important for the researcher, and even more so for the research administrator, to appreciate not only the capabilities of research, but also its limitations.

• [illegible] research [illegible]

• [illegible] must [illegible]

[illegible]

27. The management consultant is primarily concerned with problems of management. The effectiveness of industrial research varies directly with the quality of management of the research institute itself.

28. Thus, industrial research and development institutes must concern themselves with modern management methods if they wish to accomplish their assigned objectives.

29. The management consultant can perform several necessary functions in setting up industrial research and development institutes. He can assist in assessing the feasibility and type of facility that the economics and industrial levels of the area dictate; this he will do in an analytical, impartial and objective manner. He will have to become thoroughly cognizant with the psychological, political and historical factors involved, but he must first obtain all the fundamental facts.

30. The management consultant can assist in establishing a sound organization structure, fortified with practical administrative procedures. The one single feature of any human endeavour that has most bearing upon success or failure is the organizational factor. Without the soundest approach to the principles and practicalities of organization, it would have been impossible for such companies as General Motors Corporation to have grown to their current size, and to have thus been able to offer their customers the best products at the most reasonable prices, not to mention direct employment for 750,000 people, and indirect for perhaps over 1 million.

31. The management consultant can help in setting up a sound and practical financial structure for the industrial research and development institute. To this he can add appropriate budgets and controls to ensure that the management of each institute knows its exact financial position and also knows that it is approaching each technological objective with sufficient funds to achieve success.

32. After an industrial research and development institute is set up and operational, the management consultant can be of invaluable assistance. For example, to attract good research personnel there certain incentive programmes must be developed so that capable and desirable people will not only want to join the staff, but will also want to stay. The management consultant will have had considerable experience with many different situations in establishing practical employee incentive programmes.

33. The management consultant can provide invaluable assistance in providing certain practical business experience to the industrial research and development institute. Generally the institute is most interested in the question, "Can we make it work?". The management consultant is most concerned with the question "Will it sell?". Thus, he can provide assistance in guiding the objectives of research projects along industrially practical lines; this will include feasibility studies, market research and the like.

C. Using the Management Consultant

When to use the management consultant

34. The management consultant can be most useful in solving management problems that do not fall within the daily routine or normal experience of the industrial research and development institute. These problems can relate to the institute itself, or to client projects being carried on by the institute.

35. Thus, the management consultant should be counseled regarding problems of policy, defining objectives, organization, marketing, finance, and any of the other business problems that fall within his sphere of knowledge and training.

Typical problems consultants can solve

36. The consultant can assist in the solution of two types of problems: first, those that concern management of the industrial research and development institute itself, and second, those that concern projects for its clients. Often both types of problems are similar. Thus, a corporate reorganization study would follow a similar pattern to a reorganization study of an industrial research and development institute.

37. A brief listing of typical problems that can be solved by the management consultant follows:

(a) Top managment problems:

- (i) Defining company objectives and policies;
- (ii) Establishing management controls and performance records;
- (iii) Long-range planning;
- (iv) Improving communications,
- (v) Establishing more effective organization structure;
- (vi) Establishing executive incentive plans and compensation standards;
- (vii) Planning and arranging acquisitions, mergers, and divestments;
- (viii) General surveys;

(b) Research and development problems:

- (i) Analysis of company's product line;
- (ii) Analysis of new product design from economic and customer points of view;
- (iii) Review of engineering and research management and administrative capabilities, controls and over-all effectiveness;

(iv) [illegible]

(v) [illegible]

(c) Manufacturing problems:

(i) Plant location;

(ii) Plant requirements (size, facilities, lay-out, machinery, equipment, etc.);

(iii) Production processes and procedures;

(iv) Scheduling;

(v) Engineering standards;

(vi) Labour contracts and work standards;

(vii) Inventory control and materials handling;

(d) Marketing problems:

(i) Analysis of products and their customer appeal;

(ii) Planning and setting up channels of distribution;

(iii) Marketing cost analysis;

(iv) Pricing policy;

(v) Advertising, trade promotions and publicity;

(vi) Analysing market potential;

(vii) Export programmes;

(e) Financial problems:

(i) Setting up new business or industry;

(ii) Financing the new company (sources of capital and capital requirements);

(iii) Financial planning, budget control, cash flow analysis, cost control and audits;

(f) Personnel problems:

(i) Acquiring good people and keeping them;

(ii) Training programmes at all levels;

(iii) Compensation and incentive programmes;

(g) Office problems:

(i) Procedures and methods;

(ii) Equipment selection.

Requirements for the effective use of consultants

38. The booklet, "How to get the best results from management consultants" [illegible] listed the following as its requirements for most effective [illegible] consultants: 1/

"1. Careful definition of the problem

2. Careful selection of the consultant
Balance fee versus experience
Weigh one approach versus another
Important factor is results:
'A good job is well worth the cost, a poor one is a loss, no matter how attractive the price tag may have been'.

3. Agreement with the consultant on mutual obligations.
At conclusion, is organization capable of implementing the recommendations.

4. Proper supervision and support of the consultant's work

5. Follow-up on recommendations

6. Measure the results".

Selecting a consultant

39. The Du Pont management philosophy which enabled General Motors to become the world's largest industrial corporation illustrates a prime requisite in selecting a consultant. Mr. Pierre du Pont believed in finding the best man for the job and hiring him; he believed that most important was a "good man", for a good man, regardless of education or experience, knows what he knows and knows what he doesn't know.

40. Thus, in selecting a consultant, first look for a man who is basically sound, and whose judgement you trust. Then, be sure he has a sincere interest in your project, and adequate time to develop a satisfactory solution.

41. Give the potential consultant a clear definition of the assignment, and ask him to prepare a brief proposal on his approach, his time and manpower estimates, his cost estimate and his qualifications.

1/ Philip W. Shay, "How to Get the Best Results from Management Consultants" (New York: Association of Consulting Management Engineers, 1[illegible]).

42. Be more interested in the [illegible] of the team, or men, who will be assigned to the project (and to obtain this you must ask for specific names to be submitted with the proposal) than the over-all reputation or age of the consulting firm. Your problem will be solved only by the project team on location in your country, and not by the headquarters staff in, for example, London, Paris or Chicago.

43. Be wary of those consulting firms that do not in their proposals state firmly the involvement of one of their partners in your project. Do not ask for this, for nearly always the answer will be in the affirmative; the consulting firm should on its own initiative volunteer one of its partners' participation in each major project.

44. Your project is important to you; it must also be important to the consulting firm. This importance will be indicated by the team, or man, assigned to the project.

<u>Measuring results</u>

45. The booklet mentioned previously, "How to get the best results from management consultants", has a good check-list on measuring results of consulting assignments: 2/

> "1. The assignment has been carried out without upsetting the company's organization.
>
> 2. The original cost and time estimates were realistic.
>
> 3. The consulting firm's recommendations have largely been implemented.
>
> 4. The company organization accepts the recommendations as practical and is willing to 'live with them'.
>
> 5. Management has received a stimulus to its own thinking.
>
> 6. The company is willing to employ the same consulting firm again".

D. Conclusion

46. Members of the management consulting profession have been working jointly with industrial research and development institutes for many decades. Their joint efforts have accelerated the development of both the technological and the management sciences.

47. The accomplishments of management and technology can be seen and enjoyed throughout the developed nations. It is hoped that the developing nations will recognize this example and will therefore take the greatest advantage of the facilities that can be offered by industrial research and development institutes and by management consultants.

2/ Ibid.

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VII. THE ORGANIZATION OF TECHNICAL RESEARCH IN THE CZECHOSLOVAK SOCIALIST REPUBLIC

Prepared by Josef Dittert*

1. In Czechoslovakia, a number of industries have a tradition of long standing. The mining industry and the working of precious metals connected with it have had a world-wide reputation for more than five centuries. The Czechoslovak glass and textile industries have also been developed for many centuries.

2. The origin of the Czechoslovak technical school system is linked with the development of the country's industry. Recently, Czechoslovakia passed the 250th anniversary of the founding of its first engineering schools. It was these schools that began research activities in the country.

3. The importance of technical schools, and of the research work done at these schools, has become greater with the development of industry, especially the machine-building industry. It was only after the First World War that the largest industrial concerns (Škoda, Českomoravská Kolben-Daněk, the Poldi Foundry and the Iron Works at Vítkovice) founded their own research institutes, apart from the research facilities of the technical universities.

4. However, the demands of the developing industry could never be satisfied by the country's own research and development facilities. Thus, the advantageous licensing practice has come into widespread use, mainly in the newly-forming industries and in newly founded production branches.

5. The closing of the technical universities during the war-time occupation of Czechoslovakia by Nazi Germany interrupted the role of technical universities in the development of industrial research, and the orientation on the production of arms caused a rapid increase in development facilities in industrial enterprises. At the same time, the occupation of the country limited its contacts with the industry of Western countries.

6. The main development of the scientific, research and development basis of Czechoslovakian industry has, however, taken place since the Second World War, in connexion with the development of co-operation between the countries of the socialist group of nations.

A. The current organization of research and development in Czechoslovakia

7. The research and development institutions of Czechoslovakia currently employ 123,000 persons. Of this number, close to 10 per cent work at the Academy of Sciences and at university-level institutions, 68 per cent in industry and in civil engineering, 11 per cent in agriculture, forestry and water economy,

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* Director, Research Institute of Machine-building Technology and Automation, Prague.

5 per cent in medicine and the health services, etc. It is assumed that in the future the share of basic research will stay at approximately 10 to 12 per cent, and that the share of industry and civil engineering will increase slightly. It is intended to increase especially the share of the research and development basis in the machine-building industry, although it already represents more than 40 per cent of the total capacity of the research and development facilities of Czechoslovakia. The structure of research and development in Czechoslovakia corresponds, by and large, to the structure of its national economy.

8. The development basis is organized in industrial enterprises. Approximately two-fifths of the total staff of the research and development operations in the machine-building industry work at enterprise level. Their work is closely connected with the current work of the design and project groups, which are responsible for the immediate technical preparation of production.

9. In the enterprises all research and development departments are generally supervised by the director's deputy for technical affairs. He is fully responsible for the fulfilment of the "plan of scientific and technological development". The technical deputy heads a special department, which plans and studies the technical and economic aspects of the delivery programme of the enterprise, and which safeguards and supervises the work of the department for development and the technical preparation of production.

10. Applied research is generally carried out in independent institutes, functioning as "leading institutes" for a certain branch of industrial production - for instance for the manufacture of metal-working machinery; such a leading institute is the Research Institute for Machinery and Machine Tools. The function of branch leading institutes is entrusted to those institutes which are best equipped technically and which have the best staff, so that these leading institutes practically form the fundamental network of the research and development basis. Every branch leading institute has an advisory body, the so-called "Branch Board". Leading specialists of the branch are members of this Board.

11. Branch leading institutes are nominated by the central authorities responsible for the particular branch of industry. The main tasks of the branch leading institutes are:

(a) Analysing the scientific and technical level of the branch;

(b) Suggesting conceptions of the scientific and technical development of the branch;

(c) Evaluating proposed perspective plans, long- and short-term plans of the scientific and technical development of the branch;

(d) Encouraging interest in the solution of the problems of the scientific and technical development of the branch.

12. Branch leading institutes also participate in solving problems of international co-operation in science and technology, in the supply of qualified personnel, and in most cases they co-ordinate the solution of the most important tasks in the development of science and technology, included in the State plan.

Branch centres for scientific, technical [illegible] [illegible] and technical normalization centres are generally [illegible] institutes.

13. The branch leading institutes rely on the co-operation [illegible] development institutions of the branch and these are [illegible] with recommendations given by the branch leading institutes. [illegible] recommendations have direct economic consequences, they must be dealt with by the organization to which the respective institution belongs.

14. This branch system permits research workers to participate in the management of scientific and technical activities, whereas economic organs, including the ministries, concentrate in the field of science and technology, on perspective technical and economic studies, on setting targets and tasks and on the material and financial demands of research and development institutions.

15. To safeguard a proportional development of science and technology it is also necessary to attend to research in such fields, which are outside the scope and possibilities of individual enterprises of industrial branches. For this, State research institutes, controlled directly by central government organs, have been organized. One such institute in the machine-building industry is the State Research Institute for Thermal Technology, which even investigates some basic research problems, since it has scientists of very high quality. Another institute of this type is the institute which deals with the research of materials and their surface protection; a number of institutes investigate various problems of electrotechnics etc. Most industries have their own State research institutes for technical, economic and organizational problems, which investigate problems of economy in the respective branches, according to the requirements of central State authorities. State research institutes are financed from the State budget. When the research is carried out on order for individual enterprises, the costs of such a research project are usually paid for.

16. Research at universities and university-level schools is mainly organized directly at the respective university departments. Universities receive State subsidies, which permit them to increase their staff above the budget for teaching personnel and to finance research projects. They employ in this way mainly auxiliary personnel for work on research projects under the guidance of professors and associate professors. Outstanding students of advanced courses, assumed to be future scientists, are encouraged to participate in work on research projects.

17. Universities co-operate, on the one hand, on State research projects, and on the other, on problems required by enterprises. Some large enterprises also support the universities materially by giving them technical equipment. Such a case of close co-operation is, for instance, the co-operation of the Škoda Works in Plzeň with the Machine-building and Electrotechnics Technical University in Plzeň. Some technical universities also have independent research institutes, such as the Building Institute of the Technical University at Prague. Usually, however, universities have only small laboratories within individual departments. Even in the future Czechoslovakia does not expect to build larger research institutes connected with universities, since a broad network of research institutions exists in Czechoslovakia within the Academy of Sciences and the individual industrial branches.

18. However, other means are being searched for to allow a closer co-operation of top-level teaching staff with research. A number of university professors act as external heads of laboratories of the Academy of Sciences; joint institutions of the Academy of Sciences and universities are being founded - for instance, the Institute of Computation Techniques, jointly with the Technical University, or the Laboratory for Silicate Chemistry and Technology, operated jointly with the College of Chemical Technology of Prague. It is expected that external collaboration of university professors with industrial research institutes will be developed on a broader scale, because it is necessary to strengthen these institutes with highly qualified scientific personnel.

B. Central control of technical development

19. The organization of the research and development basis in Czechoslovakia is controlled in a unified way by State authorities, responsible for the planned control of the national economy. This makes it possible to avoid unnecessary duplication of the research and development institutions, and to concentrate the efforts of highly qualified staff members on projects which are of the greatest economic and social importance.

20. The group of centrally controlled institutions includes testing institutes, which see to it that technical standards and a high technical level of production are adhered to; furthermore, there are centres for technical standardization and patents services, and centres for scientific, technical and economic information, which concentrate documentation on the newest results of science and technology of the respective branches at home and abroad.

21. The State Committee for Development and Co-ordination of Science and Technology - an objective government authority - is responsible for a unified technical policy and an over-all co-ordination of scientific activities. The founding of independent research and development institutes in any branch is subject to approval by this Committee.

22. The basis of planning of the development of science and technology in Czechoslovakia is the so-called "long-term technical and economic concepts" of the development of individual branches of our national economy. These long-term concepts, in agreement with the planned demands of society, determine among others for a period of some ten years the main directions of development of science and technology. These long-term concepts are fixed in greater detail in the form of five-year plans and projected and made more and more precise in short-term, annual and biannual operational plans.

23. The plan of research in the field of natural, technical and social sciences directs the theoretical research. Its object is to discover new laws of nature and society, preparing thus a base for changes in social practice. Basically new solutions in technical sciences are utilised and applied by industrial research.

24. The content of the plan for the preparation of new techniques is the research and development of new machinery and equipment, new products and materials, and the research and development of new techniques and production processes. This

part of the plan is the widest one, since it includes the whole "industrial research", as well as research in civil engineering, agriculture, etc.

25. The object of projects in the technical standardization plan is the simplification, unification and generalization of products as to dimensions, parameters, properties, quality, etc.; and of production techniques from the points of view of utility, safety and economy of production. The role of the plan of typification in civil engineering is basically the same for the building industry as the technical standardization plan in other industrial branches.

26. Tasks set down in the plan of experimental projects and buildings aim to verify the results of research and development projects in building, and of investment problems; their usefulness, design and economy call for verification in practice. It is the object of experimental building projects to obtain experience and data for mechanized mass-building.

27. The plan of thematical tasks for inventors and innovators lists certain topics, solution of which by any citizen is rewarded. Rewards are paid by the institution which proposed the topic and which utilizes the solution.

28. The plan of the fund for science and technics determines, in accordance with the Czechoslovak planning system, the financing of the above-named plans. These means may not be used for any other purpose. They include not only money, but also investments, foreign currency and personnel assigned for research and development.

29. The plan for education and training of scientific personnel safeguards the demands of individual branches of sciences.

30. The plan for the increase of the technical level of production determines the way and the scope in which the results of especially important research projects will be applied, nominating at the same time the organizations which are responsible for the application. Very often important projects of development and science cannot be solved by a single organization. Because of their complicated nature and scope they require the material and timing co-ordination of many institutions in various branches. Such projects are planned as so-called complex projects. A co-ordinating institution is nominated for such a complex project; generally it is an organization which has the facilities for dealing with the greatest or the most important part of the problem. The co-ordinating institution shares the project with other collaborating institutions which have the required facilities. In the proposal stage the content of all parts of the project is clarified; parameters and stages of results, as well as a time-schedule for the individual stages of the project are determined. When agreement cannot be reached, higher authorities take a part in overcoming the difficulties.

31. The co-operation of partner-institutions is fixed by contract. Finally a plan is formulated for the complex project, worked out in detail, which after approval becomes a binding regulation for all participants. A co-ordinating committee is set up in the co-ordinating institution, including (besides the representative of the co-ordinating institution (chairman)) representatives of the main partners of the project, representatives of the ministry to which the co-ordinating institution belongs, representatives of university-level schools, etc. The co-ordinating committee remains in operation until the project is

finished. It has the right to inspect at all participating institutions, and if shortcomings are detected which the committee itself cannot deal with, it turns for assistance to higher authorities.

32. The State Committee for the Development and Co-ordination of Science and Technology proposes the main directions of development in science and technology, and the most important, especially the complex projects. After approval by the Government, this proposal becomes binding.

33. Individual ministries instruct their subordinate research institutes and enterprises to include these in their own plans. Plan proposals come back in the same way to the ministries. The proposals thus presented to them by subordinate organizations are inspected (whether instructions given by the Government have been safeguarded) and after co-ordination the ministries present these as their own proposal for the State plan to the State Committee for the Development and Co-ordination of Science and Technology. The proposals of the ministries are again checked, co-ordinated and then presented to the Government for approval.

34. From the preceding discussion, it is clear that the control of science is strongly centralized in Czechoslovakia; after all, there is a general trend towards centralization in the control of science throughout the world. The checking and evaluation of the results of research and development are carried out in each institution, with the co-operation of the corresponding higher authority. Practical results are the main criteria for evaluation.

35. Each research project ends with a final report, in which not only the results and their economical and technical contribution are evaluated, but also the method by which these results have been achieved. These final reports decisively influence further research and development activities.

36. The activity of the whole institution is appraised annually, on the basis of an annual report approved by the scientific council of the institution. Recommendations with regard to the trend of future activities and the building of new facilities are the main topic of these reports.

C. Co-operation of institutes for machine-building technologies with machine-building enterprises

37. Alterations in production processes and the production of new material can only be achieved with machines and machine equipment. Therefore, the products of the machine-building industry are of key importance to the economical development of every country. As long as a country does not have its own production in this field, it depends on imports. In Czechoslovakia, the volume of machine production has reached 37 per cent of the total industrial production, and products of the machine-building industries form nearly one-half of the country's export.

38. At the present stage of development, only the largest countries of the world - the Union of Soviet Socialist Republics and the United States of America - are able to manufacture all the existing range of machine products. Smaller countries - even the industrially highly developed ones - concentrate their efforts on only a part of the range, mainly because it becomes increasingly more difficult to keep products of the machine-building industry on the required high technical

level. Countries with level [illegible] their demand for machine-building products [illegible] to import even more. In Czechoslovakia, the [illegible] 10 per cent, and it is regarded as being [illegible] are concentrated in the research and development [illegible] industry.

39. The research and development branch which works directly [illegible] building industry (not including university facilities) [illegible] one-half of the resources of the country employed in this field. [illegible] (nearly one-fifth) safeguards the development of machines and other technical equipment for machine building. This part of research and development [illegible] from the point of view of control and methods of management, to [illegible] consolidated branch, and is therefore suitable for elucidating the main relations between industry and the research basis.

40. The research basis of technical equipment for machine building is distributed in three levels of control. Three state research institutes are under central control; they deal with:

(a) The application of technical sciences in machine building;

(b) The properties of materials for use in machine building;

(c) The economics, organization and general modernization of machine building enterprises.

41. These three institutions are financed by the State budget, and their scope of activity includes the entire machine-building industry. The third of the institutions named above includes, as a separate unit, the Machine-Building Institute, which provides training for the leading executive staffs of the machine-building industry. Together with design institutes, these organizations represent 14 per cent of research and development in the field of machine production for the machine-building industry.

42. The lower level of management for safeguarding the needs of our national economy in machine-building products for the machine-building industry, which is now in the process of being organized, will have as subordinate organizations research institutions, which will link the research of a certain type of machine-building technology with the research of equipment for the use in this technology. Thus, for instance, the research institute for machining and machine tools is the central organ for the research and development of all types of machining, used in machine-building enterprises. At the same time, this institute works on problems common to the production of machine tools, such as control systems for programmed machine tools, typified parts of machine tools, theoretical problems of vibration, rigidity of systems, etc.

43. It divided its capacity at a ratio of about 1:1 to research of technology, aiming to the typifications of technological processes, and on research of the construction of machine tools.

44. Research institutions for the following branches are organized similarly to those of machining research: foundries, forming, welding, heat treatment, assembly, surface treatment, non-destructive defectoscopy, measurement and material handling.

45. [illegible] of the research and development programme in the field of [illegible] for use in the machine-building industry is concentrated. The [illegible] of these facilities are met mostly ([illegible] per cent) from centralized sources, and in part ([illegible] per cent) by enterprises paying for services rendered by institutes [illegible] co-operation contracts.

46. On the enterprise level, [illegible] per cent of the research and development programme for machine building (for the machine-building industry) are organized. These organizations are mainly concerned with developing products, their projects usually ending by working out design documentation for production. The costs of these organizations are paid directly from sales of the production of manufacturing enterprises. At this level, state subsidies are seldom accorded (only for projects of wide importance).

47. The inner organization of a research institute dealing mainly with professional technology depends on its size. The Research Institute for Machining and Machine Tools, which at present has a staff of about 350, is organized as follows: 1/

(a) 45 per cent of the staff are concerned directly with research;

(b) [illegible]1 per cent prepare and produce functional samples and prototypes;

(c) 29 per cent of the staff are employed in technical services (technical and economic information, standardization and patents for the given branch);

(d) 7 per cent are administrative personnel.

48. As to the degree of training and education, there are 10 per cent scientists and 50 per cent of the personnel are university graduates.

49. In 1964, the Institute worked on eleven projects of State-wide importance (about 50 per cent of the research capacity), fifty branch projects (about 30 per cent of the capacity), and twenty cases of large-scale co-operation with enterprises (about 20 per cent research capacity).

50. The extent of co-operation with enterprises is fixed beforehand, and conditions are agreed upon by means of a contract, settling the time schedule and payments. Special attention is given to the part of the contract which determines the application of research results by practical utilization. It is often thought that research is able to present a ready solution for the most variegated cases. Experience, however, shows, that personnel of the manufacturing enterprise should participate in the final stages of solving the project, in order to assure close continuity and conserve valuable experience gained in building the prototype and in verification tests.

51. It has been found unsuitable to turn over the results of research institutes in the form of design documentation. It is better to deliver a prototype with

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1/ For a simplified organization scheme, see figure annexed to this paper.

the appropriate documentation, and to make sure of a sufficient [illegible] consultations in designing the product in the manufacturing enterprise [illegible]. In the course of production preparation, carried out directly in the [illegible] enterprise, it is possible to respect far more the technologically specific conditions of the manufacturing process, and to reflect these trends in the production documentation. In every case, participation of research staff is required in solving problems arising in the course of production by errors or defects in the documentation, especially in the testing stage. In the case of new types developed in the enterprise, it is even prescribed that the enterprise must take such a product for long-term testing to the institute, as far as this is technically possible. In every case the institute is required to issue a type certificate after the test; only then is full-scale production permitted.

D. Problems of the further development of the research and development basis of Czechoslovak industry

52. The central problems of the further development of the research and development programme of Czechoslovak industry differ in no way from similar problems of other industrially developed countries.

53. The first problem is caused by the fact that successful solutions of research projects are becoming increasingly affairs of a whole team of research and development workers, whose fields of work often greatly differ. Studies are being made of how to set up such teams and how to control co-operation within and without the team with specialized institutions.

54. The second problem is the participation of theoreticians in the solution of research problems. Basic research is becoming increasingly important, but is very costly. The easiest way is international co-operation. Several such international research institutions are already in operation in the socialist States.

55. The third problem is caused by the rising tendency to increase the concentration of forces even in applied research. The rate of concentration of forces is set by the most highly developed, largest countries, and smaller countries have no alternative but to stop work in more and more fields of production, in order to be able to concentrate forces on the remaining fields. A consequence of this tendency is the increase of the international exchange not only of industrial products, but also of the results of research in the form of licences. The scope of business in the field of mental work is coming to be so important, that one is quite justified in speaking of the formation of a research industry.

56. The author regards the evaluation of the efficiency of research and development as a fifth problem, which becomes especially sharp in the case of centralized control of industrial development in the machine-building industry. The economic effects of new designs of machines and equipment may be found at the producer level as well as at the consumer level. For the consumer-user effect is in labour material and energy saving throughout the period of use of the given machine. The producer observes the effect once - in preparing and producing the product. For an economic evaluation of a new design, the total social efficiency must be expressed as the sum of the single-time effects in the producing

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enterprise and the effects in the using enterprise (for the whole period of utilization). Using the same scale of measurement for the machine-building enterprise and for the user of its products is, in practice, often found to be a grave hindrance to the economic development of a country.

57. Finally, the sixth problem of the further development of research and development has its roots in the prolonged decision-making process by higher authorities, and thus in the great risk which one must undertake when taking a decision in this field. It is only fair, if a certain part of this risk is shared with the leaders, who must be highly educated and qualified in this field and have the full confidence of their superiors, that the whole of society, by means of State participation in expenses connected with research and development, should participate.

58. The Government of Czechoslovakia expends great sums of money so that the products of Czechoslovak industry have a high degree of technical perfection, and thus can strengthen the good tradition of the country's industrial products.

ANNEX

SCHEMATIC DIAGRAM OF RESEARCH INSTITUTE OF MACHINING AND MACHINE TOOLS

DIRECTOR — Scientific Council of the Institute with its committees

- Secretariat
- Technical inspection
- Administration
  - Economic planning and financing
  - Labour economy
  - Supplies
  - Records
- DEPUTY DIRECTOR
  - Processing of technical and economic data
  - Research planning
  - Standardization
  - Patents
  - International collaboration
- Machining technology research
  - Typification of technological methods
  - Machining research
  - Tool research
  - Measuring research
  - Machining testing laboratory
  - Machining performance norms
- Machine tools construction research
  - Basic characteristics of machine tool systems
  - Machine tool control systems
  - Machine tool design
  - Machine tool testing hall
- Production
  - Machine shops
  - Production planning
  - Production control
  - Machine operators and service engineers

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VIII. ORGANIZATION OF INDUSTRIAL RESEARCH IN FRANCE

Prepared by Jean-Louis Kahn*

Introduction

1. French industrial research institutes cannot be viewed as detached organizations. Their establishment - although of fairly recent date - and their activities are an integral part of the history of French science and industry over the last two centuries.

2. A considerable number of products manufactured and processes employed by French industrial firms are derived from discoveries that originated within some of these very firms.

3. Numerous findings of prime importance in the history of technical development can be traced to presently existing French industrial enterprises. The names of world-known French companies can be cited in connexion with essential discoveries relating to reinforced and prestressed concrete, steam and gas turbines, lighting gas, liquid air, automobile construction and tyre manufacture, clock and watch-making, combat-tank manufacture, printing, photography and cinematography, iron metallurgy processes, aluminium preparation methods, metallurgic tests, chemical processes, wireless telegraphy, television, etc.

4. The laboratories, test stations and research departments of these firms are still contributing to scientific and technical progress.

5. It must be pointed out that French power production industries were nationalized immediately following the Second World War. This led to the creation of "Charbonnages de France", "Electricité de France" and "Gaz de France" that ensure, each in its own field, the production and distribution of public utility materials and electric power throughout France. By reason of their magnitude, these national enterprises were able to set up extensive research departments. As an example, the Division of Study and Research of "Electricité de France" has a staff of some 1,700 persons.

6. Private industrial research establishments, on their part, employ approximately 90,000 persons.

7. The majority of enterprises with research departments are organized along lines that make them very similar to what it has been decided to call "research institutes".

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* Engineer, Association Nationale de la Recherche Technique, Paris.

A. Research institutes connected with universities

8. There exist in all large French cities science faculties or essential research organizations more or less directly connected with the universities.

9. The bulk of the budget earmarked for university research is administered by the National Scientific Research Centre, which itself operates on a yearly budget of over 300 million francs.

10. Institutes have been created within university facilities that devote a major part of their activities to industrial research and the training of expert engineers to participate in research work.

11. Here are a few examples:

(a) Within the compass of the University of Toulouse: the National College of Electrotechnics, Electronics and Hydraulics, and the Institute of Chemical Engineering;

(b) Within the compass of the University of Nancy: the National College of Chemical Industries, and the Petrographic and Geochemical Research Centre;

(c) Within the compass of the University of Strasbourg: the National College of Chemistry and the Institute of Chemistry etc.

12. The Atomic Energy Commission, an offspring of the French university complex that itself has played an essential role in the discovery of nuclear power, employs 23,000 persons. The Commission, a basic research organization, works along with industry in the development of nuclear techniques.

B. Research institutes under contract

13. Research institutes under contract - comparable to such establishments in the United States of America, such as the Battelle Institute - have emerged in France over the past few years. They are still of moderate extension but look forward to developing through their work, particularly for the account of small and medium-sized enterprises that are not in a position to have their individual research facilities.

14. They join private firms which for a long time have been carrying out research work under contract, in specialized fields, for clients located in various parts of the world. As an example, one enterprise of this type, specialized in hydraulics, employs some 1,000 persons in its research departments.

C. Organization of French research institutes

15. The average size of the large French industrial firms is much smaller than that of the large companies in the United States of America and the industrial

organizations in the Union of Soviet Socialist Republics; and research budgets, naturally, are in proportion to the size of the enterprises.

16. The establishment of the Common Market led, in France, to a regrouping of enterprises and, subsequently, of research services. However, prior to these measures, joint research organizations had been created in France. The country had become aware of the need for these as early as 1943, in full war-time.

17. The Statute of 17 November 1943 on the control of professional interests stipulates:

> The organizations entrusted by law with the control of professional or interprofessional interests on a national, regional or local scale may be authorized, where work is involved that falls within their province but cannot be adequately handled by their facilities proper or through private enterprises, to establish professional companies or establishments... .
>
> Founder members of a professional organization or members who derive benefits from the activities of the establishment may be required to share individually in its starting costs and operating expenses... .

18. Professional establishments did not emerge in their particular fields through an uncontrolled process. They were created by the head of the professional organization and remained subordinate to him, notably with regard to the appointment of the manager and the members of the board of directors.

19. Professional organizations were dissolved, but several organizations, based on this statute, materialized in the professional field immediately after the war. Among such professional organizations can be cited: the Iron and Steel Metallurgy Research Institute, that subsists on taxes levied on deliveries of iron and steel products; the French Petroleum Institute, that benefits from taxes included in the sales price of fuels; and the Plastic Materials Research Centre, whose resources are derived from taxes approved by decree.

20. The following Statute of 22 July 1948, determining the status of industrial technical centres, stipulates:

> In every branch of activity where the general interest dictates it, and on the advice of the trade union most representative of the employers, executives and employees in such branch of activity, there may be created, by decree of the Ministries of Industry and Commerce, of National Economy and of Finances, public utility establishments called "Industrial Technical Centres" ... .

21. The purpose of the industrial technical centres is to promote the development of techniques, [illegible] to contribute to increased output and better product quality. They [illegible] the results of their work to the branch of activity concerned.

22. The industrial technical centres are administered by a board of directors that delegates to a manager [illegible] all the powers necessary to administer a particular centre; this [illegible] must be ratified by the Ministry of Industry and Commerce.

23. The members of the board of directors are appointed by a decision of the Ministry of Industry and Commerce. A government commissioner has a right of veto.

24. The funds available to the industrial technical centres are derived mainly from: compulsory participating fees paid by the enterprises engaged wholly or partially in the branch of activity concerned; remunerations for services rendered; income from property and securities they own; subsidies, donations and bequests.

25. Interprofessional industrial technical centres may be created under similar conditions.

26. Centres governed by the Statute of 1948 are: the Hydraulic Binders Study and Research Centre; the Smelting Industries Technical Centre; the Clock and Watch-Making Industry Technical Centre; the Fatty Substances Institute; the Textile Institute of France; the Garment Industries Technical Studies Centre; the Wood Technical Centre; the Agricultural Canned Goods Technical Centre.

27. Some of the centres are formed as private associations and operate under official technical supervision. Contribution to their initial costs and operating expenses is not binding upon the members of the corporation concerned. Among these are the French Ceramics Society, the Oil and Oleaginous Substances Research Institute, the French Rubber Institute, etc. Other centres are constituted as foundations.

28. All of these institutions are of greatly varying importance. The more important ones, such as the Iron and Steel Metallurgy Research Institute and the French Petroleum Institute, have an annual budget between fr. 30 and 80 million. The budget of the majority of the others ranges from fr. 1 million to 10 million.

29. It must be specifically borne in mind that these institutions would have no significance if they were segregated. First of all, they gather basic data for their work at the very source of fundamental research, the French schools and universities.

30. Secondly, their effectiveness stems from the very close relations they maintain with the industrial enterprises of their corresponding fields of activity. Through experiences carried out in the plants and on the work sites of these enterprises, they are able to specifically determine the essential points of the problems involved. These enterprises, moreover, afford them the possibility of developing and putting to use the new processes that they formulate.

D. Activities of Industrial research Institutes in France

31. The few examples given below will serve to illustrate the role of the industrial research institutes:

Iron and steel industries

32. The French iron-hoisting industry is based, for the most part, on the iron-ore body of Lorraine, in the north-east region of France, and on coal fields located in

the northern and eastern sections of the country, i.e. near the German and Belgian borders and removed from the sea.

33. Over the past fifteen year, this industry has been confronted with grave competitive problems: competition with the iron industry of the Federal Republic of Germany, incorporated in the European Coal and Steel Community, and with "waterside" iron and steel enterprises utilizing ores of a richer iron content than the Lorrainese ore.

34. The iron and steel companies of Lorraine were all faced with practically the same technical difficulties. It was therefore natural that they should pool their resources to undertake the necessary research. The Iron and Steel Metallurgy Research Institute (Institut de Recherches de la Siaérurgie - IRSID), formed some ten years previously, was the ideal medium to carry out this work.

35. The IRSID has in Saint-Germain-en-Laye - within the sphere of the University of Paris - a scientific research centre employing about 400 persons. There, the physical, chemical and physiochemical properties of ores, castings, metals and alloys are scientificall; studied and new processes are investigated at laboratory level.

36. However, as has already been stressed, a research institute can perform efficiently only by working as closely as possible with the industry from which it stems. The IRSID therefore set up a test station in Maizières-lès-Metz, in the very heart of the Lorrainese ore region. This station has shops where industrial and semi-industrial ore-enrichment installations can be erected for experimental purposes, as also a pilot steel-plant where new processes are tested. More than 300 persons work in this station.

37. The findings of IRSID are directly put to use by the French iron and steel companies which help finance it. Also, IRSID takes out patents than can be sold, or on which licences can be granted, to French and foreign firms.

38. Discoveries stemming from the work of IRSID have repercussions on industries seemingly far-removed from iron and steel metallurgy. Thus, studies on automation have led to considerable improvement of industrial measuring instruments, such as those relating to thermometry, gas analysis, etc. Lastly, the over-all knowledge acquired in the field of iron and steel metallurgy by the IRSID engineers qualify them to act as consultants for the installation of iron- and steel-works in countries in process of industrialization.

Coal mining

39. Research conducted by the research centre of an industry specializing in the conversion of raw materials may - as already pointed out - have considerable repercussions on equipment industries.

40. As an example, investigations conducted by the Coal Mining Study and Research Centre of France resulted in the construction of various and entirely new types of mine equipment, and also of equipment manufactured in different areas of the mechanical and electrical industries.

41. This interrelation of industries is a very important factor since, firstly, it multiplies the sources of inventions, and secondly, considerably increases the utilization potential of any given discovery.

Smelting industries

42. The Smelting Industries Technical Centre (Centre Technique des Industries de la Fonderie - CTIF), in addition to carrying out general research on the metallurgy of castings, steel and various alloys, as well as on moulding and other processes, directly assists enterprises in its field.

43. This direct aid may be of an individual nature, consisting in such cases of either interviews in the plant or control tests performed in the CTIF laboratories for the establishments concerned. Interviews may deal with the replacement of smelting installations or with the installation of control equipment.

44. Direct aid may likewise be furnished collectively, for example:

(a) Conferences or seminars give technicians in the particular branch the opportunity to exchange know-how;

(b) The CTIF gives courses of instruction to trainees from various fields;

(c) A truck equipped for demonstration purposes makes the rounds of the plants;

(d) Technical training films, made in the shops, are intended to acquaint personnel with new manufacturing processes and with various types of equipment installations.

45. Technical progress groups have been organized with a view to concentrating on those technical problems confronting firms that seem to offer the most advantageous solution, and establishing guidelines on manufacturing costs.

46. Basic documentation is compiled to define and perfect methods of manufacture. CTIF engineers contribute considerably to professional training in the smelting industry by giving lectures and courses, taking part in examining boards, etc. The CTIF organises study trips and inspection tours abroad, and ascertains that the industry is represented at international conventions and conferences.

Normalization works

47. Researchers of the professional centres, by their knowledge both intimate and general of the properties of products of a specific industry, are particularly qualified to play a leading part in normalization work pertaining to their field. To give an example, the Scientific Director of IRSID supervises normalization work in the iron and steel industry.

E. Documentation services

48. In the realm of documentation, research institutes naturally render important services, as can be seen from the few examples given below, taken from many.

49. At CTIF - which has already been discussed - the Technical Information Department employs some thirty persons. It includes a documentation office, and a publishing office and society. The documentation office examines 350 magazines,

prepares analytical record cards and has items translated. The publishing society puts out, in addition to brochures and other printed matter, two periodicals, one dealing with the work of CTIF engineers and the other giving an over-all view of activities in the industry.

50. The French Fuel and Electricity Institute, on its part, publishes a monthly bulletin containing some 200 article analyses and some twenty book reviews. The bulletin is distributed in twenty-four countries.

51. The Interfederal Technical Union of Buildings and Public Works has created a technical information telephone service. Replies to questions submitted are supplied either immediately, from the file cards, or within forty-eight hours at most.

52. In addition, the majority of research institutes keep indexed files of laboratory equipment and products pertinent to the work in their respective fields.

F. Review of main organization areas of industrial research institutes in France

53. The main organization areas of industrial research institutes in France will be reviewed in their over-all aspect, classified by industrial sectors. (The figures indicated are taken from 1963 statistics.)

Mining industry

54. The institutions in this field are:

(a) Bureau of Geological and Mining Exploration: It employs about 1,000 persons. Its object is to promote the exploration and exploitation of French subsoil resources, with the exception of hydrocarbons, and to perform or have performed the geological and mining exploration work required for this purpose. It pursues a considerable portion of its activities outside of the French territory. It conducts, on the one hand general research work relating notably to general geology, geophysics, mineralogy, mining geology and ore enrichment, and, on the other hand, specific research work, such as the exploration and study of index planes and deposits, etc.;

(b) Coal Mining Study and Research Centre of France: It employs, as was already noted, some 700 persons. Its research work applies to explosives, the effects of harmful dust, coal preparation, agglomerating methods, coal chemistry, carbonization, combustion phenomena, and the various mine exploitation techniques;

(c) French Petroleum, Fuel and Lubricant Institute: It employs around 1,500 persons. Its research work concerns: first, petroleum prospecting and production - sedimentology, prospecting methods and notably geophysical methods, drilling and production techniques; secondly, petroleum refining methods and the chemistry of petroleum. laboratory investigations and studies of industrial applications; lastly, the uses of petroleum products and the operation of engines. The latter studies are very diversely oriented, ranging from tests on conventional engines of the automobile industry to advanced research on fuel piles, magnetohydrodynamics, etc.

(d) French Fuel and Electricity Institute: [illegible]. Its purpose is to promote the rational utilization [illegible] development of thermic sciences.

Gas industry

55. The institution serving the gas industry is the Directorate of Studies and New Techniques of "Gaz de France": It employs around 500 persons. It does general research work: laboratory investigations and industrial tests relating to the processing, production, storing, transportation, distribution and uses of gas. Moreover, it supplies documentation and technical assistance to the other departments of "Gaz de France".

Metallurgy industry

56. The following institutions serve this industry:

(a) Iron and Steel Metallurgy Research Institute: It employs over 700 persons. Its research work involves the geological and mineralogical exploration of deposits, iron-ore enrichment, coal-coking and blast-furnace techniques, open-hearth, basic Bessemer, oxygen and electric steel-plant techniques, and modern casting methods. It likewise deals with rolling-mill techniques, the problems of transmission of liquids and heat, and, finally, all fundamental physical and chemical research relating to the iron and steel industry;

(b) Smelting Industries Technical Centre: The Centre employs more than 300 persons. Its activities have been discussed above (see paras. 42-46).

Mechanical industry

57. The institutes serving this industry are:

(a) Clock and Watch-Making Industry Technical Centre: It employs some forty persons and helps to promote clock and watch-making techniques;

(b) Welding Institute: It employs some 250 persons and provides research, documentation, technical assistance and training;

(c) Stamping and Forging Industries Technical Centre - Ventilating, Air-Conditioning and Heating Industries Technical Centre: These are expected to contribute to important developments;

(d) Theoretic and Applied Optics Institute: The Institute employs about 100 persons doing research work in the various areas of optics;

(e) Automobile, Motorcycle and Cycle Technical Union: It employs some 100 persons. Its activities are devoted to general research work for the automobile industry, documentation and normalization;

(f) National Farm Machinery Research and Testing Centre: The Centre employs over 200 persons. Its purpose is to study in all their technical and economic aspects the over-all problems relating to farm mechanization and modernization, to find new mechanical solutions, and to adapt known solutions to agricultural techniques, soil and climate conditions, as well as to economic conditions resulting from the technique employed and the exploitation;

(g) Aluminium Technical Centre: It employs about 100 persons. It conducts all research work relating to the use of aluminium in all fields;

(h) Machine-Tool Studies and Research Centre - Screw Cutting Industry Technical Centre - Metal Construction Industrial Technical Centre: These, while only recently organized, are expected to contribute to important developments;

(i) Higher Institute for Materials and Metal Construction: This Institute employs some 100 persons. It conducts research on the physics of materials, industrial mechanics and metrology, and handles some of the problems involving automation;

(j) Association for the Development of Mechanical Industry Techniques: This establishment, expected to contribute to important developments, acts as a co-ordinating medium.

Electricity and hydraulics

58. This field is served by the following institutions:

(a) Directorate of Studies and Research of "Electricité de France": It employs approximately 1,700 persons. Its research covers all problems relating to electric-power production and distribution, as well as those in the field of hydraulics applying to hydroelectricity;

(b) Scientific and Technical Research Centre for the Development of Arid Zones and Energetics and Hydraulics Equipment in all Regions: This Centre employs some forty persons;

(c) Central Laboratory for the Electric Industries: It employs about 250 persons. It is in charge of official metrology in the field of electricity and conducts numerous investigations relating to metrology, as well as tests at the request of all public and private concerns;

(d) French Electrothermics Committee: This Committee acts as a co-ordinating medium in its field.

Transportation

59. The Research Departments of the French National Railway Company employs some 300 persons and are divided into two sections, one handling traction and rolling-stock problems, and the other those relating to fixed installations (tracks, landscaping, etc.).

Chemical industries

60. The following institutions serve this field:

(a) National Applied Chemistry Research Institute: It employs more than 300 persons and does extensive research work in the fields of chemistry and physicochemistry with a view to solving problems connected with the chemical and associated industries;

(b) Fatty Substances Institute: It employs some [illegible] persons. Its research work involves notably oils, soaps, margarine, animal fatty substances, etc.;

(c) Oil and Oleaginous Substances Research Institute: It employs more than 2,000 persons. A large portion of this staff is distributed over an area of more than 12,350 acres utilized for some twenty experimental plantations and test centres that the Institute has installed in Africa and in the Pacific region;

(d) French Rubber Institute: It employs approximately 1[illegible]0 persons. Its research work applies to both natural and synthetic rubber. The Paris laboratories work along with those of Cambodia, the Republic of Viet-Nam and some countries in Africa, and in close co-operation with the Institute of Malaya, Indonesia, Ceylon and the United Kingdom, through the co-ordination of the International Rubber Research and Development Board;

(e) Rubber Research and Control Laboratory: It employs some forty persons and concentrates on the study and quality control of rubber, and on problems involving its use;

(f) Glass Institute: It employs around twenty persons. It conducts tests, does some research and acts as a co-ordinating and documentation medium;

(g) Plastic Materials Research Centre: It employs some thirty persons and conducts basic research involving rheology, thermomechanics, physicochemistry, the electrical properties and the aging of plastics;

(h) Mineral Phosphates Research Centre: This is discussed below;

(i) French Road Tar Technical Centre: It conducts research regarding road-paving material.

Building and public works

61. Some of the institutions in this field are:

(a) Central Laboratory of the Department of Civil Engineering: It employs some 350 persons and is directly dependent upon the Ministry of Public Works;

(b) Hydraulic Binders Study and Research Centre: It employs about eighty persons. Some of its research is of a basic nature, while the rest relates to manufacturing techniques and control methods;

(c) Tile and Brick Technical Centre: It employs some sixty persons. Its work involves tile and brick manufacturing techniques, production materials and numerous application problems;

(d) French Ceramics Society: It employs some seventy persons. It conducts important basic research work involving refractory products, as well as studies on the most varied applications of ceramics;

(e) Scientific and Technical Buildings Centre: It employs approximately 220 persons. It studies problems connected with acoustics, lighting and fire-prevention, perfects methods for the determination of quality of materials used in construction, and assists in establishing specifications and achieving normalization;

(f) Inter[illegible] [illegible] Buildings and Public Works: This establishment [illegible] co-ordinating [illegible] research organizations;

(g) Buildings and Public Works [illegible] Experimental Centre: This centre, a subsidiary of the [illegible], employs some [illegible] persons. It conducts research on soils, road-paving materials, concrete, metals used in construction and particularly in reinforced concrete, etc.

62. At Saint-Rémy-les-Chevreuse, on the outskirts of Paris, are grouped the Ventilation and Air-Conditioning Scientific and Technical Committee, the Buildings and Public Works Applied Research and Technical Improvement Centre, the Institute for Applied Research on Reinforced Concrete and, in the field of civil engineering, the Institute for Applied Research on Wood, the Institute for Applied Research on Metals, the French Association for Research on Materials and the National Testing Stations for Civil Engineering Materials, as well as the Technical Association for the Development of Applications of Blast-Furnace Slag.

Leather, textiles and garment industries

63. The following institutions serve these industries:

(a) Leather Technical Centre: It employs some one hundred persons;

(b) Textile Institute of France: It employs more than 350 persons. It co-ordinates the activities of eight regional laboratories and conducts basic research in chemistry and physics, as well as technical studies;

(c) Garment Industries Technical Research Centre: It employs some fifty persons. It undertakes short-term research projects involving present techniques, as well as long-range studies in view of developing new manufacturing processes. In this connexion, the Dyeing and Cleaning Technical Centre can also be cited;

(d) Cotton and Exotic Textiles Research Institute: It employs approximately 1,500 persons. Its work applies to the following plants and textiles: cotton, sisal, jute and grass-cloth. Its activities extend to the following fields: agronomy, entomology, genetics, phytopathology and technology. It has seventeen experimental stations or centres in the French-speaking African States and in Madagascar;

(e) Technical Association for the Production and Use of Linen and Other Bast Fibres: It employs some twenty persons.

Wood industry

64. The institutions serving this industry are:

(a) Wood Technical Centre: It employs over fifty persons. Its activities centre on forest exploitation, saw-mill operation, the biological and chemical study and technological testing of woods, wood-working, glueing, bonding and preserving methods, and fire-proofing processes;

(b) Tropical Woods Technical Centre: It employs more than 200 persons. It includes a main establishment located in Nogent-sur-Marne, and branches installed in Ivory Coast, the Congo (Brazzaville), Gabon and Madagascar.

Paper and cardboard industries

65. The Paper, Cardboard and Cellulose Industry [illegible] employs some fifty persons. Its research deals with paper pulps, the [illegible] of paper sheets, paper grades, paper industry engineering [illegible].

Food industry

66. The Meat Curing, Pork-Meat and Meat Canning Technical Centre and the Technical Training and Improvement Centre of the Intersyndical Union of the French Biscuit, Cookies, Instant Foods and Desserts, and Dietetic Foods Industries employ some ten persons each.

67. The Martinique, Guadeloupe and Reunion Cane and Sugar Technical Centre, the Agricultural Products Canning Technical Centre and the National Canned Foods Institute each employs some twenty persons.

68. Other institutions serving the food industry are:

(a) Laboratory of the National Syndicate of Sugar Manufacturers of France: It performs analyses of products used in sugar manufacturing, as well as conducting industrial research;

(b) French Coffee, Cocoa and Other Stimulating Plants Institute: It employs more than 700 persons in its branches in France, some countries of Africa and Madagascar;

(c) French Overseas Fruit Research Institute: It employs over 200 persons. It has many laboratories and testing stations in overseas territories;

(d) French Vinegar Industry Research Centre: It conducts technological research;

(e) Wine Technical Centre: It employs more than 100 persons;

(f) French Industrial Beet Technical Institute: It employs some forty persons.

G. The National Technical Research Association

69. The research institutes can contact the research departments of the large industrial firms within the framework of the National Technical Research Association (Association Nationale de la Recherche Technique - ANRT), which has its main office in Paris.

70. The general aims of the Association are to help its members operate more efficiently through the development or establishment of all suitable channels of communication, the pooling of the know-how, requirements, experience and availabilities of each, the voluntary co-ordination of certain work activities and the constitution of every means for joint research and action, and to ensure their joint representation before the public authorities and the qualified foreign and international organizations.

71. The association pursues its activities for ... [illegible] committees and technical groups whose task it is to carry out ... [illegible] and to release various publications.

H. Research institutes in France ... [illegible] further industrial development of Africa

72. In conclusion, the author will describe as an example one of the numerous research institutes established in France to further the industrial development of Africa. The Centre d'Etudes et de Recherches des Phosphates Minéraux (CERPHOS), a former technical division of the North African Phosphates Agency, assumed legal status when the Agency ceased to exist.

73. The average phosphate content of crude ore extracted in Algeria and Tunisia was about 60 per cent whereas Moroccan crude ore had a phosphate content of 70-75 per cent. The main function of the Agency was to ensure a common market for these ores. It fulfilled this assignment, on the one hand, through commercial operations in which sales of these ores were co-ordinated and, on the other hand, by initiating technical research with a view to enriching the Algerian, Tunisian and, eventually, Moroccan ores. The phosphate content of the Algerian and Tunisian was increased to 65 per cent at the outset and, recently, to 75 per cent.

74. The beginning of exploitation of the Taïba and Benin deposits, in Senegal and Togo, respectively, led to new research for the purpose of increasing to 80 per cent the phosphate content of the ores of both West and North Africa. The Agency, and subsequently CERPHOS, had charge of the over-all research work.

75. The organizational set-up of the technical facilities of CERPHOS, located in Aubervilliers, in the vicinity of Paris is as follows. It will be noted that these facilities are divided into three departments: (a) the laboratory department; (b) the semi-industrial department; and (c) the industrial department.

76. The laboratory department comprises, first, ore-dressing laboratories. Each ore is first examined in a petrographic and mineralogic laboratory equipped with microscopes and other special apparatuses. The data furnished by this laboratory are then utilized in an ore-processing laboratory where a handful of men in white smocks, working with glass instruments resembling large test-tubes, elaborate processes as yet unknown for the separation of ore constituents.

77. Secondly, there are chemical laboratories, in which work of three types is carried out:

(a) Analytical research for the perfecting of new methods of analysis;

(b) Search for new processes utilizing phosphorus material, e.g.: new methods for manufacturing dicalcium phosphates, phosphoric acid, sodium-calcium and potassium-calcium thermal fertilizers, and for the recuperation of uranium from phosphates etc.;

(c) Control analyses.

78. The semi-industrial research shops are set up under sheds built next to the building housing the laboratories. Such industrial or reduced-size apparatuses

[illegible] flotation cells, centrifuges, gravimetric tables, etc.; [illegible] manufacture of products derived from phosphated material: thermo-[illegible], furnaces, fluidizing apparatus, etc., make it possible to test [illegible] the laboratories.

79. The industrial department comprises:

(a) A drafting section where plans are drawn up, on the basis of data furnished by the semi-industrial test shops, for new installations to be constructed in Africa;

(b) Engineers who are sent to Africa to supervise construction work;

(c) Survey engineers who likewise go to Africa to explore new deposits. This department also includes a station for round-the-clock industrial tests.

80. Research and perfecting of processes, descriptive and estimated evaluation of industrial installations, construction supervision - CERPHOS handles all the phases of "Technogénie", the French expression corresponding to the English word "Engineering".

81. Thus, through highly specialized research channels, CERPHOS, an offshoot of the former North African Phosphates Agency, is achieving technical co-operation at a level encompassing a group of countries: those of North Africa, Senegal, Togo, etc.

82. Moreover, CERPHOS lies at a crossroads from which two paths stem: from Aubervilliers (in the Paris suburbs), the work involving exploration of deposits and construction of installations leads to Africa; from Aubervilliers, the study of new processes that requires continuous contact with fundamental research facilities leads to the Latin Quarter, the heart of the French University.

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IX. THE DEVELOPMENT OF INDUSTRIAL RESEARCH INSTITUTES

Prepared by Robert R. Adams*

Introduction

1. The author of this paper considers it a triple pleasure to participate with you in this important meeting. First of all, he is thoroughly convinced that research institutes are an essential element in accelerated national and regional economic development and is honoured by this opportunity to share his observations with you. Secondly, Batelle Institute, the organization with which he has been associated for many years, was dedicated by its founder to the furthering of industrial development through research. The general theme of this meeting is, therefore, of special interest to all the staff at Battelle. Thirdly, and possibly most important of all, he is especially pleased to have this opportunity to join with his friends and former associates at the Industry Institute in welcoming you to Lebanon. May your visit be both enjoyable and profitable, and may you return to Lebanon soon and often.

A. Background information

2. It has been suggested that this author direct his remarks to the role of industrial research institutes in developed countries in strengthening the work of local research institutes in developing countries. Before approaching this subject directly, however, he would like to digress briefly and cover some general background so that there may be a common platform on which to build the main discussion.

Types of development institutes

3. The term "research institute" may mean different things to different people. Development institutes, sometimes referred to as research institutes, have taken many different forms designed for different specific purposes and roles in national or regional economic development. Within the broad classification of research or development institutes, one finds such diverse organizations as productivity centres, servicios, industrial development centres and even the technical sections of some industrial-development banks. Some of these organizations deal primarily with long-range planning activities; some are concerned primarily with economic feasibility studies; and some are established primarily to provide guidance and consulting services for small industry. Some deal with a relatively broad range of economic activity, while others are concerned primarily with agriculture or with a specific type of industry.

* Battelle Memorial Institute, Columbus, Ohio, United States of America.

4. Each of these types of organization can make an important contribution to economic development, but many of them are unduly restricted in their ability to respond to broad segments of the national or regional needs. It is, of course, possible that these limitations might be at least partially avoided by the creation of several of these development institutes, each with a different scope and field of activity, within the nation or region. However, this would normally not represent efficient utilization of human and financial resources.

The industrial research institute

5. The true industrial research institute on which this paper is primarily based has a broader scope than is usually encompassed in the more typical types of development institutes just mentioned.

6. As discussed more fully by Mr. Ralph Krause, of Stanford Research Institute, in a paper presented at the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas, held in Geneva in 1963, such an industrial research institute should be able to serve government policy-makers and planners, industrial leaders and their companies, business and financial organizations, and the scientific and educational community. 1/ Such an institute can:

(a) Develop technical manpower and enhance the scientific and technical capabilities of the country or region;

(b) Provide technical assistance in developmental and industrial planning;

(c) Undertake industrial research and provide technical, economic, and managerial services and guidance for industry;

(d) Provide liaison with, and obtain services from, foreign personnel and other research organizations.

7. The industrial research institute, as the term is used here, therefore, combines the functions of a typical industrial or economic development centre and a productivity centre and incorporates a strong technological section with staff and facilities capable of serving a broad range of industrial needs.

Group approach

8. A scope of this magnitude implies a group approach. The staff of such an institute should include personnel skilled in industrial technology, industrial and developmental economics, and industrial management. By incorporating this broad range of skills in one organization, it is relatively easy to assemble a combination of several academic disciplines to attack a specific problem. When properly guided and applied, such a group effort can provide maximum efficiency in the utilization of available resources, human and otherwise.

1/ United Nations Conference on the Application of Science and Technology, Geneva, 1963 (United Nations document E/CONF.39/I.43), "Role of a research institute" by Ralph Krause.

9. In general, through the use of the group approach, the research institute should be able to identify available natural resources and to select the most economic processes for their effective utilization. It should be in a position to carry out technical-economic and market feasibility studies to identify attractive industrial potentials and to select the most suitable processes and equipment on the basis of the stage of development, the size of the market, the available raw materials and other pertinent considerations. This will include pre-project planning and costing, as well as the adaptation of processes and equipment to local materials and conditions. It should be able to assist in the design of the plant, including lay-out for process economy as well as specifications for the mechanical, electrical, and other services, and also in the supervision of the construction and installations. It should be in a position to supply guidance to management in such areas as initial financing procedures, administrative organization, production and quality control, cost accounting and marketing methods. If necessary, the institute should be able to conduct plant training programmes in these areas.

The research institute and economic development

10. The potential importance of such an organization to a developing economy is obvious. The needs and the rewards have been stressed in other papers presented at this and at similar meetings. Francis Godwin, in another paper presented at the 1963 United Nations Conference in Geneva, described such institutes as an "essential growth hormone" in the accelerated economic development of any country. 2/ The author particularly likes this analogy. A hormone is an agent which excites or stimulates other activity, something like a catalyst. A properly organized and functioning industrial research institute can have the same effect on economic and industrial development.

11. The concept of excitation or stimulation is extremely important. If the institute performs its proper role in economic development, it must be a leader in encouraging the formation of new industry and in stimulating government action as required. It is not enough that it merely respond to externally identified problems; it must exert leadership in the identification and promotion of economic potentials.

12. This means that instead of responding only to specific requests for research assistance, the institute staff should be alert for new possibilities of stimulating the economic development of the country or region. There is a unique challenge in identifying such unexploited natural resources as clay deposits suitable for ceramic tile and refractory production, in utilizing agricultural wastes for paper or fibreboard production, and in developing an economic means of recovering salt and other elements from sea-water or of providing food from the sea. Potential industries should be assessed. The food-processing industry, the leather industry, the cement industry, the manufacture of building blocks and the textile industry are typical examples. In each case, preliminary technical-economic feasibility studies should be made. Key factors for consideration are the more economic utilization of an existing resource, the creation of a new

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2/ United Nations Conference on the Application of Science and Technology (United Nations document E/CONF.39/I.45), "The Research Institute as a Key Industrial Development Instrument" by Francis Godwin.

resource, the reduction of foreign currency requirements through local production of items otherwise imported, the creation of new export possibilities, and the more productive utilization of the local labour supply. Local marketing practices and outlets must also be considered.

13. If a nation or a region is to develop and "take off" it must generate technological momentum. This momentum can be generated and maintained only if the industries are sound both economically and technically. The industrial research institute can provide the basis for ensuring the necessary balanced development. However, to do this properly, the institute must always be a step or so ahead of the local position, at least in its thinking. In such studies, groups composed of members with economic skills and members with technological skills are highly effective.

B. Organization of industrial research institutes

14. No two industrial research institutes will be exactly alike, although many of the problems will be similar. The current stage of economic development, the resources of the nation or region, cultural variations, the approach of the Government and of the private sector toward industrialization, and the backgrounds of the available staff would all influence the character of the organization. As a result, there is no one set, packaged organizational plan through which assistance can most effectively be supplied. Each case must be considered on its own merits and a programme formulated to fit the existing needs. Even this programme would probably require modification as the new institute took form and began operations. However, the experience developed through the establishment of industrial research institutes in Europe, Mexico, Ceylon, Lebanon and elsewhere, does make it possible to formulate certain general principles or guidelines.

Long-term effort

15. First of all, it should be clearly recognized that the creation of a capable and effective research institute is a long-term effort. Several years would normally be involved in the organizational and training stages, and several additional years of support might be required before the institute was firmly established.

16. For example, in the establishment of the Battelle laboratories in the industrially advanced countries of the Federal Republic of Germany and Switzerland, it was found that a period of five or six years was required before either of the laboratories could be considered really on its own. A training period of from two-and-one-half to three years was required to transfer the specialized techniques of this type of research management and operation to the local administrative and technical staff, even though they had excellent academic backgrounds and experience in industrial research. An additional two or three years were required before the institutes were fully established in their communities, had demonstrated their effectiveness, and had reached a fully self-supporting status. The Ceylon Institute of Scientific and Industrial Research became effectively self-supporting after about five years of operation. 3/ The Industry Institute,

3/ Godwin, op. cit.

here in Lebanon, has had a similar pattern, if allowance is made for the temporary interruption of activities as a result of the 1958 crisis.

17. This is a heavy investment by any standards. Is it worth it? In pointing out the magnitude of the task, the author's aim is merely to be realistic rather than pessimistic. The potential value of an effective research institute does, as experience shows, clearly justify the investment of the necessary effort and capital. It is, in reality, a conservative investment. At the same time, however, a certain amount of patience is required. In any developing nation, the need is so great that the leaders (governmental, industrial and professional) may become impatient and expect results too quickly or try to start with inadequate preparation. Such desires, although normal, can only result in a long-term detriment to the new institutes.

<u>Independent contract-research institutes</u>

18. In discussing organizational problems, the author wishes to direct attention primarily to a specific adaptation of an industrial research institute, which he feels may well be its most productive form. At the same time, however, the majority of his comments will be applicable to any industrial research institute, as well as generally pertinent to any of the more limited forms of development institutes.

19. This specific form of industrial research institute might be termed an "independent contract-research institute". On the basis of the author's experience, these two modifiers - independent and contract-research - can be very important.

20. The research institute should be truly independent if it is to be of maximum effectiveness. It may have initial, or even continuing, financial support or subsidy from the Government, from the United Nations or a foundation, or from industrial interests; but it must serve both the Government and a wide range of industrial and business interests (whether nationalized or private) and, as such, should be effectively independent of control by any of these. The usual government methods of civil service employment, political appointments, budget control and purchasing procedures are designed for the particular expedients of public administration, and these are normally unsuitable for the operation of an industrial research institute. In addition, and possibly even more important, where industrial development is proceeding under the private enterprise system, businessmen are universally reluctant to entrust their private affairs, plans, and problems to the public domain.

21. The ability to do work under contract can also be important. The term "contract research" implies that the institute is reimbursed for its services by the recipient. This is not only desirable but essential if the organization is to be truly independent and self-supporting. Human nature dictates that services obtained without charge are not valued so highly, and therefore not utilized so effectively, as are services purchased or paid for. Also, the existence of a contract implies an understanding between the institute and the client, whether it be a government agency or an organization from the private sector. The direction of the institute's research in response to real or existing needs, the mechanism for communication (both of the problems and the results of the research) between the institute and the client, and (where appropriate) the confidential

treatment of the client's interests are all implied in a ... contractural relationship. Furthermore, the existence of ... deadlines, helps to enforce efficient and orderly work ...

C. Assistance to developing institutes

22. Technical and managerial assistance has been provided to developing research institutes through a variety of techniques. Staff members of the new institutes have been brought to more highly developed countries for additional academic training and for on-the-job training programmes in specific industries and laboratories. Individual consultants, both short-term and long-term, have been retained to assist the local staff.

23. Although short-term consultants can be very effective in providing specific expertise to supplement the abilities of the local staff in later stages of the institute's operation, there are definite advantages in the longer-term approach during the initial phase.

24. Every nation or region is different. Some are achieving effective economic development through a system of nationalized industry; some are developing primarily through a system of private enterprise; others are using a combination of the two systems. In some cases, the Government plays a leading role in the development of natural resources, and in others this is left primarily to the private sector. Some nations have abundant resources, and some have little or none. Some have a well-developed cadre of industrial managers, and some are almost completely lacking in this area. Cultural backgrounds and customs vary widely and must be taken into account. Legal and financial procedures differ widely.

25. It is extremely important that the individuals providing the assistance understand these variant factors as well as possible. This normally takes a significant amount of time and is one of the factors that often limits the effectiveness of the short-term consultant, at least as far as general planning and policy guidance are concerned. The educational process involved is a two-way street. The techniques successfully applied elsewhere cannot necessarily be transferred directly to the new institute. They must be modified to fit the local situation. The fundamental structure of the institute must be tailored and fitted to the unique environment in which it will operate.

Team approach

26. As has already been indicated, an industrial research institute is a relatively complex organization with many facets in its organization and operation. In most cases, therefore, the new institute would require assistance in several areas and this would usually involve several individuals or consultants.

27. The author is convinced that there are many advantages to be gained in obtaining these consultants as a team through a direct contract association with an established and experienced research institute. The ability of such a team to work together harmoniously as a result of the common background, previous associations, and unified channel of responsibility is extremely important.

Preferably, such a team would work with the new institute from the initial planning stage to the point where the local staff has developed sufficient experience to continue on its own.

28. Many vital policy decisions must be made during the early planning stages of the new institute. The initial scope of the institute's activities must be determined. Policies for its operation must be formulated, and these play a vital role in determining the ultimate success and effectiveness of the operation. The initial staff must be selected, and general plans developed for the facilities and equipment. All of these activities must be budgeted and scheduled so that each stage is reached at the proper point in the over-all development. The experience of a team from an established institute could be invaluable during this critical period.

29. The ideal procedure, in all probability, would be to select an established institute and complete general arrangements for assistance as soon as the basic decision to consider the formation of the new research institute had been reached. Key personnel of the established institute would then be in a position to work closely with the local leaders in defining, through mutual consultation, the best make-up for the assisting team.

30. As this team worked with the local group (both the national leaders and the initial key staff members of the new institute), all could learn a great deal from the early planning sessions and policy discussions that will help to ensure the ultimate success of the new organization. If essentially the same team were retained throughout the training stages and the initial operation of the new institute, the team members would continually add to their understanding of local conventions and conditions, and their ability to provide sound guidance to the local staff would be greatly enhanced by this understanding.

Team requirements

31. The size and make-up of the team might well differ in each specific instance. In the case of the independent contract-research institute described earlier, at least three primary areas would normally be covered: (a) research institute management; (b) industrial technology; and (c) industrial management.

32. Each of these areas might involve one or more individuals as the situation required. For example, institute management might include an administrative director and a business manager. Industrial technology might include a chemist or chemical engineer, a mechanical engineer and an electrical engineer. An agricultural specialist could be included if this area were to be incorporated in the institute's scope. Industrial management might include one person skilled in production management or industrial engineering, one skilled in market analysis and sales techniques, one skilled in finance and cost accounting and one skilled in economic-feasibility studies. Such a basic team, supplemented as required by short-term specialists, should be able to bring the desired experience and guidance to the new organization.

Organization and training

33. The primary roles of an industrial research institute constantly change during the development process of the nation or region. For this reason, it is imperative that the organizational structure of the institute be flexible so that it can easily adjust to these shifting requirements. These shifts, however, are usually involved primarily with changes in emphasis and in the degree of sophistication rather than in the basic areas of technology a-. industrial management to be covered. The level of the requirements would change as the level of economic development progressed. In the early stages of industrialization, the emphasis would normally be on small and relatively simple industries. As the economy grew, as the markets increased, as the labour force gained skills and as over-all technological sophistication increased, the institute eventually might find itself concerned less with craft-type skills and more with systems technology concerning engineering problems in fertilizer plants, the petrochemical industry, foundries, etc. The ability to respond to these changing conditions and requirements means that the local management must be thoroughly grounded in the peculiarities and techniques of industrial research management.

34. Here, the assistance of the established research centre could be quite valuable. The experience of such an institute, both administrative and operational, could be used to advantage in helping to plan the most effective initial scope, in developing an organizational structure with the requisite flexibility to cover future requirements as development progresses, in planning the facilities (including offices, laboratories and equipment), and in guiding the initial operation. Although such assistance can be most advantageous, and one might say even essential for an efficient and effective operation, the author wants to stress that it is extremely desirable that the maximum capabilities be developed in the indigenous staff. Technology may rightfully be considered a major natural resource of any developing area. The full development and utilization of this resource requires the full development of local human capabilities. Through the assistance of the established institute, the local management and staff of the developing institute could be trained in the specialised techniques of contract-research operation. There is no better training than actually working on real problems in a real environment under the guidance of competent and experienced leadership. In this way, many initial (and possibly fatal) mistakes and false approaches could be avoided, and the indigenous technological resource could be developed with maximum efficiency.

35. Any country contemplating the creation of a research institute should have at least a minimum number of academically trained individuals to form a nucleus of the staff. Normally, this does not create a problem, as at least a few trained people are nearly always available by the time a nation or a region reaches the stage where such an institute can be truly effective. In fact, if there is a shortage of trained personnel, a research centre might be especially effective in providing a mechanism whereby the abilities of the few could be spread out to serve a wide diversity of interests. In addition, more could be accomplished through a collected group effort than through the summation of the individual efforts.

36. Experience both in the United States of America and in other countries, however, clearly has shown that academic training alone, no matter how thorough, is far from sufficient for the efficient organization and operation of an

industrial research institute. The administrative problems of such an institute are quite specialized, and the research approach and methodology (whether in the area of industrial technology, resource development or economic appraisal) are necessarily quite different from those typical in the academic environment.

The proper foundation

37. It cannot be overstressed that the management of an industrial research institute is a very specialized task. It is not enough that the institute's services merely be offered. They must be used and used effectively.

38. If the new institute is to be utilized effectively, its character must be above reproach and it must inspire confidence and respect. This is especially true in the initial stages. One false step, one breach of confidence, or one dissatisfied client could cause damage that might never be repaired. This does not mean that every research problem, whether an economic study or a technical project, must be completely successful. If the answer can be guaranteed in advance, it is not a research problem. However, it is important that the new institute not promise more than it can be expected to produce. It is important that the client be clearly advised of the problems and of the probabilities of developing the desired information. It is important that the probable costs of commercializing the results of the investigation be recognized in advance. It is important that the work be conducted with a full understanding of the cultural and economic background in which the results will be utilized. And it is important that the results of the investigation be presented in such a manner that all of the ramifications can be clearly understood by the client. Again, this is true whether the programme involved is an economic feasibility study, the development of engineering specifications for a new facility or equipment, or concerned with some process development.

39. Here, again, the assistance of an established institute could be especially effective in the initial stages of the new institute. The experience and reputation of the specialists from the older organization coupled with the intimate knowledge of the local conditions and the identification with the country or region supplied by the indigenous staff could accomplish much more than either group acting independently. As the local staff gained experience and built their own reputation on the basis of work successfully completed, the assistance of the foreign organization would no longer be needed.

Subsequent activities

40. Even after the new institute was well established and working effectively on its own, with its operating policies well set and its staff trained in the techniques and experienced in the problems involved, there is still an important residual advantage in having developed the close working relationship and the bonds of mutual understanding with the more mature research institute.

41. For many years, there would be problems with facets so specialized that the new institute could not be expected to have the necessary expertise. In some cases, the necessary expert could be supplied on a short-term basis directly from the older institution; or, in other cases, the older institution (with its acquired knowledge of the local problems) could assist in locating and arranging for the services of a qualified consultant.

42. In the same general way, technical research programmes at the new institute would, from time to time, require the use of specialized equipment that could not be economically justified for purchase by the institute. Often, this equipment would be available in the older and larger laboratory, and arrangements could be made to have the tests run there. In the same way, guidance on the selection of new equipment could readily be made available, and staff members of the new institute could visit the older laboratory for special training in new research techniques or in the operation of specialized research equipment.

43. The relationship with the established institute in the more developed country would also provide a direct channel for the transfer of available scientific and industrial information. This might involve such areas as technical books and periodicals, industrial catalogues of technical and process equipment, or suggestions for the possible adaptation of new industrial techniques to the local situation.

D. Epilogue

44. In conclusion, the author would like to re-emphasize a well-known but often ignored fact.

45. Most industrial processes are developed in the more technologically advanced countries. In these countries, capital is relatively cheap and labour is tremendously expensive. As a result, process equipment tends to be highly automated to reduce the labour component, but often at the expense of a high degree of complexity with higher capital costs and increased maintenance problems.

46. When a new industrial activity is considered for a developing country, there is a normal tendency to think in terms of only the most modern facility potentially available. This is an understandable matter of pride, whether of ownership, of national prestige or of technological endeavour. From the viewpoint of economic development and of maximum return on investment, however, this may not be the most effective course of action.

47. There are many cases where it would be economically advantageous to re-examine the applicability of adapting some of the older processes to fit the local requirements. These processes often use simpler and less expensive equipment and are better adapted to the shorter runs of the developing economy. Although the labour requirements may be higher, a lower degree of skill is normally required, and the economic returns both to the plant owner and to the country might be much higher.

48. In stressing this word of caution, the author's remarks are directed not only to the local industrialists, the government planners and the staffs of the developing institutes, but also to the potential foreign teams or consultants assisting such organizations.

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X. ORGANIZATION OF INDUSTRIAL RESEARCH ON A REGIONAL BASIS WITH PARTICULAR REFERENCE TO ICAITI

Prepared by Manual Noriega Morales*

A. Historical development of regional research

1. Organized industrial research on a regional[1/] basis in Central America dates back to 20 January 1956, when the Central American Research Institute for Industry (ICAITI) began its operations. Prior to this date, Central America had no institution capable of carrying out scientific and applied research for the industrial development of the region on a highly competent professional level. Useful industrial surveys and studies were non-existent and the number of qualified investigators capable of pursuing independent research work was totally inadequate. In consequence, ICAITI provides a well-defined case history for the historical development of regional research in Central America; and as far as the author knows it is also the first example of a multinational technological institute.

2. While, within this framework, this paper will present some guidelines and suggestions relevant to other developing regions, the exposition which follows is necessarily cast in the form of a specific discussion of ICAITI's development.

3. The Ministers of Economy of the five Central American countries, meeting as the Committee on Economic Co-operation in Central America under the United Nations Economic Commission for Latin America, adopted a resolution, in August 1952, requesting the United Nations Technical Assistance Administration and the Commission's secretariat to provide a mission which would make recommendations on the establishment in Central America of an institute for industrial research and technology. The prime duties and functions of this institution as set forth in the resolution were to be the following:

(a) To conduct research on the natural resources of Central America with the objectives of developing industrial enterprises;

(b) To conduct studies of Central American industries and to propose improved techniques for production, utilization of waste products, establishment of quality controls and related studies, for the purpose of raising productivity;

(c) To act as consultants to private industry, and, in collaboration with the latter, as well as the labour unions and government agencies, to develop plans to improve work methods;

(d) To adapt existing or new technologies to the capital structure and economic and social conditions of the region;

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* Director of the Central American Research Institute for Industry.

1/ Throughout this paper the terms "regional" and "region" are used in the sense of a multinational entity and not a geographical segment within a nation. Thus the Central American region includes Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua.

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(e) To act in an advisory capacity for the Central American Governments in matters of industrial technology, including the selection of experts in connexion with industrial projects;

(f) To participate in promoting interest in and knowledge of research as applied to industry.

4. The United Nations technical assistance mission began its work in August 1955. It found from the outset that there was an urgent need for the Governments to undertake organized programmes to pursue the following objectives:

(a) The improvement of scientific knowledge of the natural resources of the region;

(b) The accelerated development of such material facilities as transportation, electric power, etc., and those of an institutional character such as vocational education, credit facilities, etc.;

(c) The creation of appropriate services for the better economic ultilization of new resources and the improvement of techniques now in use in the exploitation of the available resources (agronomic institutes, agricultural extension services, etc.).

5. The United Nations technical assistance mission found the following situation existing in Central America at the time with regard to research:

(a) Some research was undertaken in the area by universities, by industry and by agricultural research centres. While the research undertaken was often of excellent quality, it was inadequate for the technological needs of Central America;

(b) Since the industrial enterprises in the area were small, they undertook little if any research effort;

(c) The agricultural research centres undertook the most comprehensive programmes of research, both quantitatively and qualitatively. The need of the area, however, frequently required these centres to extend their activities beyond strictly agricultural research and to undertake work that might be termed industrial technology;

(d) In each country there were some activities of development and experimentation. However, it was felt that it would require a much greater effort to develop such centres into effective research organizations for industry than to pool all resources into one common research institute as proposed by the Mission.

6. On the basis of the recognized needs for research, the UNTAA Mission felt that an institute for industrial research and technology should undertake, among other tasks, to provide technical information, assistance and advice for the developing industries in the region and the local development organizations; carry out long-term research with a view to diversifying the economy of the area on the basis of its unique natural resources; raise the living standards of the Central American population; promote industrial development of local raw materials and co-ordinate with agricultural research agencies studies in this field.

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7. The UNTAA Mission's report was discussed and approved by the Committee on Economic Co-operation in Central America in its meeting held in San Salvador, El Salvador, in May 1955 and, in consequence, in the same year the Basic Agreement establishing the Central American Research Institute for Industry was subscribed to by the five countries. The prime purposes of the Institute as set forth in the Basic Agreement are as follows:

(a) To carry out studies on production, preparation and use of local raw materials now existing or which may be available in the future, with the aim of discovering or proposing new products, methods of manufacture or uses. The Institute may, with this object, create research centres and laboratories and experimental establishments;

(b) To develop, improve and test procedures, methods, tools, utensils, equipment, and materials for new industries, for agricultural production, mining, domestic industries, artisan occupations and trades and for allied activities of management, conservation, storage, packing, transport, maintenance and repair services;

(c) To carry out studies of existing producer enterprises with the aim of solving technical problems, reducing production costs, improving production techniques, discovering useful by-products, eliminating and reducing risks, and establishing superior methods of verification and regulation of quality;

(d) To undertake, free of charge or for a fee, research tasks for government institutions, industrial organizations, private enterprises or persons who desire to make use of the services of the Institute;

(e) To undertake or participate in a practical form, in the preparation, publication and dissemination of technical information useful to the producers of the region;

(f) To help, in any other form, the progress of technology of production, of research and of technical training;

(g) To co-operate with the offices concerned of the Governments of the Central American isthmus, and with universities, technical organizations and other bodies, whether governmental or not, in the promotion of scientific and industrial research and the training of researchers and technical experts, artisans, and specialized workers.

8. ICAITI was officially inaugurated in Guatemala City on 20 January 1956, although it did not occupy its permanent buildings until March 1957.

9. During its first eight years of existence ICAITI has provided valuable consulting services to the industry of the region and has carried out a considerable number of technical-economic studies and investigations on an ample selection of topics. Some of the most important projects carried through and consulting services extended by ICAITI have been the following:

(a) Elaboration, conservation and refrigeration of agricultural raw materials, food-stuffs, fats, oils and cereals;

(b) Studies on the installation of fertilizer and insecticide plants;

(c) Industrial utilization of [illegible] from agricultural [illegible]

(d) Advice in the installation and operation of a [illegible] plant.

(e) Elaboration of a project for the manufacture of manioc (cassava) and corn-starch, including the utilization of starch for manufacture of syrups, dextrine and others.

(f) Investigation of the dehydration of tropical fruits and vegetables;

(g) Assistance in the planning, modernization and expansion of textile mills;

(h) Study on the possibility of establishing a steel industry in Central America;

(i) Development and patenting of a new process for the manufacture of cornflour. This project resulted in the installation of industrial plants in three Central American countries;

(j) Reorganization of the production, administration and accounting departments of two pharmaceutical industries;

(k) Preliminary study of the marketing of sheet glass in Central America;

(l) Project for the establishment of modern slaughter-houses;

(m) Market and feasibility study on a rayon plant in Central America;

(n) Technical assistance in the exploitation of a salt and gypsum mine.

10. ICAITI's laboratories have carried out a considerable number of analyses and investigations. Some of the most important ones have dealt with chemical products, fertilizers, foodstuffs, alcoholic beverages, flour, cosmetics, minerals, leather, fats, oils, industrial gases, cloth, textiles and forestry products.

B. Organizational structure of the Institute

11. The maximum authority of ICAITI rests on the Executive Committee, which is integrated by the Ministers of Economy of the five Central American countries and the Director of the Institute, the latter designated so far by the United Nations. The Director is responsible for the direction and administration of the Institute and maintains close contact with the United Nations and other international agencies. ICAITI also draws on the collaboration of an advisory committee, which is composed of six leading Central American industrialists and six executives of the Central American Economic Integration Programme.

12. The Institute is organized in the services described below.

Industrial economics division

13. This division covers the economic aspects of the projects developed by the Institute and in which one or more of the different divisions and specialized sections in technological fields also participate. The division is designed to carry out the following activities:

(a) Feasibility studies and evaluation of projects;

(b) Industrial accounting studies;

(c) Market studies;

(d) Studies on rationalization, methods and procedures.

Industrial services division

14. This division is the main channel for the Institute's industrial development studies and factory planning activities.

15. It studies questions of products, process technology, equipment, labour requirements, production costs, investment, scale of operation, location and so on, in relation to established or potential markets, available raw materials and other supplies, transportation facilities and other local conditions. It produces schemes for the layout and housing of complete production units or extensions to existing ones. It maintains contact with suppliers of machinery and equipment on a world-wide basis and prepares documents needed as basis for purchasing and installation contracts. It keeps informed of technological advances in other countries and suggests possible fields of research and development for trial in the laboratories and pilot plant.

16. In addition, it provides a service of direct aid to manufacturers in day-to-day problems of plant operation, technical management, quality control, etc.

17. The division consists of the following sections: textile, food technology, leather technology, fats and oils, and geology and mining.

Laboratories and scientific and technological research division

18. The prime purpose of this division is to work on the discovery of new technological processes and their adaptation to industrial uses in Central America. It searches therefore for formulae and methods for the industrial utilization of regional raw materials.

19. Its services cover a wide scope, ranging from the preparation of experiments and analyses to the carrying out of the fundamental investigations for the industrial utilization of raw materials and agricultural waste products.

20. The analytical section provides a valuable service to private and governmental organizations, preventing costly and complicated procedures in sending samples to foreign countries for analysis.

21. Its personnel keeps abreast of technological research in other countries so as to be able to adapt the results to Central America.

Standards division

22. The standards division was established with the specific [illegible] out Central American ICAITI standards. In this connexion, it establishes the minimum requirements that a product should meet for the specific use that it is designed to serve. Standardized products in terms of quality, dimension, methods of experimentation and analysis, and other technical characteristics, have the purpose of guaranteeing the quality of the product and facilitating commercial relations within the area and with the rest of the world.

23. Within its working programme, this division has begun by elaborating those standards which for commercial and industrial reasons are of primary importance to the region.

Engineering and technical services division

24. This division assists the industrial consulting and services division in the design and construction of pilot plants. It is also in charge of the maintenance of the building and equipment of the Institute, having a modern workshop with specialized mechanical, electrical and carpentry equipment.

Documentation and library division

25. The documentation and library division is in a position to provide most of the technical information required by ICAITI's specialists and outside persons and organizations. The library has some 5,000 books which include works in economics, industrial organization, and pure and applied sciences. It also has catalogues and directories of industrial machinery and equipment, reference books, 300 subscriptions to scientific and technical journals, and documents published by the United Nations and other international organizations.

Accounts division

26. It is in charge of maintaining the financial control of the Institute. In this division the costs of the different projects of consulting services and of investigations carried out by ICAITI for its own account, as well as income from private and governmental sources, are registered. All accounting operations, including the control of warehouse supplies, are carried out by mechanized systems.

Administration

27. The administration is in charge of the organization and supervision of all matters related to the execution of such internal work as correspondence, files and registry of equipment, and installations. It is also in charge of administration and control of personnel, and of providing auxiliary services to the experts.

28. The descriptions given above are summarized in the figure I, the organizational chart of the Institute (see annex I).

C. Relationship with other private and public organizations in the region

29. The Institute maintains permanent contact with private and public organizations in the area. As an institution working on a regional basis, and as part of the economic integration programme of Central America, ICAITI works in close co-operation with other integration organizations, e.g. the Central American Bank for Economic Integration (BCIE), the Permanent Secretariat of the General Treaty of Economic Integration (SIECA), providing technical information and elaborating projects to be used for the determination of economic and industrial policies on a regional scale. The Institute maintains close contact with local chambers of commerce and industry, private investors and the various official economic integration agencies.

30. Aside from this permanent relationship with the integration offices, ICAITI collaborates with local development institutes (semi-autonomous governmental organizations) providing advisory services in the internal organization and in the working out of such projects as fertilizers, insecticides and chlorine-caustic soda plants, grain storage facilities, geological evaluations of known deposits and investigations of new ones, etc. In a number of instances, specific projects and advisory services are rendered to private organizations like local sugar-cane growers associations, cattle-breeders associations, essential oils associations, and others. In most cases, studies and reports have been elaborated which often resulted in the establishment of new sugar-cane refineries, slaughter-houses, etc., or modifications in the existing organizations, processes and products.

31. However, a great part of ICAITI's work has come directly from private enterprise and investors working on an individual or on a corporate basis. Although in some cases the work entailed technological investigations and applied research, the major part of ICAITI's services for this group consisted of feasibility studies, market studies, determination of plant locations, evaluation of plants and supervision in the installations of new machinery and processes.

32. With some industries permanent arrangements for regular and occasional laboratory inspections and quality control determinations have been set up, aside from the usual laboratory analysis service that the Institute provides for local industry.

D. Some organizational problems of regional research institutes

33. The preceding sections have dealt at some length with the inner workings of ICAITI as an Institute dedicated to carrying out technological research for the benefit of the Central American region.

34. In the following paragraphs an attempt is made to present some of the chief problems that may be encountered in the establishment of research institutions on a regional basis. Always using ICAITI as a frame of reference, the author has endeavoured to draw some general conclusions which might be useful to other regions.

... The scope of this paper does not permit [illegible] problems involved in the organization and operation [illegible] institutions. The author has therefore selected some typical [illegible] of great value in elucidating the general picture [illegible] organization of research institutions on a regional basis. [illegible] the following topics have been selected:

(a) Problems of location;

(b) Problems of financing;

(c) Problems of obtaining highly qualified personnel;

(d) Criteria for selection of research projects.

Problems of location

36. It is virtually impossible to make broad generalizations concerning all the location problems of a multipurpose regional research institute. The problems involved run the full gamut and are obviously a complex function of the particular region under consideration.

37. Nevertheless, the problem of location could be a determining factor in the success or failure of a regional research organization. The provision of the proper environment therefore plays an important role in effective research. It is significant that successful research institutes throughout the world, except those having specialized objectives, are located in or near the larger centres of population where they have the greatest possible access to other scientific, industrial and educational institutions. The more facilities exist in the way of mechanical, electrical, woodworking shops and general construction facilities, the lower the installation and maintenance cost will be.

38. The above factors are not only helpful in the day-to-day operations, but the scientific staff find the social, educational and scientific amenities necessary to their lives.

39. In the case of the Central American region, the variable factors were relatively few and the problem was simplified by many common features. Historical ties, homogeneous heritage of language, race and culture, common needs and goals - all these factors, and many others, contributed to make the problem of location a relatively simple one.

40. The majority of the five Central American countries offered to accommodate the Institute and provide a building and certain additional facilities. In the UNTAA Mission's opinion, Guatemala City and San Salvador offered the most suitable locations for the Institute. However, Guatemala City afforded the following favourable features:

(a) The existence of a more scientific environment;

(b) The seat of the most ancient university in Central America;

(c) The existence of another technical institute, the Institute of Nutrition of Central America and Panama (INCAP);

(d) The excellent climate and comfort for attracting personnel.

(e) A good communications centre.

41. San Salvador offered, on the other hand, the advantage of being closer to the other Central American countries, but the climate was an adverse factor.

42. In view of the combination of most favourable features in Guatemala City, the Institute was established in this capital.

Problems of financing

43. It is exceedingly difficult to estimate with pin-point precision the financial requirements for the operation of an institute whose entire organizational structure is still on blueprint. The most that can be done at the planning stage is to draw on the experience in other countries, modified in keeping with the prevailing conditions in the region under consideration. The expenditure plan for the first year of operations should therefore be flexible enough to allow for the uncertain elements.

44. ICAITI's financing experience, attuned to the conditions that might obtain in each particular region, could serve as an aid in establishing a general pattern for the prospective financing of regional research institutions.

45. In the case of ICAITI, as regards financing, it was assumed from the outset that the United Nations and the five participating Governments would support the Institute in its first five years of operation.

46. It was provided that the United Nations contribution would be a diminishing one, from $US75,000 in the first year to $US30,000 in the fifth year; whereas the five Governments would increase their share, on an equal basis, from $US100,000 in the first year to $US200,000 in the fifth year.

47. In addition, it was foreseen that the Institute would be able to count on an income of its own, derived from such services rendered to industry as consultations and analyses.

48. In ICAITI's case, it was also forethought that the Institute could receive donations from public and private institutions which could enable it to expand its activities. However, such eventualities should be considered additional to any prospective estimated budget.

49. Experience has shown, however, that the aforementioned assumptions have not been realized. After eight years of operation, ICAITI has not yet attained self-supporting status. While income from private enterprise has been increasing steadily since 1959, when the Institute had passed its organizational stage, it still falls short of ICAITI's total financial requirements (see annex II). Likewise, private donations have not been forthcoming.

50. ICAITI currently receives financial support from the following sources:

(a) Contributions from the Central American Governments;

(b) Allocations from the United Nations Special Fund;

(c) Income from services rendered to private enterprise.

51. The Institute operates on strict budgetary terms, [illegible] of projects and is subject to an external audit of accounts.

52. Summing up, ICAITI's financing experience clearly shows that no [illegible] should be set for the financial support of a proposed regional research institution. Ample leeway should therefore be left in setting up the financial arrangements of the proposed institute.

Problem of obtaining highly qualified personnel

53. A major problem in the establishment of research institutions in developing countries is the lack of trained research workers in the fields of science and technology.

54. The establishment of ICAITI had to cope with this problem. The soundings of the UNTAA Mission on the organization of this regional institute revealed the extent of this limiting factor. The Mission found that everyone connected with university work was aware that the general trend of economic development would require a more trained technical personnel. Executives and development institutions stressed the fact that the shortage of trained personnel in the various fields of engineering was a limiting factor in industrial progress.

55. The UNTAA Mission came also upon the fact that although a number of young people had gone to foreign countries to obtain professional training in various fields of science and engineering, the number was so limited that their influence in industrial development was negligible. It also ascertained that scientists graduated in foreign countries quite often pursued highly specialized studies that had little or no application at all in their own countries.

56. Therefore, during its formative years, ICAITI had to rely heavily on foreign technical personnel. This feature also added a new modality to the organization of the Institute. Since its inception, it has been necessary to make provisions for the gradual recruitment and training of Central American professionals. A modest training programme was thus envisaged as part of the Institute's activities. During ICAITI's first nine years of work, this programme was confined to obtaining and training personnel for the Institute.

57. In this respect, local counterparts of foreign experts are put to work together in the technological and industrial projects undertaken by the Institute. By these means the local personnel acquire the necessary experience eventually to assume the duties that have been discharged by foreign specialists.

58. A measure of the success of the aforementioned policy is the fact that at present ICAITI only has seven foreign professionals, accounting for 8 per cent of the over-all staff of the Institute.

59. An extremely important factor bearing on the problem of obtaining highly qualified personnel is the need to offer salaries that are attractive enough and are compatible with the salaries offered by private enterprises or other international agencies. A sound policy of fringe benefits and incentives is therefore essential. In addition, great care should be taken to give the personnel the status to which they are entitled.

60. During the past nine years, ICAITI has accumulated ample experience in various fields of research, particularly in the utilization of indigenous raw materials and the development of certain industrial processes. In addition, it has well-equipped laboratories, adequate pilot-plant facilities and an excellent library. Since the local universities have neither the funds, time nor facilities for undertaking an adequate research training programme, ICAITI feels that the time has come to use its facilities for a programme of professional training in science and technology.

61. Although a training programme of such scope was not envisaged in the proposed organization of ICAITI, the Institute feels that it must make an effort towards closing the widening gap between the industrialization of the area and the lack of trained technical personnel.

62. ICAITI intends therefore to initiate the following training programme. An average of two trainees per country (ten in total) would be selected from Central American university students who have completed their studies in the fields of science and technology and are about to submit their thesis. These students would undertake research of regional interest to ICAITI. The training research programme would be designed to give the students the opportunity to make use of modern technical methods and make contributions to technological knowledge. This programme would also increase the supply of well-trained technical personnel for future work at the Institute or the local industry.

63. This modest training programme could be expanded if the necessary financial support were to be obtained from private enterprises, or other national or international organizations.

Basis for selection of research projects

64. The technological, economic and social conditions prevailing in developing countries under consideration are essential determinants in the choice of projects that a regional research institution should undertake.

65. The historical development of ICAITI contains some features which can serve as guidelines for the establishment of technological institutions in regions in which conditions similar to those in Central America prevail.

66. In order to arrive at a decision on the nature of the research projects to be selected, it is useful to focus attention on a few strategic variables having wide economic and industrial implications. These strategic variables are naturally part of a more complex function whose form is given by the existing economic status and technological development of each region.

67. In general, there are two classes of projects at ICAITI: those which private clients and regional or national public organizations bring to the Institute with fairly well-defined objectives and subjects upon which work should be conducted. There are also other research activities which ICAITI conducts with its own funds for the general benefit of Central America. The following comments pertain only to the selection of projects on which ICAITI uses its own financial resources.

68. There are a sufficiently large number of industrial needs in Central America, so that some means must be used to decide which ones shall be the first to be given active attention. To assist in making such decisions, it is useful to have some basis and some broad principles of operations to make the first selections.

69. At ICAITI the following economic, social and technological needs have been taken into consideration as basis for selection in research projects and other technical activities:

(a) Industrialization of regional raw materials;

(b) Utilization of agricultural waste products;

(c) Evaluation of natural resources;

(d) Assistance to small and medium-size industries.

Industrialization of regional raw materials

70. Specific projects in this field are handicapped by the fact that the natural resources of the Central American countries are largely unknown. It is evident then that the full utilization of regional raw materials must be preceded by an inventory of such resources. However, the limited knowledge of its availability has already served as a basis for the undertaking of some specific projects in this field. There are currently a sufficient number of known raw materials upon which ICAITI can draw for studies and development of technological processes.

Utilization of agricultural waste products

71. Agriculture in the broad sense represents the main economic activity at present in Central America. Projects concerned with the utilization of existing agricultural wastes require close scrutiny. The enormous surpluses of these materials indicate the need for undertaking specific projects aimed at discovering new uses for these by-products. The Institute has given due attention to this field of activity and up to the present has conducted investigations on the evaluation and adaptation of new fibre decortication processes, improved methods for retting of fibres, yeast growing on blackstrap molasses, modern manufacture of wallboard from fibres, straws, bagasses, and wood waste, manufacture of paper from mixed tropical forest and uses of coffee wastes.

Evaluation of natural resources

72. This task is tremendous and its scope is beyond the objectives and financial resources of an institute for technological research. However, in collaboration with government agencies, the Institute can provide valuable assistance in collecting data for inventories of natural resources. There is currently a great interest on the part of the Central American Governments to undertake geological and mining investigations, and ICAITI has already given valuable assistance in preparing proposals for pre-investment projects to the United Nations Special Fund. Likewise, it has been envisaged that the Institute could make facilities available to experts or universities from abroad who would be interested in undertaking basic research on the natural resources of Central America. All in all, this field requires studies which a technological institute should undertake on at least a partial basis.

Assistance to small and medium-size industries

73. This is a regional need of major importance which poses some problems of a financial nature. It is obvious that the Institute should endeavour to give maximum assistance to this industrial sector. The task entails, however, considerable difficulties, for this economic sector is, in most cases, in a precarious financial situation and cannot afford to pay for technological assistance or research. The Institute must therefore find the way to give the best possible technical assistance and advice to such small-scale industries.

74. On the basis of the major needs of Central America, it seems desirable to establish some general criteria which would serve as a sound basis for the selection of projects, with the proviso that there is no set formula for determining such criteria. It is also pertinent to point out that because the Institute charter is broad, there is need to limit the scope of its activities. Within this framework, the following suggestions may be useful:

(a) Projects must promote the general welfare and prosperity of the region;

(b) Projects should not duplicate work being done by others;

(c) Research effort should be concentrated on the adaptation of well-known technologies to the area;

(d) Attention should be focused on projects having to do with the processing of manufacturing materials rather than on the growth or extraction of raw products;

(e) Particular attention should be given to the problem of labour-consuming industries <u>vis-à-vis</u> capital-consuming industries;

(f) Due consideration should be given to projects with respect to the transformation of household industries to small-scale industries.

Criteria (c), (e) and (f) merit further elucidation.

75. <u>Adaptation of well-known technologies to the area</u>. It was recognized from the start that ICAITI should be socially productive and contribute to the standard of living of the Central American population by aiding both the immediate and long term aspects of industrial development. In this connexion, the immediate need was for technological services that would aid in transferring technical "know-how" to the area. But in this regard a work of caution is pertinent. It is evident that the developed technologies throughout the world grew under economic and social conditions vastly different from those encountered in developing areas. Transplanting advanced technologies <u>per se</u> in developing countries does not spur industrial development lag. The existing economic situation in less developed countries calls for an adequate adaptation and not a transplantation of the know-how of the industrialized nations. Furthermore, as Jack Baranson has rightly pointed out, economic reasons are not the only ones that stand in the way of such transfer. As a case in point, he quotes the following example: 2/

2/ Jack Baranson, "New Technologies for Emerging Economies", <u>Harvard Business Review</u>, vol. [illegible], No. 4 (July-August 1961), pp. 145-150.

"In order to make wheat flour acceptable to certain Asian countries accustomed to rice consumption, it was necessary to simulate the taste, texture, and even the shape of the rice grains."

76. This is not an isolated case. A similar psychological and social problem was encountered in Central America. The Institute of Nutrition of Central America and Panama, after developing "Incaparina", a low-cost protein nutrient, had to cope with the problem of how to persuade the Guatemalan Indians, whose way of life is rooted in ancient customs, to accept this new beverage. These Indians are very keen on a local drink called atole, a household-made concoction very low in nutritive value. The problem was solved by promoting and selling "Incaparina" as a better atole.

77. Labour-consuming industries vis-à-vis capital-consuming industries. The Central American region suffers from a surplus of labour and disguised unemployment, owing in part to the explosive population growth. This situation is aggravated by the fact that some of the main crops (sugar, coffee, rice and cotton) are harvested and processed during the same period of the year. This creates peak activity during four to six months and sharp decline to a low level during the rest of the year. On the other hand there is lack of financial resources available for investment. Therefore, in order to achieve a proper balance ICAITI pays due attention to projects that result in greater aggregate value in terms of the existing unemployed labour force.

78. Transformation of household industries to small-scale industries. Household industries are important in the economy of the Central American region. The transformation of these artisan activities into well-organized económic industrial units is a tremendous problem which entails psychological, social and educational aspects. This field provides ample ground for specific projects which ICAITI must undertake.

79. Moreover, the industrial development of the Central American countries with its inherent element of diversification has called for every effort to open up qualified channels of information and technological assistance to assimilate the latest technological processes and ultimately to develop an adequate pattern of modern industrial society. This important factor has greatly shaped the organization of the Institute and is still a guideline in its operations.

80. Finally, mention must be made of the fact that a time variable always enters in the selection of research projects. A provision for this variable must be included in planning the establishment of any regional research institute so as to make it flexible and capable of change to meet the needs that are found in the active life and dynamic growth of the organization.

E. Concluding remarks

81. The historical development of ICAITI offers a sound basis for outlining some general suggestions in connexion with the establishment of technological research institutes in developing countries. The following conclusions draw on the experience gained in setting up and operating ICAITI and on surveys conducted in this field by United Nations experts.

82. A technological research institute in a developing country should undertake research, investigations and projects aimed specifically at improving or developing technical processes and methods which may promote the expansion of existing or the development of new industries.

83. The economic and industrial needs of the region under consideration should determine the selection of the projects which the institute may undertake. The research to be carried out should be "applied" rather than "basic" and should be directed towards adapting already known principles to existing local technologies. This should not preclude the undertaking of fundamental research in connexion with the industrial utilization and processing of local raw materials, including waste materials, for which techniques have yet not been developed. Long-term research should be part of the institute's activities, but it should be oriented towards specific regional needs. Results of this research would, in the long run, contribute to the existing technological knowledge.

84. The above-mentioned pointers bring to the forefront the fact that strict specialization is not justified in a research institute working for the benefit of a multinational region. Such an institution would inevitably evolve into a multipurpose organization. This indeed has been the experience at ICAITI.

85. Even though such an institute may be Government-sponsored, it should be autonomous and run its course without any governmental interference or political pressures. The autonomy of the institute should therefore be guaranteed in its charter.

86. Parallel to its activities as a public service organization, the institute should from the beginning endeavour to build up a broad clientele among private enterprises, so as to be prepared for the time when it might have to subsist and carry on as a strictly self-sustained institution.

87. Governmental financial support and/or international assistance should be required until the institute should have acquired sufficient income from private enterprise for work performed on a contractual basis. Governmental commitments to support the institute should be made for several years. Such commitments should be set forth in the basic agreement on the establishment of the institute.

88. The institute should recruit from the start a staff of top-flight technicians and research workers. The availability of trained technical personnel in each particular region would, of course, be a determining factor in the number of foreign experts that the institute would have to hire. Provisions should be made, though, to incorporate gradually national technical personnel in the institute's staff. During its formative years, the institution should train national personnel for its own staff. Later on it might embark on an advanced training programme aimed at increasing the supply of highly qualified professionals for the future work of the institute or the local industry.

89. It is important that the salary policy for qualified staff members be liberal and thus encourage the retention of key personnel. Promotions should be granted merely on the basis of merit and past performance. The institute should strive to give its professional staff higher remuneration than in private enterprises, otherwise the institute would be at the mercy of constant shifts of personnel and in danger of losing its key research workers to private industry.

90. Finally, a regional research institute must conform to the basic needs of the area and must be flexible enough to adapt its activities to the ever-changing social, economic and technological conditions of the region concerned.

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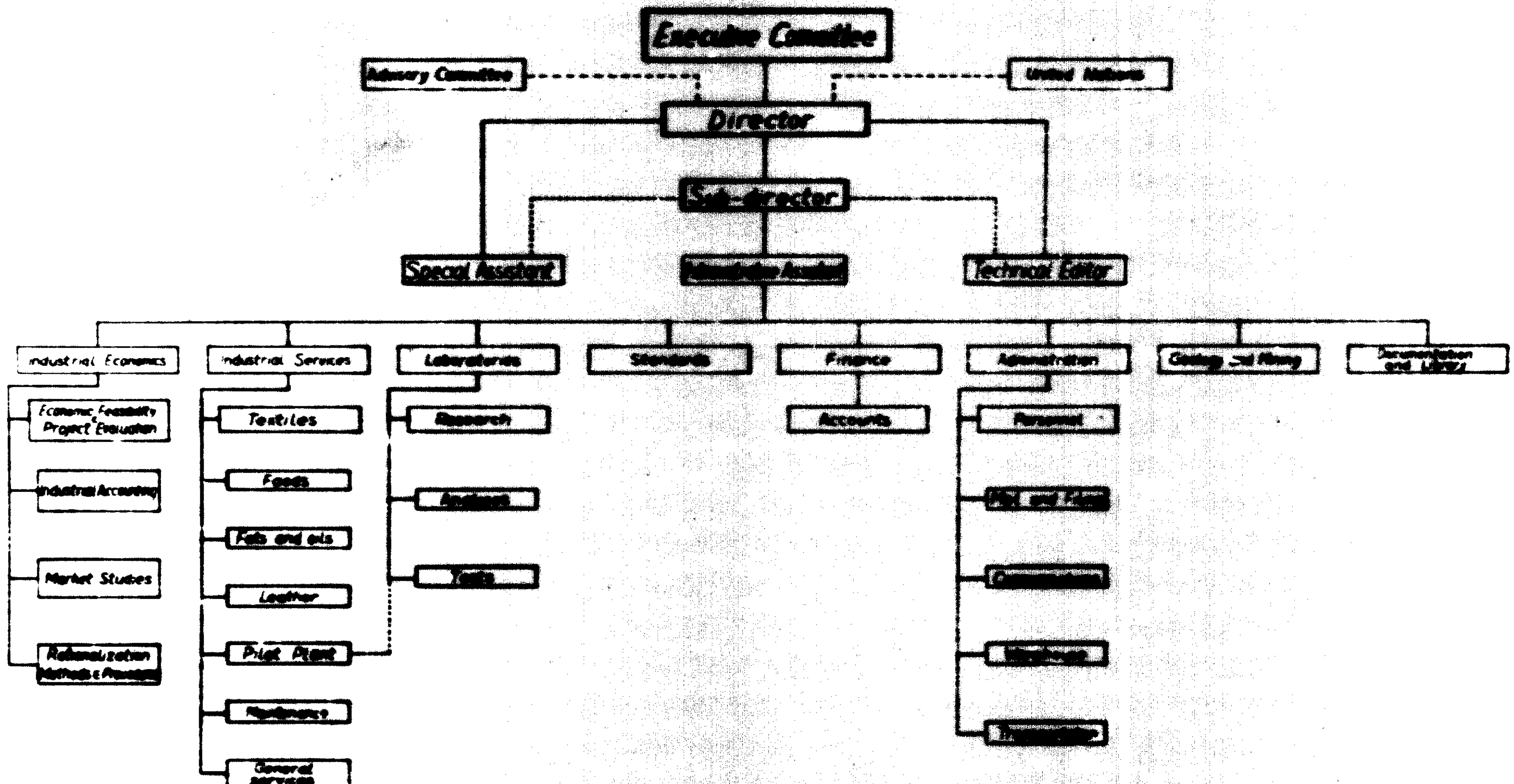
Sales No.: 59.II.B.1.

ANNEX I

FIGURE I

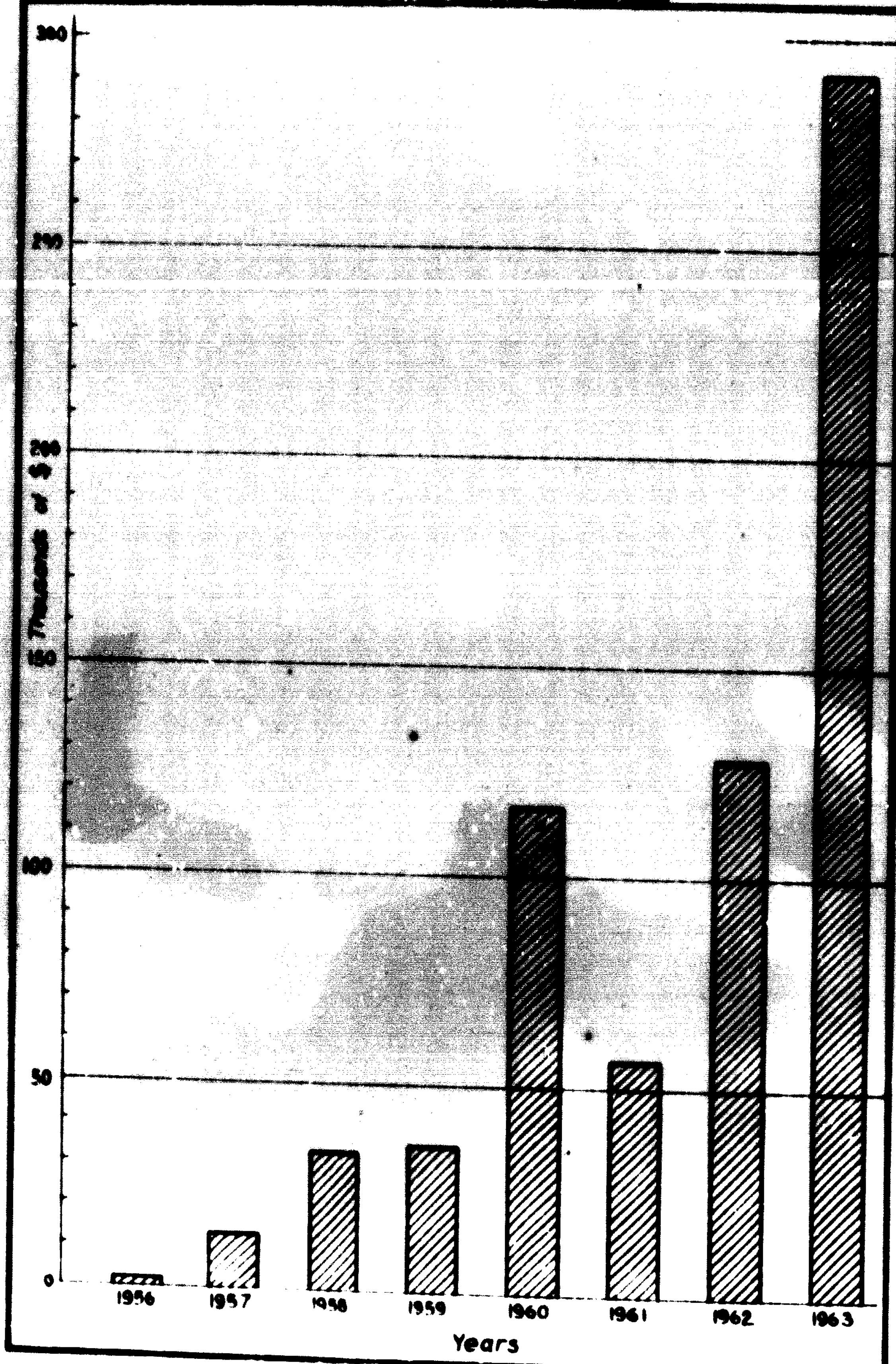
ORGANIZATIONAL CHART OF ICAITI



ANNEX II

FIGURE II

ICAITI'S INCOME FROM PRIVATE ENTERPRISE



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XI. MANAGEMENT OF AN INSTITUTE SERVING INDUSTRY WITH REGARD TO PROJECTS

Prepared by F. Schippers*

Introduction

1. Institutes serving industry are engaged in the gaining, application and transfer of knowledge. Depending on its goals, a specific institute would stress one of them: research institutes gaining new knowledge and transferring it, training institutes doing just the reverse, while extension institutes would emphasize the application of modern know-how in industry.

2. This paper will concentrate on a non-profit institute, the management of which has to consider the following characteristics:

(a) The major part of total cost of an institute consists of salaries and wages;

(b) The personnel devote a part of their time to (creative) thinking, meaning that control of efficiency is by no means easy;

(c) Continuity of an institute depends highly on the quality of the work performed;

(d) As the activities deal with data obtained from industry, care must be taken that they are treated confidentially;

(e) Recording the "output" of an institute is a difficult task, because there is no common denominator. The output volume expressed in money value gives a poor indication for comparative purposes.

3. Many institutes embody these characteristics; their assignments are normally rather large and of longer duration. They apply to a development institute as well as to a management research institute and to others.

4. Each particular institute has to adapt its choice of personnel (including the manager), its structure, control systems and financing to the activities to be performed and to its size and degree of decentralization, as well as to the circumstances in which it has to render services to industry.

5. By providing a frame of reference with regard to some aspects of institute management with regard to projects - based on experiences in the Netherlands as well as in developing countries - it is hoped to initiate discussions and an exchange of experiences. This may well lead to better management of institutes

* Director, Research Institute for Management Science, Delft, the Netherlands
This paper is a contribution of the Government of the Netherlands.

dedicated to accelerating the growth and ... industry in developing countries.

A. Structure according to projects

6. If, for purposes of analysis, this subject is approached ... in the case of a (servicing) industry one arrives at the following considerations.

Resources within the organization

7. They consist of manpower and know-how. The latter could be partly put down on paper but would be mainly in the minds of the personnel of the institute. Together with skill, these would provide the manager with the means to fulfil the goals. Documentation would be an unavoidable function within the institute. Selection of new personnel would draw heavily on the management.

Resources outside the institute

8. Each institute would profit by making use of and co-operating with outside people and organizations. It would be impossible to have all necessary specialistic know-how within the organization, which would even not be justified economically. This too points out the necessity of documentation, while it also indicates the need for communication.

Production

9. The majority of the orders - which the author prefers to call "projects" (see annex I) - would be different from each other, regardless of whether they result from inside or outside initiatives. Some projects might be more or less identical with former ones. However, the characteristics of the "production" of the institute would be that of a piece-production system, which requires a high standard of flexibility of organization and frequent changes in the utilisation of the available capacity. The production function may need equipment (e.g., a laboratory).

Marketing (acquisition)

10. This function is often too neglected, the more so as many of the staff have no commercial background. A purely passive policy in this field has to be considered undesirable. If the institute received an abundance of orders, the selection of them should be made with great care. As this function must be seen within the serving task of the institute, it is clear that considerable attention would have to be paid to public relations.

Development

11. This means especially the development of manpower and know-how: an active library, training of personnel, keeping up to date, stimulating initiative and maintaining contact with the world outside the institute.

12. The above-described short analysis leads to three major conclusions for the structure:

(a) Project set-up; for each project the organization should be organized *ad hoc*;

(b) Create a team (in which there are different responsibilities) which is flexible;

(c) Maintain contacts with industry as well as with other bodies or institutes.

13. In concluding this section, some organizational characteristics of small as well as of larger institutes are mentioned below:

(a) Small institute: preferably all-round people; a horizontal organization in which the responsible staff members are made leaders of the projects (each of them would, from time to time, have to work under one of his colleagues, the latter being the leader of another project); staff functions in the library, documentation, administration, reproduction, laboratory, etc.;

(b) Larger institute with regional offices: a vertical organization up to the regional office level, for the remainder a horizontal organization; centralized specialistic and functional departments (laboratory, efficiency department, statistics, training, operations research, etc.); a communications problem.

14. For those charged with setting up and managing an institute in the sense of the present paper, annex II provides a frame of reference. Annex II concerns the relation between utilization of time and groups of personnel; the time utilization in the institute is divided into four categories of work: operations, creative work, organizational work and personal care. These categories of work will be encountered in each of the activities described in paras. 15-21.

B. Control

Time

15. Each productive employee should note how much time he spends on what. This could be done each day by means of a code for each of the activities. For administrative reasons, it is easier to divide a working day into ten units of time ("deci-days") than in hours; however, this is not essential. Each week the administration would receive from all employees these forms and records of the time spent, shown in two ways: per project and per employee.

16. The recording concerns the total time for which the employee is paid. Therefore, there must also be codes for public holidays, vacation and illness.

17. The rest of the time represents available capacity and can be divided into:

(a) Time spent on direct productive activities: "projects";

(b) Time spent on indirect productive activities: "developments";

(c) Time spent on non-productive activities: "overhead".

Each activity should be designated by a code for reference purposes.

Projects

18. Each internal or external order would be called a project. The financier of the project would be known. The contents of the project would be recorded; a budget and time schedule made and a project leader appointed (see also annex [illegible]). All time spent on the project would be recorded by referring to its code; this would include preparatory work, carrying out the project, studying literature, follow-up, etc.

Development

19. These activities might lead to projects, but at this stage the costs would not be covered by income for that particular activity. There would be no budget for each activity coded under this heading; however, the total "development" must be estimated in the year budget and thus controlled.

20. These activities often have a public relation aspect. Examples are: (a) preliminary set-up of a project without having an order; (b) surveying new markets or orders; (c) writing papers for conferences; (d) information on activities of the institute (written or orally); (e) training of a staff member in a field presumably of future importance to the institute; and (f) research.

Overhead

21. This would include activities for the institute as a whole, such as: capacity planning, bookkeeping and administration, representation, training of staff. Furthermore, if they were not concerned with a specific project, it would include the library, documentation, internal affairs, etc.

Cost

22. Costs would be determined by multiplying the time spent on projects with a pre-calculated tariff per unit of time. This system could be used both for the institute as a whole and for the projects. In order to arrive at total cost, the costs depending on the activities - being variable per project - should be added. Examples of variable costs per project are:

(a) Use of material and energy for testing;
(b) Outside advisers or lecturers;
(c) Extra travelling expenses;
(d) Other costs not included in the tariff per time unit.

23. The pre-calculated tariff would consist of the fixed cost (regardless of activity) and would be calculated separately for groups of similar, productive personnel. The basis for the tariff per group would be salaries plus social charges of that group; the allocated costs would be added to this total. The latter (e.g. wages of clerical staff, depreciation of assets, operating costs) are considered proportional to the productive time.

24. There would be no objection to allocating in the same manner some cost items which in principle would be variable per project (e.g. travelling costs and PTT-costs), provided that they were small as compared with salaries. The total amount per employee should show only insignificant variations over several

years. This method would eliminate recording per project and would simplify invoicing to principals.

25. To arrive at the tariff per productive day the total cost per man <u>per annum</u> must be divided by the expected productive days of that man. If it concerned an employee (or group) who - besides productive work - performed a high percentage of non-productive work during the year (e.g. directors) the tariff might prove to be extremely high. In that case, part of the cost of that group should be borne by lower groups, thus increasing the latter's tariffs and lowering that of the top group.

26. It would depend on the financing of the institute whether the time spent on "development" was allocated to the direct productive time or treated separately. The time spent on non-productive work would be estimated as a percentage of total time for the whole institute and should be controlled separately.

27. The total direct and indirect time of the institute multiplied by the tariffs per category (it is recommended to have only a few categories) should cover all expenditure less variable costs per project; the latter would be charged directly to principals.

28. Of course, an annual check of the pre-calculated tariffs - by comparison with real expenditure - would be necessary. Efficient control of projects is effected by comparing and analysing the estimated time (planning) and the real ones.

29. In large institutes, e.g. with various staff departments and laboratory, it would be feasible to calculate tariffs per unit time for making use of such a department or laboratory. The calculation system is in accordance with the practice in industry.

<u>Activities</u>

30. In order to enable management to control the efficiency of the institute as a whole, it is recommended to introduce written weekly reports on activities performed. These reports by all productive employees could be compared with the administrative data on weekly time-utilization.

<u>Quality and secrecy</u>

31. As mentioned before, control on these aspects is rather difficult. Fixed procedures in this respect are hardly possible. It involves a lot of reading and discussing of the responsible officers with the staff members. It is important that this control should be up to date (if a report is sent to the principal <u>post festum</u> control is of little use).

32. The best way to avoid work of too low a standard and/or difficulties with principals on the aspect of secrecy would be to:

(a) Select personnel carefully;
(b) Instruct and train personnel;
(c) Create a sphere of responsibility in the institute;
(d) Create a team spirit among the employees.

C. Financing: forms of income per project

The principal paying all expenses

33. Periodically the institute would submit an invoice to the principal. The total amount would consist of fixed and variable costs (variable per project). The fixed costs would be calculated by multiplying the number of days spent on the project by the price-tariff per day. The price-tariff would be based on the cost tariff but the former would be higher in order to cover expenses for continuity of the institute (e.g. temporary under-utilization of the capacity occurring between projects). The institute should provide the principal beforehand with estimated costs; a maximum is often stated in the contract.

The principal paying a lump sum

34. In the contract, the parts of the total sum which must be paid during the carrying out of the project should be stated. With this form of payment, the institute would bear the risk of carrying out the project.

The principal paying a part of the expenses

35. This means that the income from the principal would be less than the expenses. In this case, there would be two possibilities:

(a) The client would be charged with a tariff per time unit, which would be lower than the cost-price tariff. In principle, the charged tariff could be zero; however, this is not recommended in dealing with industrial clients; co-operation of industry would be better if a moderate amount were charged;

(b) The principal would pay only a part of the expenses of the project, e.g. not for preparatory work, but for the execution only.

36. With regard to both possibilities, the institute must look for supplementary sources of income. For instance, the institute could have a standing offer of a governmental office that if a project had to be carried out on request of a certain group of clients (e.g. small-scale industry) the Government would pay the loss on the costs per day. Another possibility would be that of contributors for certain research or for preparatory work.

The principal's payment being conditional

37. This means that the principal would offer an amount of money for carrying out a project if, and only if, another party would do the same. Both amounts together would cover the expenses of the project. It could happen that the institute would cover the latter amount of money, expecting to obtain such money from another party in the future, implying that the institute bears a risk. For this and other risks, it would be necessary that the institute - being non-profit - develop a reserve fund. Sources of income for this fund could be proceeds of publications and lectures.

38. The foregoing discussion makes it clear that in a number of cases the income for a project may come from several resources.

I. Summary

39. This paper recommends that the organization and management of an institute serving industry be according to projects. At the same time, the institute would deal with several projects (internal or external orders), which would be in different phases of execution. The phases - links of a chain - have different characteristics and would require different skills, as well as different capacities. In order to arrive at a chain of "olympic" rings, co-operation, feedbacks and overlapping would be necessary.

40. The organization of the institute would be also according to projects, which means it would be highly flexible. One staff member would co-operate in several projects; for one or more projects he would be the leader. In this way, a high degree of utilization of the manpower capacity could be reached. The project-wise management implies an excellent team spirit amongst the staff members of the institute.

41. The line of command would be short. By means of a (time) budget, management would assign a project to a staff member who would be fully responsible for quality, quantity of time spent and for the progress of the project.

42. The administrative control of the institute (per productive employee and per project) would be based on time recording. Fixed costs would be calculated by means of time spent multiplied by a tariff, which would be different for various groups of personnel.

43. It is believed that the frame of reference discussed above would contribute to a higher degree of efficiency of institutes serving the industrialization of less developed areas.

ANNEX I

SCHEME OF A PROJECT

The following concerns a research project; however, most steps will also be recognized in other types of projects.

Steps	Contents
1. Preliminary study:	Starting on own initiative or request from outside; ending with a report "set-up of project"; Statement of problem or task and its importance, which results are expected, consult documentation and experts; Estimate of time consumption, delivery time, outside assistance, needed skills; Outline of carrying out: how to gather data, whether pilot study is necessary, alternatives.
2. Decision:	On the basis of the "set-up of project", information management of the institute would decide on cost and financing. Prior to their decision, management would certainly have to evaluate the scientific and economic value of the project. The project would be assigned to a staff member.
3. Carrying out:	The project leader would receive a (time) budget plus date of delivery. A budget is a plan, quantifying the project, it instructs the project leader and is a means of control. Within the carrying-out step, one may distinguish: preparation (i.e. formation of the organization, instruction and training of project staff), gathering of data, analysing, etc.; and finally reporting to the principal.
4. Generalization/conclusion:	The project leader would present an over-all report plus calculations of time spent plus list of documentation and would indicate follow-up actions, if necessary. Sometimes new course material would be developed.
5. Transfer of new knowledge:	To institute's staff; to interested persons or parties by means of publications, conferences or courses.

ANNEX II

SOME IDEAS CONCERNING THE RELATION BETWEEN UTILIZATION OF TIME AND GROUPS OF PERSONNEL

1. On behalf of those who may be charged with setting up and managing an institute in the sense of the present paper the following frame of reference will be of assistance.

2. The time utilization in the institute could be divided into four categories of work:

(a) Category "operations" means that kind of work from which you see an output: reports, publications, recordings, graduated participants of courses, drawings, products, etc. Much of "operations" may be performed by the lower level of employees in the institute, but by no means entirely. The "operations" would be possible only as the result of category.

(b) Creative work, among which one finds reading, testing, discussing, making sketches, calculating and surveying, is in short: studying and thinking. The category would include also "receiving instruction" and "developing".

(c) The category "organizational work" would consist of guidance and co-ordination, including, e.g. task description, instruction, planning, control, discussing, external contacts, administration, etc.

(d) Category "personal care".

3. Putting total time utilization for each group of employees at 100 per cent, the distribution over the four categories of work would be different per group (level). An example:

Number of persons in group

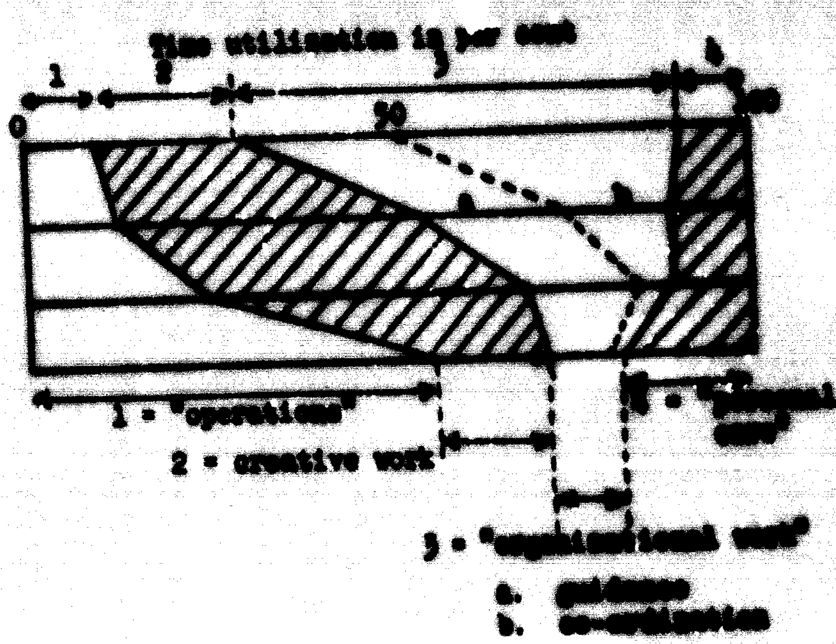
2 Directors

3 Project leaders

6 Researchers

9 Data collectors a/

20



a/ It could be that this group is not in permanent service of the institute; for data collecting the institute could make use of students and of employees of industry.

4. As on each of the four horizontal lines the parts represent percentages, changes in one of the latter would, of course, influence the others.

5. The above presented pattern would depend on the institute's activities, its organization and its staffing. The pattern is a tool to arrive at the optimum structure. In an existing institute, it is possible to record this pattern by means of ratio-delay study.

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XII. THE RESEARCH INSTITUTE AS A CHANNEL FOR UTILIZATION OF FOREIGN TECHNICAL SKILLS

Prepared by Lawrence W. Bass
and S.J. Langley*

Introduction

1. In highly developed countries, securing technical assistance from external organizations is a common practice for speeding the process of acquiring new technology. Even the largest companies, in spite of their internal resources of specialized personnel, frequently find it advantageous to seek knowledge, know-how, and advice from outside. In the United States of America, industrial firms probably devote at least $US200 million of their annual research and development budgets to projects placed in other professional research organizations. This is exclusive of the large sums spent for consultative services on managerial problems.

2. In developing countries, external assistance is even more important to accelerate the transfer of technology into their economies and to ensure that it is put to effective use. In general, these newer nations do not have in local organisations the wide variety of background and experience that are necessary for the rapid implementation of modern industrial and public projects. To postpone undertakings until all the necessary skills and know-how have been developed would delay the course of socio-technological advances.

3. A broadly based research institute, undertaking defined projects on behalf of individual firms or government agencies, can offer an effective and discriminating channel for obtaining technical assistance from abroad. It can perform the functions of diagnosing the problem and type of technical information required, of evaluating the various sources of information, of serving as a bridge for adapting foreign experience and know-how to local conditions, of establishing a channel of communication between the local project and the external consultant, and of providing a focus for the use of the information in implementation. When the institute has become sizable and diversified, it can help to overcome the handicap of geographical separation by making use of foreign consultants on a range of projects being conducted for different local clients.

4. In this discussion, the authors are speaking chiefly in terms of research institutes that conduct their work through contracts covering individual projects, in which at least the major direct costs are defrayed by the respective sponsors. Even when support comes also from the Government or philanthropic sources, there is real advantage in the requirement that the beneficiaries should share the expense. In the first place, this policy ensures that each project has been

* Arthur D. Little, Inc., Cambridge, Mass., United States of America.

carefully evaluated from the point of view of utility. Secondly, those who are giving such financial support will follow the progress more attentively and are therefore more likely to grasp opportunities to apply it. Finally, these arrangements encourage a better motivation for the technical staff by giving them a sense of purpose in carrying their assignments to positive conclusions. All in all, an organization that aims at being self-sustaining creates a professional climate conducive to optimum contribution to the economy of the country.

5. The history of contract research is valuable as background for considering its utility in developing countries. The concept of research institutes and independent laboratories operating on a self-sustaining basis has been notably successful in the United States of America, and experience in that country indicates that similar organizations could play a very important role throughout the world. Contract research in the United States of America goes back many decades to the foundation of Arthur D. Little, Inc., in 1886, of Mellon Institute in 1913, and of Battelle Memorial Institute in 1929. This type of service to industrial undertakings expanded considerably in the period following the First World War, and has experienced a spectacular rate of growth during and since the Second World War. There are now numerous research institutes and independent laboratories located in various parts of the country employing a total of several thousand scientists and engineers.

6. The evolution of contract research in Western Europe is a fairly recent phenomenon, because previously more dependence had been placed on research associations composed of companies in a particular sector of industry. National policy in many countries favoured these associations whose laboratories are often in part financed by the Government. As an example of the trend toward contract research, however, in the United Kingdom, where research associations began to flourish over forty years ago and sponsored research was virtually unknown until recent years, eight contract laboratories now receive about £2 million per year, a sum which is one-third the size of the funds contributed by industry to the fifty-two association laboratories.

7. It is particularly fitting that this conference on research institutes should be held in Beirut, because here the Industry Institute affords an outstanding example of the success that such an organization can attain. Established in 1953 as an independent, non-profit Lebanese corporation with public status, it has expanded rapidly in a decade and now occupies a well-equipped group of buildings in which a competent staff carries out practical studies not only for Lebanese interests, but also for several other countries in the Middle East. Its range of activities covers a wide sector of industry and includes economic and managerial projects, as well as technical investigations.

8. Procedures involved in seeking foreign assistance are discussed in three major sections of this paper. First, there is an outline of the chief reasons why outside professional services considered justified by large and small firms in industrialized countries, with comments on the pertinence of these considerations to developing countries. Then an analysis is made of the various areas in which foreign technical help can be productive. Finally, the general policies to be followed in getting the greatest benefit from consultative services are pointed out. These apply also to the relationships that need to be developed in a given country between a research institute and its local clientele.

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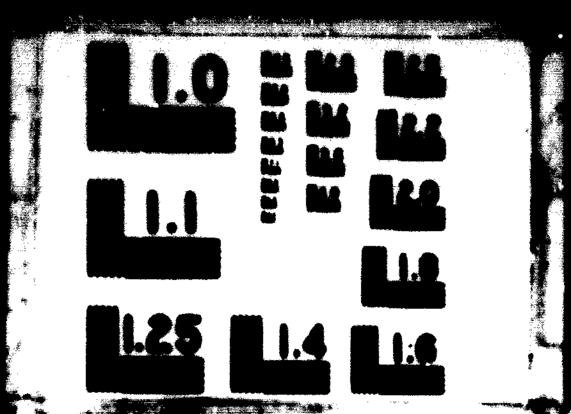

A. Reasons for seeking outside help

Specialized knowledge and experience

9. These are the most obvious reasons for seeking consulting services, particularly in areas in which the client is inadequately staffed. Many firms in industrialized countries prefer, in a given case, the shorter path of obtaining expert assistance in new technical areas, rather than that of committing themselves to the longer course of developing parallel talents internally, which may require a number of years before adequate proficiency is attained. In exploratory projects in which timing is not the vital factor, the company may wish to become better acquainted with the field through a consultant before taking on the obligation of recruiting and indoctrinating specialists, who have the expectation of long-term employment even though the specific projects for which they were engaged do not come to fruition. In a given country, the cost of using a consultant would usually not vary greatly from the expense of carrying out the assignment with internal personnel, if these costs were realistically calculated. Where large differentials exist between local and foreign costs, judgement has to be reached regarding the true economy represented by more rapid transplantation of information.

Relief of work overload

10. This is, of course, a logical reason for using consultants. It is obviously uneconomical for a company to maintain a technical staff that is sufficiently large and diversified to handle peak-loads resulting from the addition of major projects to the normal programme. Furthermore, it is usually not practical to recruit and indoctrinate large groups of professional personnel on a temporary basis. Hence managements tend to restrict their technical staff to a size adequate for their basic requirements and to rely on external organizations for sudden surges in their technical activities.

Breadth of background for evaluating alternatives

11. This may be of great help in reaching a decision regarding a proposed course of action. Broad exposure to similar problems during the course of consulting practice provides a basis for critical evaluation of other methods of reaching the same general objective. An experienced consultant not infrequently finds it necessary to redefine the problem in the interest of providing the client with a more useful solution.

A fresh approach

12. This is recognized by sophisticated companies as an important advantage to be obtained by use of an outside consultant, even when they possess strong technical resources of their own. There is always a tendency for internal personnel to follow a somewhat standardized pattern of analysis and attack and hence to suffer in greater or lesser degree from the defect of preconceived judgements. It is often the case that an outsider who is not steeped in the established organization and tradition of the client may be able to propose more imaginative courses of action than the regular staff.

Transfer of ideas and methodology

13. Such a transfer from one branch of industry or technology to another may lead to new break-throughs. Here again breadth of experience in areas that are not closely related can lead to a different type of solution that has a proved basis of practicality in other types of operations.

Access to broad sources of information

14. This is a very valuable asset which can make available knowledge that might not otherwise be brought to bear. Because of the very rapid advances in technical progress throughout the world, it is becoming increasingly difficult for an individual or isolated group to keep up to date on all developments of potential application to a given problem. Through varied experience in his own practice and through contact with colleagues, the individual expert is not limited to his personal background but knows where to turn for guidance to a much wider range of information.

Greater objectivity

15. Objectivity in scrutinizing the pro's and con's of a project is a major advantage of an outside consultant. The closer an individual is to a particular situation, the greater is the likelihood of inherent biases that influence his opinion. This is why prominent companies often engage outsiders to study their internal organization and functions in order to uncover built-in obstacles to optimum performance.

Professional methodology

16. Professional methodology, developed through diversified experience, is valuable in selecting ways for defining problems, in outlining procedures for attacking them, in using effective techniques for assembling and analysing information, and in interpreting the findings in practical terms. Many developing countries are not short of theoretically trained personnel, but these individuals often have not been exposed to the types of professional work needed to implement industrial projects. These are talents that are ripened by experience. A valuable by-product of working with foreign consultants is that their methodology and techniques for organizing work, which have been perfected in other assignments, are more easily transferred by on-the-job co-operation rather than by formal educational procedures. In this way the local personnel have an opportunity to absorb within a practical setting those skills suited to their environment which have evolved through technical practice in highly sophisticated economies.

Elements of [illegible]

17. This is an attribute of experienced consultants. This self-confidence of the individual in his ability to make sound judgements results from past involvement in other successful undertakings. It is difficult to define, but it has real significance in evaluation of the validity of the basic premises of a project and in recognition of those obstacles which are not major factors in implementation, but can be overcome in due course without adverse effect on timing.

B. Types of services in which consultants are valuable

18. Description of the types of professional services listed below serves two purposes for this presentation: (a) providing a comprehensive check-list of areas of technical proficiency; and (b) outlining the kinds of assistance a research institute may be able to offer to local firms and government agencies.

19. These types of technical activities have become highly specialized functions - they may be considered secondary disciplines - with their characteristic skills, background and methodology. In large companies in the western world this status is recognized by establishing organizational groups of professionally qualified personnel working in their individual capacities. There are even technical associations in many cases, for example, in such areas as administration of research and development, quality control, cost engineering, instrumentation, market research, commercial development and operations research, through which practitioners can exchange views and experience on common problems. Technical journals have often been established for publication of the philosophy, methodology and case histories in these specialized areas.

20. This list of individual functions also points out the areas of proficiency which should gradually be built up in developing countries in research institutes and related organizations in order that they may serve these economies on a broad basis. Through recognition of their respective contributions to sound economic development and through joint projects with foreign experts, a body of experience could be built up which would form a strong internal resource for the future.

National and regional surveys of economic development potential

21. Such surveys represent a type of work in which several groups, particularly in the United States of America, have developed specialized skills. They bring together teams of specialists in the fields of economics, public administration and the various industry areas appropriate to the region concerned. Their approach is to combine a broad analysis of a region's resource potential with special studies of the prospects of existing industries and an examination of new opportunities; proposals for immediate implementation of industrial and other projects are presented in sufficient detail to prepare the way for engineering and design studies. Few organizations, even in the United States of America, have sufficiently wide and diversified staff resources to carry out economic development potential surveys without the supplementation of their own personnel with experts from industry, research and academic [illegible]; it is also a common practice to associate indigenous staff with regional survey projects, provided either by the regional or local government [illegible], or secured by local recruitment.

. [illegible] techniques for handling regional [illegible] in [illegible] similar [illegible] result of the trend in industrialized countries [illegible] formulation of product and marketing [illegible] experience for carrying out regional development surveys and for [illegible] industrial investment opportunities in terms of resource availability, market potential and long-term regional and national interests. In particular, it has helped to crystallize procedures for the productive co-ordination of the activities of specialists of widely differing professional skills and backgrounds. [illegible] of the most interesting work in this area has been done in the Middle East - in Iran, Iraq, the United Arab Republic and, to a limited extent, in almost all the countries of the region.

Assessment of national technical resources

23. This is a related type of activity. In the belief that the greatest source of technical strength in a country is its population of trained personnel, the starting point for planning the use of this collection of talents is comprehensive knowledge of the size, quality and deployment of professional manpower. The carrying out of such studies on behalf of the Government might logically be assigned to a research institute, because of its broad coverage of industrial activities in a variety of fields.

24. The facts can be ascertained by a country-wide survey of personnel in scientific and engineering work, including those in government departments, industry and institutions for education and research. The inquiry, preferably by precoded questionnaire to facilitate tabulation and analysis, should cover educational background, years of professional experience, field of employment, character of employment, technical area of specialization, geographical location and occupational status.

25. The development of such information is imperative for establishing policies to encourage strategic use of technical manpower by a developing country. What plans can be formulated for more logical distribution of trained personnel in the areas of education, government and industry? Are the strengths in various sectors of technology and science in balance with relative needs? What are the future requirements? Centralized planning for a large technical effort is extremely difficult at best and certainly can be done more effectively with a firm knowledge of the existing pattern. In a similar way, information could be collected on a nation-wide basis about technical organizations and programmes.

Documentation of industrial opportunities

26. This is a field requiring particular expertness and objectivity. The collection and interpretation of the requisite information on evaluation of raw material supplies, technical and economic characteristics of process, production facilities and operation, and particularly domestic and foreign marketing forecasts, are all skills that ripen with experience. It is an essential part of the implementation of plans for economic development. The final form of analysis is essentially an investment prospectus to justify the use of private capital or to ensure a satisfactory return to the national economy.

Product development

27. Product development is a laboratory operation that might be assumed to require no outside help, but here too extensive experience plays a role in arriving at an optimum solution in shortest time. The techniques for defining product specifications, the give-and-take weighing of alternatives and the selection of criteria for evaluating practical performance are not ordinary abilities.

28. The development of preserved-food products, for example, is often of great importance to developing countries to increase the nutritional level of their populations, to conserve renewable natural resources and to secure a greater economic return to their farmers. Evaluation should be made of the types of products that have evolved in industrialized countries to determine what parts of this technology are best adapted to local needs, raw materials, manufacturing limitations and distribution and consumption patterns.

Process selection

29. This, too, is a sophisticated procedure requiring objective analysis of the economic and technological advantages of various routes that might be used for going from raw material to finished commodity. While information in the literature is helpful, usually the data are of general character and need to be interpreted in the light of experience to be valid for a specific case.

30. For a preserved food, for example, after the general character of the product had been decided, there might be a need to analyse the economics of different forms of processing in order to make a choice among sterile canning, spray or roller drying, quick freezing, or even freeze drying. What would be the minimum economic size of plant for these different processes? What would the relative costs be in terms of the value received by the ultimate consumer? How would the form of product suit the local marketing and consumption pattern? What form of packaging should be used?

Evaluation of projects by stages

31. Evaluation of products in increasing degrees of depth at successive stages is a sophisticated technique being used more widely in industrialized countries. For their purposes, these procedures are especially important to avoid costly, unproductive research and development which might be carried too far in the wrong directions. In developing countries, the subject has still greater significance because of their more restricted resources of technical manpower and because of greater urgency in bringing successful undertakings to fruition.

32. Failure to make an evaluation at various stages of a proposed project to produce quick-frozen fruits and vegetables might lead to expenditure of much technical effort in product and process development before it could be determined that the required plant would be too small for economic operation or that marketing would be too limited because of restricted refrigerated storage in distribution and consumption. Valuable time would have been lost and a fresh start would have to be made in a new direction.

Construction of manufacturing plants

33. This has become a highly specialized activity in western countries. Even the largest companies often use engineering contractors for this purpose rather than assembling the large internal staffs required. It is no wonder that developing countries have relied largely on foreign engineering firms for construction of their plants. In the case of the preserved-food product mentioned above, it is highly unlikely that there would be justification for developing new types of equipment or of fabricating specialized items when they could be purchased abroad at reasonable cost.

Marketing policies and studies

34. These have reached an advanced stage in the western countries, particularly in the United States of America. In developing countries, strong emphasis is often placed on the need for production capacity, with less regard for the requirements of the market-place.

35. In fact, much productive equipment stands idle because of inadequate market demand or because of the inability of plant managers to market their output. Production executives preoccupied with problems of running their plants smoothly are seldom the best judges of the products that are most likely to find ready markets or that are most needed for the economic and social advancement of the countries in which they are located.

Organization studies

36. Such studies have become a form of consultative service in much demand in highly developed countries. As sophisticated exponents of the newer concepts of management, consultants are often called in by companies to evaluate the existing form of interrelationships among different functions in order to recommend organizational changes that will result in a smoother and more effective operation. Such studies are carried out for large, medium-sized and small firms. There is no universal answer, but the proposed solution must be evolved from a critical analysis of the existing situation followed by synthesis of improved policies, patterns and procedures to fit the individual case.

C. Relationships for successful use of consultants

Consultant an extension of the client

37. Consultants should be regarded as extensions of the client organization for the purpose of a given project. This relationship is of paramount importance.

38. This requirement is true also for the relationship between the staff of a research institute and its clientele. When the research institute acts as an intermediary between local firms and foreign consultants, special efforts should be devoted to ensure that an atmosphere of mutual understanding, respect and co-operation are established throughout the chain of individuals concerned.

Confidence in consultant's integrity

39. Recognition of the integrity of the consultant, a corollary to this principle, is essential for sound working relationships between the local firm and the research institute and is equally imperative in dealings with foreign consultants. Any doubts about ethical treatment of information required for definition and prosecution of the project might result in the withholding of data or opinions that would expedite progress toward successful operation.

Responsibility for project

40. Responsibility should be concentrated in single individuals in both the client and the external research organization. Experience has amply demonstrated that failure to recognize this principle can lead to frustrations, disagreements and confusion. Many satisfactory professional and personal relationships between members of both organizations can be expected to develop, but responsibility for the conduct of professional work and its review and assessment by the client organization cannot be diffused without serious danger of misdirection of effort and the possible frustration of the fundamental purpose of the project.

Mutual agreement on terms of contract

41. Mutual agreement as to the scope, cost and duration of the project should be established between the client and the consultant. This is usually effected through a written contract which defines the objective of the work, the area of responsibility of the consultant or research institute in conducting the assignment, the procedure for charging and payment, the length of time involved and the timing and character of reports. The terms should be reviewed periodically by the consultant and the client to make sure that they are still a matter of mutual agreement.

D. Conclusion

42. The reasons for seeking consultative help, the types of services which consultants can provide and the proper relationships between client and consultant have been outlined. In essence, the effective use of consultants involves: (a) diagnosis of the problem and type of technical assistance required; (b) evaluation of various potential sources of knowledge and assistance; (c) creating a favourable atmosphere for adapting foreign experience and know-how to local conditions; (d) establishment of a channel of communication between the client and the consultant; and (e) providing for the effective transfer of information and know-how to the implementation of the project. Emphasis has been placed on using the services of foreign consultants, but this approach is in fact merely an extension of the principles under which a research institute should act on behalf of its local clientele.

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XIII. THE ORGANIZATION OF SCIENTIFIC AND INDUSTRIAL RESEARCH IN THE UNITED KINGDOM

Prepared by the United Kingdom Department
of Scientific and Industrial Research

1. In the last few years, there has been a remarkable increase in the number of scientists and administrators from newly developing countries who visit the technically more advanced countries to see how research is organized there and how the organization is adapted to meet changing circumstances. Some people find this interest a little puzzling, because political, economic and technological conditions vary greatly from one country to another, and it is hard for persons in the United Kingdom to see clearly how their experience is directly relevant to, say, countries which have only just ceased to depend wholly on primary production. But discussions with the visitors to the United Kingdom have revealed many points of common interest and emphasis will be placed upon these in the following account.

2. The chart annexed to this paper shows the formal structure of authority and responsibility as it currently is (October 1964). The organization of civil science by the Government has been examined by a special committee of enquiry, the Trend Committee, which reported in October 1963. The substance of the Committee's recommendations has been accepted by the Government. At the same time, following the issuing of the Robbins Committee Report on Higher Education, other changes in the administrative structure of civil science in the United Kingdom have been made. These are described below. The more fundamental of the proposed changes are described at the end of the paper. The diagram emphasizes an important feature of research organization in some of the more developed countries - a complex partnership between Government, industry and the universities and colleges of technology.

A. <u>The research councils</u>

3. In the United Kingdom Government, responsibility for civil science has rested for many years with the Lord President of the Council, a Cabinet Minister with certain duties related to the ancient Privy Council but no departmental responsibilities. In 1959 the title of Minister for Science was created, and, until February 1964 the two posts, of Minister for Science and Lord President of the Council, were held by the same Minister. In February 1964, the ultimate control of both science and education was vested in the new Secretary of State for Education and Science, under whom is a single department comprising two distinct administrative units, each controlled by a Minister of State. The Minister of State responsible for science has under him four research councils: for scientific and industrial research, agricultural research, medical research and for research in nature conservation. There is also the Overseas Research Council, to advise on the formulation of policy in respect of scientific research in or for overseas territories, and to co-ordinate the activities of the government organizations concerned. In addition, the Minister of State is responsible for the United Kingdom Atomic Energy Authority, which is referred to in paragraph [illegible],

[illegible]

4. It is important [illegible] research council [illegible]. The chief task of a council is to promote research for specified purposes and within a specified field and it can do this in several different ways: [illegible] with grants-in-aid; by placing contracts for particular research projects; or by doing research itself, either in its own laboratories or in units which it sets up in research institutions. Building up a creative and consistent policy over a wide field comprising many academic subjects and many conflicting interests is a difficult task in which research administrators need the advice and guidance of specialists and of potential users of research results. This is provided by the research council - in a general way at its own meetings, where recommendations are made final, but more particularly at meetings of specialist committees, where the bulk of the collective thinking is done.

B. The Department of Scientific and Industrial Research

5. The Department of Scientific and Industrial Research (DSIR) has three main functions, apart from its information activities, which are not relevant to this paper:

(a) To support through grants promising researches in universities, colleges and other institutions, and through scholarships, the postgraduate training of scientists and technologists;

(b) To encourage industry to do research and apply scientific knowledge, chiefly by helping to form and finance cooperative research organisations;

(c) In its research stations, to conduct such basic and applied research as necessary to meet the civil needs of the United Kingdom and, to a limited extent, of other countries.

C. Scientific grants

6. It is impossible to perform these functions well unless DSIR can build a working partnership with the universities and colleges, on the one hand, and with industry, on the other. Like many other countries, the United Kingdom has taken much care to preserve the independence and academic freedom of the universities in an age when they can no longer survive and expand on private sources of income. The bulk of their money comes from the Exchequer through the University Grants Committee, referred to [illegible] grants [illegible]. Apart from capital [illegible]

[illegible]

[illegible] charge to serve at some point in his career. The scheme works well and has proved flexible during a rapid expansion in grants in recent years. It has been described here in terms of the universities only but it applies equally to colleges of technology which are publicly owned institutions and whose capacity for research is being expanded rapidly as part of government policy.

The view is now widely held in the United Kingdom that the universities, being free from outside pressure and control, are the natural homes of unfettered and fundamental research. Work in government departments or government-sponsored organisations in industry is concentrated in applied research and on more basic research designed to provide a sure foundation or background for applied research. It is in work of this kind that DSIR seeks to build a partnership with industry. But industry, like the universities, is organised predominantly on a free-enterprise basis and the problem is to reconcile this freedom with government assistance.

3. Industrial Research

Because the United Kingdom has a wide variety of long-established industries, it is easy to believe that the pattern of industrial research must be simple. In fact it is just the opposite. There are science-based industries, like chemicals, petroleum refining and light electrical engineering, where research is an indispensable function of all leading firms. At the other end of the scale there are older, craft-based industries, such as cutlery and furniture, whose firms are generally too small to do their own research and whose traditions may hinder the growth of interest in research. In between stand industries of many different kinds: for instance, [illegible], like jute and leather, whose survival is threatened by keen competition from overseas producers or substitute materials; [illegible], notably aircraft and electronics, that have developed largely [illegible] and others, including [illegible] engineering, where [illegible] of collective research and development [illegible] but the larger, [illegible] is neglected.

[illegible]

following the United Kingdom's example. In such an association members pool their resources on an agreed financial basis, appoint a director of research and establish a council to build up and develop a suitable programme of work and to provide technical liaison services for members. Apart from making income-tax concessions, the Government is prepared, through DSIR, to help industry to build up research associations to an appropriate size; its grants are made conditional on the raising of a specified income from industry, and the precise terms of grants are revised periodically according to the progress and needs of each association.

11. Because of the variety of circumstances in United Kingdom industry, research associations have a part to play in far more industries than might seem likely at first glance and there are now fifty-one of them in existence. Even science-based industries may have common problems which are better tackled on a co-operative basis than by large individual firms, which may duplicate each other's efforts unnecessarily. In other industries, with firms of various sizes, co-operative research is of greatest benefit to the medium-sized units. But experience has shown that research associations are of particular value in industries with predominantly small firms, where co-operation is easily the most economical method of getting research done. Here they become the technical centres of their respective industries, the main sources of information and advice and useful training grounds for the industry's scientists and technologists. This side of the research association's work must be of particular interest to those countries whose first concern is to learn to apply the results of research already done and to develop in their own scientists and technologists the skill necessary for this.

12. Another important feature of many research associations is the direct participation of member firms in certain areas of research, usually by membership of steering committees, but occasionally also by the provision of pilot-scale facilities in an existing plant. In this way, members not only become involved in particular projects and ready to apply the results, their general interest in research tends to grow and they can therefore derive wider benefit from membership of the association. The Government too is a potential user of information provided by research associations; one condition of the DSIR grant is that the results of research should be made available to government departments as well as to members, and representatives of these departments often become closely concerned with research projects in which the departments have particular interests.

13. In order to ensure close and regular personal contact between DSIR and the research associations, the Research Council appoints two visitors - one academic and one industrial - to each association for a period of years. The visitors discuss the work of the association with the director and staff, give them practical help and guidance, assess the programme of work and report to DSIR from time to time, especially when the association's grant comes up for renewal. This scheme has been in operation since just after the Second World War and it works very well.

E. DSIR's own research

14. In newly developing countries, it is often necessary for industrial research to be undertaken, at least in the early stages, by a government department or a development corporation. This is particularly so where the industry is new and struggling, or where research is necessary before a new industry can be launched. There are cases of this in the United Kingdom too. Atomic energy research, for both military and civil purposes, is being carried out in association with industry by a public corporation, the United Kingdom Atomic Energy Authority. Most basic research on aircraft and aeronautics is done either at Government defence research stations or in industry or the universities under defence contracts. The nationalization of coal mining, gas and electricity supply, and public transport has led to the creation of national research organizations within the public corporations that are responsible for these industries.

15. The DSIR research stations in general serve a broader field of industry or the nation as a whole, though they pay special regard to the research needs of industries that lack an adequate scientific background and to research problems that are common to several industries.

16. One major function is to extend the frontiers of knowledge in applied science and engineering so that industry can be provided with the basic information needed for the solution of particular problems. Another is to provide for industry national and international standards of measurement of various fundamental physical quantities (such as length, mass and time), and also related secondary standards of reference materials.

17. Several of the stations are engaged on research which can provide information to central and local authorities on such matters as air and water pollution, road safety, noise, and the extinction and prevention of fires, in which the Government is responsible for the health, safety and welfare of the citizen. Another broad function of this kind is to carry out research and development in such subjects as the natural resources of the country, and the design and construction of buildings and roads, which are nationally important and which affect the efficiency of industry as a whole.

18. Each station is charged with the functions that suit the particular conditions in the field which it serves, so that the pattern of research varies greatly from one station to another. But all stations keep their fields of research under constant review in order to define objectives and to maintain in Government, industry and the public a lively interest in the value of research. They must be prepared at any time to conduct research on matters of broad public interest. They also find it useful to carry out particular research projects, in co-operation with industry wherever possible, which not only enable them to demonstrate to industry the value of research, but which will also help them to understand industry's problems more fully and to identify fields in which more research is most urgently needed.

19. It will be clear that this work, like that of the research associations, depends on a thriving partnership between DSIR and industry, and with other government departments where appropriate. Fire research, for instance, calls for the interest and co-operation of makers of fire-fighting materials and of the authorities responsible for fire regulations in buildings. Research on road-making

and road safety similarly involves the highway authorities, civil engineering contractors and those who manufacture the materials and equipment. Work in engineering cannot be of much practical value unless industry is closely associated with its progress and is interested in making early use of the results. Thus DSIR has made a practice of inviting industrial as well as academic and government representatives to sit on the advisory boards and steering committees which help to plan the work of its stations. Industry similarly participates in the work of the "subject" and "project" committees that guide so much of the research done at DSIR stations, and the stations themselves are prepared to undertake a variety of work on repayment for industrial firms or for interested government departments.

20. So far DSIR has not found it necessary, as other research councils have, to set up its own units in universities or colleges. But its stations have from time to time placed contracts with outside organizations for particular research projects that are more appropriately done there than within DSIR. Recently the Council for Scientific and Industrial Research has been considering the possible scope for research and development contracts financed from its central funds, and it has reached the conclusion that there may be in industry a limited number of large projects which, while they may well achieve an important technical advance, are too speculative and too uncertain of providing an adequate financial return over a short enough period to attract support from private sources or the Government's National Research Development Corporation. The Council is therefore prepared in suitable cases to join with industry in financing such large, long-term ventures and, if the ventures are successful, to recoup its money by a levy on sales. This is a new departure for DSIR; major long-term contracts of this kind have so far been confined to the defence departments, which not merely sponsor the projects but also direct the use of results.

F. Problems of priority and balance

21. Newly developing countries with limited resources for research and development have acute difficulty in deciding where to allot priority. Even in more developed countries problems of priority exist and must be faced in the construction of research programmes. But there is equal difficulty in obtaining a balance in the total research effort of the nation. A few industries mobilise adequate resources spontaneously and without difficulty; others can only do so with aid from the Government. Others still have difficulty even with the help of government funds. There are various explanations for this last category - for example, economic decline, leading to shortage of resources for innovation; temporary prosperity weakening the incentive to innovation; and lack of managerial initiative. In recent years DSIR has been examining closely some of the more important industries in which there has been doubt whether the total effort on research and development is satisfactory in comparison with other industries. It has sent out small teams of economists and scientists or technologists to try to assess what the requirements are and to make recommendations concerning the scale and direction of future effort. At least two of the completed studies (in the machine tool and the shipbuilding/marine engineering industries) have led to a good deal of useful action. Other studies are under way, and the Research Council has reached the conclusion that such exercises are extremely valuable despite the inherent difficulty of persuading organizations to collaborate if they think that they may suffer adverse comment and publicity as a result.

G. Staffing

22. It will be seen from this survey of DSIR's work that it is mainly engaged in doing or promoting research in the ultimate interest of the nation as a whole. One recurring problem is the recruitment of officers suitably qualified and experienced for its work. These officers form part of the scientific civil service and the great majority of them are permanent staff recruited by the Civil Service Commission, like officers in the more general classes of the service. Since the Commission goes to much trouble to recruit people with sufficient ability, aptitude and initiative for the classes to which they are recruited, it is not surprising that government scientists share the reputation for ability and assiduity that is enjoyed by the civil service as a whole. One practical difficulty is that the qualities required for research and for technical administration are very different. Thus, the administrators must be officers specially recruited and developed for this work, preferably with a training in science, or research workers transferred from the laboratory as their aptitude for administration develops - or their aptitude for research declines. DSIR draws its administrators from both groups and, although on the whole it is successful, it finds some vacancies difficult to fill and has to exercise much patience in its search.

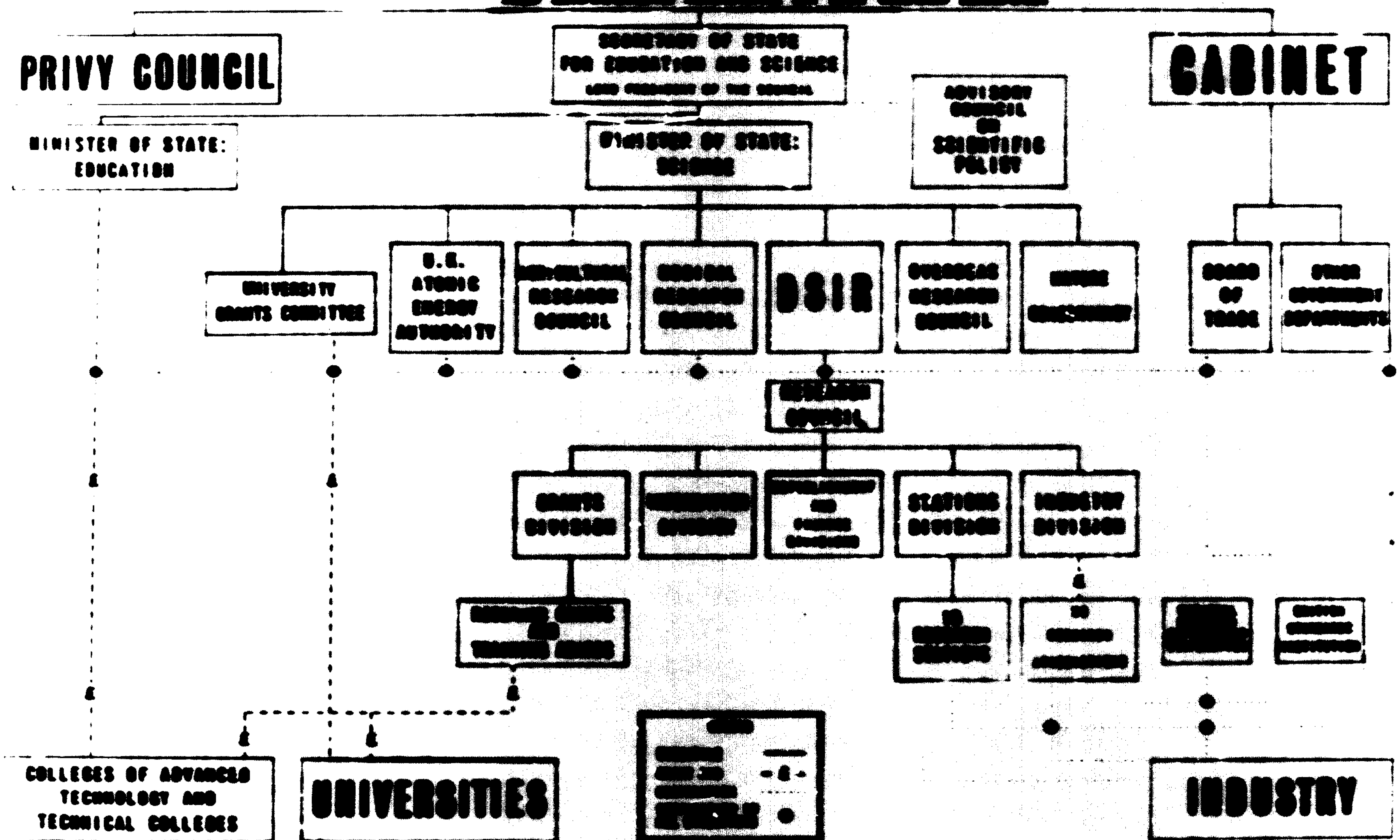
H. Conclusion

23. It is hoped that this brief account of the organization of scientific and industrial research in the United Kingdom will be of help to newly developing countries that have still to solve the basic problems of organization. Perhaps the most useful lesson to be learnt is how much can be done in many branches of science for the expenditure of comparatively little money. The fifty-one research associations tackle a wide variety of problems on a total budget of only £9 million, of which DSIR contributes £2 million. In 1963, 4,036 research studentships and 147 research fellowships were maintained at a cost of £1.7 million. In the academic year 1962-63, 513 new research grants, with a total value of £3.6 million, were made to universities and colleges; in 1963, 929 grants were current. Including a net expenditure of more than £7 million for its own stations, DSIR had a total net expenditure in 1963 of £17.2 million.

24. As stated in paragraph 2, the Government proposes to make a number of far-reaching changes in the structures of its civil science organization, following the recommendations of the Trend Committee. The main one is that the DSIR should be dissolved and its responsibilities distributed among three new bodies. First, a Science Research Council to support projects in pure and applied science, to be responsible for the National Institute for Research in Nuclear Science (NIRNS), for Conseil Européen de Recherche Nucléaire (CERN) and for the United Kingdom interests in space research. Secondly, a Natural Environment Research Council, to take over the Geological Survey and Museum and the work of the Nature Conservancy and other bodies. Thirdly, an Industrial Research and Development Authority (IRDA) to have the same status as the Research Councils and to take over most of DSIR's research stations, together with the Department's responsibility for the support of industrial research. The National Lending Library and the Laboratory of the Government Chemist, two of the DSIR stations, will become the direct responsibility of the Department of Education and Science. No major changes are proposed in the functions of either the Medical or the

Agricultural Research Council. The Overseas Research Council will likewise be dissolved and its functions taken over by the Department of Technical Co-operation. A new Council for Scientific Policy, to advise the Secretary of State for Education and Science on national scientific needs, will replace the present Advisory Council on Scientific Policy.

FIGURE I.


PRIVY COUNCIL
CABINET
MINISTER OF STATE: EDUCATION
ADVISORY COUNCIL ON SCIENTIFIC POLICY
UNIVERSITY GRANTS COMMITTEE
U.K. ATOMIC ENERGY AUTHORITY
DSIR
STATIONS DIVISION
COLLEGES OF ADVANCED TECHNOLOGY AND TECHNICAL COLLEGES
UNIVERSITIES
INDUSTRY

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XIV. TECHNICAL SCIENCES IN POLAND

Prepared by I. Malecki*

1. One of the main organizational features of a socialist State is planning and co-ordination of activity on every level. This of course applies also to problems of technology and to its basis - science.

2. The chief organization which co-ordinates the entire research in the area of technology in Poland is the Committee of Science and Technique, an organ with the authority of a top state administration, headed by a deputy prime-minister of the Polish Government.

3. The stations which carry on research in the domain of technology are organizational grouped in three institutions: the Polish Academy of Sciences, the Ministry of Higher Education and ministries (departments of state economy).

4. The number of stations in these individual groups in 1964 was the following:

Stations	Polish Academy of Sciences	Ministry of Higher Education	Ministries
Institutes	15	14	92
Research departments a/ b/	80	1,255	745
Other organizational units (laboratories, centres) b/	147		303

a/ In higher education - Chairs.

b/ Subordinate to institutes, or autonomous.

5. All these institutions currently have a total of 59,727 workers, including 5,092 senior scientific and research workers, and 22,572 assistant scientific and research workers.

6. The main task of research institutions subordinate to the Polish Academy of Sciences is to conduct fundamental research. Such research is carried out in many directions. In general, all research pertaining to technical disciplines, carried out by the Academy, can be divided into three groups:

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* Deputy Secretary-General, Presidium and Council of the Polish Academy of Sciences.

(a) Mathematical-physical and geological-geographical sciences, concerned above all with problems of mathematics; physics; astronomy; geophysics; geological sciences; geography; physical chemistry and organic synthesis;

(b) Technical sciences embracing inter alia problems of mechanics of continuous media, fluids and gases; electronics; magnetism; energy transformation; vibrations; communication theory; automatics; mathematical machines; fluid-flow machines; chemical engineering and chemical apparatus construction; rock formation mechanics; scientific information; and the peaceful utilization of nuclear energy;

(c) Biological sciences where research should be stressed in the field of biochemistry and biophysics; experimental biology; hydrobiology; botanics; ecology; zoology; anthropology; ecology and morphology of mammals; dendrology; general genetics; palaeozoology; parasitology; and experimental and systematic zoology.

7. Research in the above problem is carried out by institutes, autonomous departments and research centres, laboratories and the like, subordinate to the Academy. These institutions differ very much as to their size: their personnel ranges from some scores of employees to over a thousand. Many subjects, particularly those which are broad and complicated, are elaborated by several centres, one usually playing a leading role.

8. Independently of the above within the Polish Academy of Sciences, fifty-seven committees and commissions work on specific problems.

9. The organization of institutions subordinate to the Ministry of Higher Education is different. The basic unit carrying out autonomous research is here the chair in a university which possesses its own laboratories and quite often auxiliary workshops. In schools of university level, there sometimes exist institutes in which a number of thematically closely interrelated chairs are grouped.

10. The main task of a chair is, of course, didactic work. None the less the chairs conduct independent research, sometimes of a fundamental character, but more often in only applied research. In many cases, the chairs solve problems directly important to the national economy and even conducive to practical application.

11. As concerns their organization, the chairs are rather small units, employing several or some scores of workers. This does not hamper their ability to be very distinctly felt in the economic life of the country.

12. The third group of institutions which conduct independent scientific research in the field of technology and in related areas consists of institutes and other scientific-research centres, subordinated to departments of state economy (ministries). The basic task of such institutions is to carry out applied research conducive to practice. As to their size, they are very diversified and have from several to a couple of thousand workers.

13. Considering the necessity of solving problems viewed from the angle of the needs of supervising ministries, the work of these research stations often embraces a very wide range of problems and, to a certain degree coincides with

research conducted by other departments. Of course there is a tendency to try to eliminate that duplication of research and one can say that in general this is achieved. This problem is one of the main tasks of the Committee of Science and Technology.

14. Research in general is carried out by particular ministries in the following areas:

(a) The Ministry of Building and Building Materials Industry: house-building; building organization and mechanization; research on social problems and on work protection; glass and ceramics industry; industry of bonding materials; and building technics;

(b) The Ministry of Communal Administration: public transport; in towns; sanitary services; and parks and gardens;

(c) The Ministry of Mining and Power: economics, work organisation and mechanization in mining; power system; utilisation of energy; energotechnology; work organization; and problems connected with petroleum industry (geology, geochemistry, electronics, drilling, exploitation, etc.);

(d) The Ministry of Home Trade: economics, structure and technics of trade;

(e) The Ministry of Transport: road technics (designing, exploitation, road surfaces, bridges and other road objects); research on the development of railways technology, including matters of protection and maintenance; telecommunication, technology, exploitation and technical progress; and also the problems of motor transport (organisation, servicing, equipment, road traffic);

(f) The Ministry of Agriculture and of Wood Industry: forest management; forest products utilisation; soil science; sylviculture and forest protection; pulp and paper industry, and wood processing and technology;

(g) The Ministry of Communication: microwave communication; measuring instruments; wire teletransmission; communication teletechnics; power plants (for communication); television; transmission network; electroacoustics; radio communication; wave propagation; technique and organisation of postal service; telegraphy; erecting work; transmitter aerials; science of materials and elements of telecommunication; standardisation of communication equipment; theory of telecommunication; and wire transmission;

(h) The Ministry of Chemical Industry: antibiotics; inorganic and general chemistry; heavy organic synthesis; chemical technology; production and use of paints and lacquers; pharmaceutics; chemical fertilisers; rubber and organic industry; plastics; and synthetic and man-made fibres;

(i) The Ministry of Heavy Industry: plastic working; chemical utilisation of coal; electrotechnics; refractories; precision mechanics; non-ferrous metals; iron and steel metallurgy; metal cutting; foundry technique; welding; heat technique; tele- and radiotechnics; electronics; agricultural machinery; aeronautical equipment and telecommunication;

(j) The Ministry of Light Industry: leather industry; bast fibres and textiles;

(k) The Ministry of Food Industry and Food Purchase: sugar; fermentation; fat and meat; and herbs industries;

(l) The Ministry of Agriculture: economics in agriculture; plant breeding and acclimatization; agricultural mechanization and electrification; agricultural melioration and grasslands; plant protection; inland water fisheries; pomology; soil science; fertilization and cultivation of plants; and veterinary science and zootechnics;

(m) The Ministry of Higher Education: problems of automatic power systems; research on higher education; and basic problems of architecture, town-planning and building;

(n) The Ministry of Shipping: fishing technique; fisheries technology; fisheries industry economy; technical exploitation of fishing vessels and ports; seashore protection; and sea transport economies.

15. The scope of work of institutes subordinate to various central state organs is very wide. It embraces problems of scientific, technical and economic information (theory and utilization of information); work protection from the point of view of technical equipment as well as labour physiology, psychology and sociology; problems of housing considered from many angles; economics and structure of industry (management, analysis of economic activity, production organization, materials management, transport, etc.); problems of geology (stratigraphy, mineralogy and petrography, geochemistry and geophysics, hydrology, deposits of oil, gas, coal, ore, salt, rare and radio-active elements, etc.); problems of water management from the point of view of technology and economy; problems of labour; of town-planning and architecture; of industrial products design; of hydrology and meteorology; and of broadly understood planning and economic research.

16. The above-described organizational structure is not a rigid one as concerns the range, and more so, the level of the work carried out by individual stations. To draw a distinct line separating, for instance, stations carrying only fundamental research from stations which carry out applied research would not be possible. Also a number of subjects elaborated by the stations of the above-mentioned three groups of institutions are interrelated and to a certain degree coincide. Delimitation of the range of interest according to the given characteristics of groups of institutions should be treated as fundamental and, for those stations, as having a guiding character.

17. Results of research carried out by institutes and other scientific-research centres are published in periodicals and in continuous and serial publications, whose number exceeds 500 titles. They are also published in books. The actual review of these works by way of derivative information is published in English in the following publications of the Polish Academy of Sciences: Polish Scientific Periodicals - Current Events and Quarterly Review of Scientific Publications (books and serials), and also in the publication edited by the Central Institute for Scientific, Technical and Economic Information - Polish Technical Abstracts.

D03880

XV. PLANNING OF SCIENTIFIC RESEARCH IN THE SOVIET UNION

Prepared by N. Oznobin*

1. There are more than 500 different scientific institutions in the Union of Soviet Socialist Republics in which about 100,000 scientists are working.

2. The whole system of institutions working on research in industry could be divided into four main groups:

(a) Scientific, technological institutes of a certain branch of industry;

(b) Scientific research institutes of the Academy of Science;

(c) Educational institutes and universities;

(d) Scientific laboratories at factories.

3. The first group of the institutes, which perform more than 80 per cent of all applied research work, is the most important. Every branch of the Soviet Union's industry has its own group of technological institutes. For example, light industry has research institutes dealing with cotton, silk, synthetics, boots and shoes, etc. Each institute has some well-equipped laboratories and its staff usually consists of more than 100 scientists. Such an institute conducts practically all scientific research in this branch of industry.

4. How is scientific research planned in the Soviet Union? It should be said, first of all, that there are two types of planning. One is the short-term or current planning, and the other is the long-term or perspective planning.

5. The perspective, or long-term, plan of scientific research for a period of five or more years, formulates only the main direction of the research. This plan gives a list of the institutes which will be engaged in scientific research in connexion with a certain problem.

6. The main type of planning research is a short-term plan for a period of one or two years.

7. What is the method of preparation for this plan? The formulation of this plan begins in the institute which prepares it in accordance with the applications or orders from factories or firms which want research to be done on some problems which they themselves could not solve. These orders are then allocated by the institute according to their fields. Those problems which are beyond the competence of the institute, or do not reflect progressive trends in the development

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* Deputy Director, Economic Institute of State Planning Committee of the Union of Soviet Socialist Republics.

of technology, are not included in the plan. Knowing its field of work, the institute itself could propose some important problems to the factories and if accepted by them, the problems might be included in the plan of scientific research of the institute.

8. When the plan has been prepared in the institute, it goes to the branch State Committee. The branch State Committee after receiving plans from all institutes of the given branch industry prepares a combined plan of scientific research in the branch. The problems which are repeated in the various plans of different institutes, problems which have local character or do not reflect progressive trends, are excluded from the plan by the Committee. The Committee may include new problems in the plans of the institutes which play a very important role in the development of this branch of industry.

9. The branch State Committees bring their plans of scientific research to the organisation which has the responsibility of preparing a state plan of scientific research in the country. This organ is called the State Committee on Co-ordination of Scientific Research of the USSR. The State Plan is not a sum of the plans of the institutes. It includes only the main problems on whose solution many institutes will be working and for which the process of the research requires co-ordination. The plan which is co-ordinated in this organization is subject to the approval of the Government and after this becomes a law.

10. In brief, in the Soviet Union there are four stages in the preparation of the plan of scientific research:

(a) Factories;

(b) Institutes;

(c) The branch State Committee;

(d) State Committee on Co-ordination.

11. By organising research activities in this manner, it is always possible to concentrate the financial resources and personnel on the solution of the most important problems aimed at technical progress and the increase of productivity.

D03881

XVI. AN APPRAISAL OF THE EXPERIENCES OF THE FEDERAL REPUBLIC OF GERMANY IN INDUSTRIAL RESEARCH AND DEVELOPMENT FOR THE INDUSTRIALIZATION OF DEVELOPING COUNTRIES

Prepared by Klaus Billerbeck*

1. Industrial research and development have played a very important role in all stages of German industrialization, both prior to and after the formation of the Federal Republic of Germany. It appears impossible to discuss all aspects of them in a short paper, so the author has restricted himself to some points which are interesting, in his opinion, for the specific problems of the developing countries. He has especially attempted to show how industrial research and development were incorporated in comprehensive industrial promotion schemes in order to ensure sufficient incentives for the industrial take-off.

2. It seems to be natural that people are studying the ways and means by which the advanced countries were and are progressing in order to derive suitable patterns for their own economic progress. Here they find the predominant role of industrial activities and the field for the application of technical progress that proves to be the most powerful engine for modern economic growth. Technical progress can be broken down into its elements in order to see the essential impact on industrial development more clearly. Following Lewis, the three decisive steps are the formulation of scientific principles (generally known as basic research), their application to technical problems and, finally, the further development of an invention to its commercial use. The last two stages can be distinguished, according to the force of impact, between inventions and innovations. Keirstead stresses the strategic role of the first group, whereas the latter group is linked with the first by derivation. Strategic inventions giving rise to new industries occur discontinuously, while the stream of innovations flows more or less steadily. The sequence between occurrence of inventions and the strength of impulses of derived innovations decides the balance of economic development. While basic research is indispensable for advanced countries, developing countries in their first stages of industrialization can largely rely on application from an existing reservoir of techniques in most of the relevant fields.

3. Modern economic development runs largely on the same line and the same needs arise everywhere. But this does not mean that all countries should follow the same path of industrialization. Here the factor endowment of each country comes into the scene. Lack of capital and skilled labour is a common feature in developing countries. The consequence of a rash transfer of technical progress from the advanced countries is the creation of centres of progress as small islands in a vast ocean of stagnant areas. The evolving clash leads to a dual economy, with the concentration of the scarce factors in these centres leaving

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* Director, German Development Institute, Berlin.

aside the vast majority of the population and of the country. Even had they the possible stimulating effects emanating from the centres, they run the risk of silting up instead of becoming cumulative because of the lack of mediators in the stagnant areas. 1/

4. In the author's opinion, this situation calls for a special organization of industrial research and development in the developing countries. Two different types of institutes should be established:

(a) For the needs of the centres of progress, advanced techniques should be prepared for application;

(b) For the needs of the stagnant areas, special techniques have to be elaborated that correspond to the given factor endowment of these areas and that help to stimulate self-sustained incentives for economic activities.

5. The next section explains how industrialization in Germany in the nineteenth century was promoted by industrial research and development in the framework of comprehensive programmes. Their realization created the bases for a self-sustained growth of innovations that supported and supports economic growth steadily.

A. Historical background

6. The industrial take-off in Germany in the nineteenth century was performed in different ways according to the regional factor endowments. This paper deals only with some areas that were not favourably endowed with natural resources as such a situation often prevails in depressed areas of the currently developing countries.

7. German industrial promotion in these regions was characterized by considerable governmental activity. The Government not only acted as legislator and administrator, but tried forcefully to strengthen the incentives that were called forth by strategic inventions. As a prerequisite, the State was largely interested in creating a sufficient potential of skilled labour which could use the advantages of technical progress and contributed to its further improvement.

8. Industrial promotion, known as "Gewerbeförderung", offered a more active support to the spreading entrepreneurship than is generally acknowledged by referring to the customs policy. Its role must not be overvalued. Though regarded by liberal economists as a case of Government-protected industrialization, Germany relied to a lesser extent on a high customs system than Austria, Russia, France or the United States of America. Even the famous "Zollverein" from 1845 was largely preoccupied with co-ordinating the customs administration in order to enlarge fiscal revenues instead of using its regulation for a deliberate commercial policy. Industrial promotion centred on domestic policy measures.

9. One can distinguish three fields of promotion that most programmes had in common. These fields are discussed below.

1/ Myrdal would say that the spread effects lag behind the backwash effects.

Technical assistance

10. This field comprised facilities for collecting and spreading the achievements of technical progress. Exhibitions and fairs were organized, technical advice was given for the users of new machinery. This often required the search for foreign craftsmen who were invited to settle in the promoted area.

Economic assistance

11. This was necessary to finance the introduction of new techniques. The need to grant loans at favourable terms made it necessary to evolve adequate banking procedures. They were the forerunners of development banking. New markets had to be found, e.g., for the textile products suffering strong competition from abroad. Market research was an integrated part of these promotion programmes. So the scope of activities extended largely over the purely technological aspects of technical progress.

Training assistance

12. This assistance finally also took different forms. A prerequisite to successful vocational training has been a solid primary education. Regions which had at their disposal a broad and effective school system had an earlier start in industrialization, e.g., Wurtemberg and Saxony. Though the number of industrial workers and engineers was not impressive in the first stage, compared with the rural population, it was important to have a large reservoir of trained labour out of which the most gifted men could be selected. The education in primary schools was followed by a training in technical colleges where technical skills were acquired.

13. Some examples may illustrate how these different fields were combined in concrete promotion programmes. Famous names are linked with them.

14. In 1821, Beuth founded his industrial institute (Gewerbe-Institut) in Prussia, which had a considerable impact on industrial research and development. Soon it became a centre for technical training and industrial research for ingenious men who received a major stimulus for their later achievements. Though being insufficient in number, the leading industrialists began here. Borsig, the producer of the first locomotive in Germany, and Schichau, who acquired an international reputation through his shipyards in Elbing, worked at the institute.

15. A comprehensive promotion programme was initiated in Wurtemberg by Steinbeis, a successful industrialist from the Saar region. He created the conditions for the intensified industrialization of Wurtemberg in south-west Germany about 1850. Technical assistance took the above-mentioned form. A permanent exhibition of designs ("musterlager") and the organization of foreign tours to study modern techniques abroad should be especially mentioned. The import of foreign techniques was also favoured by the condition that credit facilities for importing new machines were linked with the obligation to show and explain them to other interested firms. This was done to counteract the general trend of restricting the access to similar supplies by asking for patents. Such a combination of incentives for individual entrepreneurship and social obligation seems to be an optimum solution. Three types of institutions existed for the training of skilled

labour. Industrial continuation schools (gewerbliche fortbildungsschulen) were responsible for a general training of skills, technical schools were available for acquiring special skills and apprentice workshops offered a place for practical work.

16. The success of these efforts in Wurtemberg can be seen in the spreading of nearly 2,000 firms with about 60,000 employees in a period of twelve years. There were outstanding achievements during this creative period. Daimler invented the petrol engine, Junghans built up his well-known watch factory and in Heidemheim the Voith factories became an important supplier of machinery. All these ingenious men got their decisive promotion in a so-called central office (Zentralstelle) where they were supported generously. 2/

17. Wurtemberg currently has a firm place among the important industrial areas of the Federal Republic of Germany. It is even better endowed than many others of them. A widely scattered range of production of specialized precision machines lessens the impact of economic fluctuations by which other areas are sensibly hit. The actual industrial structure of Wurtemberg offers stability. The growth of its industry is largely stimulated by a continuous flow of innovations which comes out of a long tradition of ingenuity. It has to be stressed, however, that such a development requires a broad basis of adequate general education. An isolated promotion of technical progress would lack its cumulative effects. Given the sharpening clash of many dual economies, one has to be aware of the implications of a one-sided concentration of industrial research and development activities.

18. Another example of systematic industrial promotion is Eastern Prussia where a centralised programme was launched during the 1920's and 1930's. Owing to its unfavourable location and its rural character, the province was losing its labour forces, who were attracted by the prospering industrial centres. Though mineral resources were not available, industry found sufficient attraction by a well-conceived production of consumer goods. This was centrally prepared in the State Office for Industrial Affairs (Landesgewerbeamt) in Königsberg. An important aspect for opening new markets was to guarantee a high quality of the new products. The office helped to find out appropriate materials and equipments. Since then quality improvements have played an ever-increasing role for gaining and keeping international markets. Industrial research and development have had to pay careful attention to it. In particular, close contact was held to Königsberg University, where special problems were studied in the frame of diploma and dissertation theses. 3/

B. The actual situation in the Federal Republic of Germany

19. The foregoing historical examples of industrialization may be interesting for the planning of comprehensive industrial promotion in the stagnant areas of the

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2/ The office currently enjoys a wide-spread reputation under its new name, Landesgewerbeamt Baden-Württemberg, as the most experienced institution in industrial promotion in the Federal Republic of Germany.

3/ As it is often remarked that academic studies are too abstract, the scarce creative capacity should be directed more straightforward towards applied subjects. This brings relief to the research institutes and prepares students in a better way for their future tasks.

developing countries. For the centres of progress, however, techniques to be applied are in many cases very similar to those used in the advanced countries. Therefore, the current organization of industrial research and development in the Federal Republic of Germany is discussed below.

20. The diversification of the industrial structure requires a broadening of the research and development activities. According to the branch and size of firms, different forms of its organization have become necessary. Here one can distinguish them by the degree of independence from their supporters:

(a) Research and development by industrial firms;

(b) Corporate research and development;

(c) Consulting engineering.

Research and development departments

21. Large firms can generally afford their own research and development departments. They are needed to improve continually the supply of their commodities in order to keep their competitive position. At the same time, they have to fulfil consulting functions. These firms must offer complex projects for their customers under varying conditions. Sometimes, however, it is even advantageous for them to build up common consulting institutes where the experts of the affiliated firms are collaborating. For instance, four large metallurgical firms - Thyssen, Mannesmann, Phoenix-Rheinrohr and Hoesch - have established the Ruhr Consulting, GmbH. Given the scarcity of experts, this may often be the only solution as one would rarely succeed in finding them in all fields for exclusive employment in a research institute. This is mainly true for basic industries.

Corporate research and development

22. Smaller firms, on the other hand, depend largely on corporate research and development. Industrial branches that consist mainly of small and medium-sized firms generally support common research and development institutes. They are united in the Board of Industrial Research Associations (Arbeitsgemeinschaft industrieller Forschungsvereinigungen). Its objectives are to facilitate the exchange of ideas between the affiliated research institutes, to co-ordinate the research projects (including the concentration on crucial targets), to consult new industrial research institutes and to distribute public grants and credits. The board is financed by its members. Owing to its independent status from the State, it has become a mediator between the State and the associated group of industrial research institutes. The State has entrusted the Board with the investigation into the planned research projects. If a project is to be supported financially by the State, the Board is obliged to find out the economic and scientific feasibility of the projects, the adequate calculation of costs, the existence of personnel and equipment that are capable of executing the project and the adequate private support of the research institute by the interested industry. The Board has also to survey the execution of the research projects. It gets the property of the equipment acquired by the supported research institutes.

23. This form of a decentralized organization of industrial research and development with the co-ordination by a central institution has the advantage of great flexibility in adaptation to the special needs of individual industries, whereas, on the other hand, new stimulations can spread easily from a centre. One finds a similar form also in the United Kingdom. Corporate industrial research goes back there to the First World War. Its success encouraged the industrial associations of the Federal Republic of Germany to follow this path after the Second World War. One may currently say that this became an indispensable development. Otherwise, the small and medium-sized firms would have lost more and more of their contact with the continuing technical progress, putting its further existence into question. But the current efficiency of industry in the Federal Republic of Germany relies largely on the network of these firms. They allow for a large flexibility in industrial supplies that favours their international competitive position. For the developing countries with their narrow markets, a broad large-scale production of a wide range of intermediate products is not feasible. The division of labour is restricted by the size of the market. Therefore, these countries will always depend much more on a diversified structure of small and medium-sized firms that has to be built up and where industrial research and development will bring similar problems.

24. An important branch of industrial research and development, namely the technical rationalisation, is largely centralized in the Federal Republic of Germany. Here, the inter-industrial relations are especially strong. The co-ordination and standardisation of different proceedings, intermediate and final products shall stretch over the largest possible range of industries. Close contact to industry is kept by the collaboration of industry with a large number of experts from individual firms. So the Board of German Working Engineers (Arbeitsgemeinschaft Deutscher Betriebsingenieure) has the support of about 10,000 engineers.

25. They try to solve organisational and technical problems and to spread their experience among members. Documents, principles and means for economic production of the different industrial branches are elaborated by the Committee for Economic Production (Ausschuss für wirtschaftliche Fertigung). For a special aspect, the investigation into the best organisation of manual work, the execution of labour studies for finding norms and the publication of respective principles, the Association for Labour Studies (Verband für Arbeitsstudien), commonly known as "Refa", has a comprehensive experience. All these three institutes are united in the Board of Trustees for Rationalisation in the German Economy (Rationalisierungs-Kuratorium der Deutschen Wirtschaft - RKW).

26. Since the Second World War, another form of industrial research and development organisation has been spreading more and more in the Federal Republic of Germany that has also considerable relevance for the developing countries and especially for their centres of progress. Following the example of the United Kingdom and the United States of America the industry relies increasingly on the support of the independent consulting engineers. In the United States of America the far-going division of labour and standardization of production required a net of linking agents. Consequently consulting engineering developed out of the structure of industry in the United States of America. In the Federal Republic of Germany, on the other hand, industry has grown largely under vertical integration. Project design, consulting, production and supply have often been united in the activities of one firm. These highly integrated firms still exist

mainly in the metallurgical and chemical industries. Their advantage lies in, among others, the close contact of research and production.

27. Therefore, consulting engineering in the proper sense established itself only in the 1950's, but in a short time it has gained a considerable position on the international market. The comprehensive technical knowledge of Germany's (Federal Republic) industrial development is now the backbone of these consultants' activities. In addition to designing of projects and personal services, they execute engineering services which can be either new industrial research projects or further developments of given techniques that have to be adapted to special needs. Here one finds the virtual field of industrial research and development.

C. Implications for the industrialisation of developing countries

28. The foregoing section has shown how industrial research and development during the first stages of German industrialisation were incorporated into the comprehensive industrial promotion and how they have found adequate organisational forms for the highly advanced stage currently found in the Federal Republic.

29. At first it was a policy tending to spread new production methods that were not highly elaborated technically, but which were required mainly to awaken entrepreneurial abilities and to train certain skills on a large scale. Here the country's experiences in the early stages of its industrialisation as presented in the previous section could be relevant for the developing countries, especially in their stagnant areas.

30. Then technical progress became more and more sophisticated. Technical skills became increasingly specialized as more complex capital equipments had to be used. The advanced countries today need highly qualified basic research and very specialized applied research. Furthermore, a differentiated set of institutions is necessary to use the results for industrial development.

31. For the centres of progress the actual shape of industrial research and development in the advanced countries can serve, to a certain extent, as an example. But owing to the scarcity of capital and technical knowledge, industrial research and development will generally have to be restricted to some advanced techniques that can be applied only on a relatively small scale. In any case, it has to be considered that the costs of research and development must be in relation with the size of production that will be affected by them. For many developing countries, where hitherto centres of progress have been only in an initial state, great parts of modern techniques are out of reach as their application requires large-scale production for which adequate markets are lacking. A regional integration of research and development activities embracing several countries seems to offer the only solution. This shows again that market research has to precede all applied research projects.

32. The large majority of the population and of the country, however, remain unaffected by the modern techniques. They live in stagnant areas with traditional habits of production. Here it is important to try to achieve improvements based on the existing standards of village skills, as, for instance, improvements in the methods of slaughter and tanning, to obtain better quality leather; or to replace

certain wooden parts of a hand-loom by metal components in order to increase the weaving speed; or to design a simple hand-press to achieve better utilisation of oil-producing fruit; or to develop a better mixing process for the village [illegible] and paper manufacture, etc. All this is simply an improvement of primitive methods, but it opens a field of application for technical progress, the size of which (a 1,000 million people in more than 1 million villages) is no less important than the fields of atomic power or automation. This small example shows that the application of the scientific knowledge of the industrial countries can be effective in the developing countries only if it is adapted to the "requirements" of the development of the stagnant areas.

33. According to their specific requirements, industrial research and development, in the author's opinion, should be done in research and pilot stations that must be created for all traditional economic activities (chiefly agriculture, village industries and crafts) and where their efforts are appropriately concentrated and specialised on goods produced in the traditional sectors concerned. Their job is to work out "new" production techniques and practicable methods of organizing the supply of materials, standardization, marketing, etc.; and also to train advisory staffs to demonstrate the new methods and encourage the villages to adopt them. Since progress must be gradual but continuous and stagnation at any level is to be avoided, the centres must continually devise new improvements, train additional advisers and provide refresher training to keep all staffs up-to-date in the latest techniques. At institutes in industrial countries, as well as in developing countries, basic research for village development by improving the traditional techniques must be carried out in order to suggest new approaches, innovations of a more far-reaching kind in technical and economic matters and to supply thoroughly trained personnel to staff the experimental centres in the field. Eventually, a complete network of research and pilot centres should be evolved, covering every possible kind of investigation which may have a bearing on village development.

34. Without the simultaneous development of the stagnant areas, an exclusive promotion of centres of progress by the unique application of modern forms of industrial research and development would strengthen the polarization effects and lead to an increasing clash in the dual economy between centres of progress and stagnant areas.

35. Following these reflections it seems to be indispensable to arrange industrial research and development in developing countries in different forms:

(a) For the centres of progress suitable for the application of modern technical progress;

(b) For the stagnant areas suitable for the shaping of technical progress on the basis of traditional techniques, in order to stimulate economic incentives that tend to support a self-propelled growth in these areas.

36. In conclusion, the author would like to point out that the Government of the Federal Republic of Germany tries to transfer some of the technical schools (Gewerbeschulen) that have been established under German (Federal Republic) technical assistance in many developing countries, into industrial promotion centres (Gewerbeförderungszentren). Here the experiences of the first stages of industrialization will be considered.

D03882

XVII. AUSTRIA'S CONTRIBUTION IN INDUSTRIAL RESEARCH

Prepared by Kurt Dottelbacher*

A. Austrian industrial research

1. After the critical effects of the First and Second World Wars, Austria, as a neutral country with a population of 7 million people, could successfully enter a new stage of its economic development. The considerable loss of territory in 1918 called for a new structure and organisation of Austrian industry, which led to the creation of new industrial centres and the shifting to other production fields, as well as the establishment of new industrial plants.

2. Industrial development began from the primary industry. Last not least, it was also encouraged by the Nationalisation Act of 1947, which provided for the proper grouping within the industry and emphasized the importance of primary industries working under the supervision of the State.

3. Contrary to the situation in other countries, nationalisation in Austria affected, in the first place, the primary industry only as can be seen from the figures given below. Only in rare cases does nationalisation reach into the field of processing and finishing industries.

4. Nationalisation, which has been centred and co-ordinated in the Federal Chancellor's Office, Department for Nationalised Enterprises, comprises at the present time:

TABLE 1. Nationalisation of industries in Austria

Industry	Percentage
Pit-coal production	85.3
Brown coal (lignite) production	95.6
Natural gas production	99.0
Crude oil production	90.0
Steel output	95.6
Pig-iron output	99.4
Aluminium output	69.3
Non-ferrous metals output	100.0

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* Industrial and Market Research Department, Voest.

5. Currently, 22.4 per cent of Austria's industrial value added can be attributed to nationalized industries, and 77.6 per cent to private enterprises. This mixed structure has proved to be successful, as shown by the following rate-of-growth figures for industrial production:

TABLE 2. Growth of industrial production in Austria

Year	Percentage
1937	41.9
1950	60.9
1956	100.- (110%)
1960	126.-
1963	141.6
1964 (first half year)	148.5

6. In this connection, however, Austria's achievements in the fields of electricity supply, traffic, canalization, social matters and private co-operative societies had considerably facilitated the production and marketing of individual agricultural producers and must be mentioned as well.

7. Certainly it would not have been possible to achieve all this had not specialized research centres efficiently participated in this development.

8. Austria has a number of research centres, and the most important ones are mentioned below:

(a) Austrian Economic Research Centre;

(b) Austrian Crude Oil Research Centre;

(c) Austrian Foundry Research Centre;

(d) Austrian Atomic Research Centre;

(e) Austrian Building Materials Research Centre;

(f) Austrian Forest (wood) Research Centre.

9. These research centres co-operate closely with the entire industry of the country and regularly and frequently exchange the results of research work among themselves. It is, therefore, possible to solve completely new problems that may come up for an industrial enterprise, in co-operation with these research centres. Furthermore, the Austrian research centres maintain close contact with similar institutions all over the world.

10. The research centres are either national research centres attached to universities and similar specialized institutions, or private research centres. Most of these centres are independent and serve scientific purposes only. There are two ways of functioning:

(a) A certain national office places an order with such a research centre for specified research work to be performed;

(b) The research centres are approached by companies to solve and clarify problems which come up within the company or in connexion with business relations with foreign countries. Contacts of representative Austrian enterprises with developing countries may be particularly pointed out.

11. To a large extent, Austrian industries have shifted to establishing their own research and planning centres, which specialize in certain fields and pay great attention to the problem of feasibility studies for all kinds of industrial projects.

12. As an example, Vereinigte Osterreichische Eisenund Stahlwerke AG. of Linz/Donau Austria, as the largest Austrian enterprise in its field, has made feasibility studies for South America, Africa and South-East Asia, which will deeply affect the economy of these countries if these studies are realized. Especially for this purpose, the company has set up a particular division for the close examination of these "special projects" from the technical (raw materials, energy and working power) and commercial (marketing, market research and expenses) points of view.

13. The problems are generally put by the company itself or in co-operation with national and international research centres. Such studies may comprise:

(a) Mining (coal, ores, fluxes);

(b) Iron and steel industries (existing raw materials, available manpower, available energy, markets, competition);

(c) Mechanical engineering and steel construction industries (power plants, electricity supply, etc.);

(d) Chemical industries (The fertilizer, plastics paper and wood-working industries);

Austria has given particular attention to the capacity expansion of these industries during the past years.

B. Austria's industrial research and contribution to developing countries

14. A possible Austrian contribution to developing countries has been outlined above. In this connexion, however, it should be pointed out that Austria holds a leading position in the iron and steel production of the world. Developed in Austria by Voest-Linz, the LD steel-making process was introduced all over the world through the supply and installation of complete steel plants or their most

important equipment. In the LD process, technically pure oxygen is blown onto the hot-metal bath.

15. At present, approximately eighty LD-steel plants are in operation and another sixty are either planned or under construction. This equals a total capacity of approximately 70 million short tons of steel.

16. By 1970, the share of this steel-making method, which is of particular importance for developing countries because it involves low capital expenditure and elastic operation, will most likely reach 25 per cent of the total world steel output.

17. Austrian industries are not only closely co-operating with each other, but also with research centres in other fields (The fertilizer, plastics, paper and woodworking industries), so that it is possible to extend genuine and positive assistance to developing countries for the development of their national industries and the establishment of plants already being designed.

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XVIII. ORGANIZATION PATTERNS OF INDUSTRIAL RESEARCH AND DEVELOPMENT ACTIVITIES IN ASIA AND THE FAR EAST

Prepared by the Secretariat of the United Nations Economic Commission for Asia and the Far East

Introduction

1. Organizational patterns of industrial research in the countries of the region covered by the Economic Commission for Asia and the Far East (ECAFE) present a great diversity both in approach and in stage of development reached. However, certain trends are noticeable in the developing countries. The Governments still have to play a large part in fostering and maintaining industrial research, as private initiative and investment are still relatively limited. Again, except perhaps in Australia and Japan, investment in industrial research continues to fall far short of desirable levels.

2. That industrial research is important appears to be generally well recognised and Governments are paying increasing attention to this field. A great handicap to rapid development has been the lack of trained workers resulting from poor standards of scientific education at the graduate and post-graduate levels. It appears that attention is being paid to this problem also.

3. The matter has been discussed in the Committee on Industry and Natural Resources of the Economic Commission for Asia and the Far East, which has, while reviewing industrial research and development activities in the region, stressed the urgent need for expanding and strengthening industrial and technological research in countries of the region by the establishment of high quality industrial research institutes within the region itself, with such assistance as multilateral and bilateral programmes can provide.

4. In this paper, an attempt is made to present the current status of development of industrial research institutions in some of the countries of the region, with particular reference to organizational pattern and coverage. No attempt is made to evaluate the results achieved, and the material presented is confined to those countries from which it has been possible to gather data.

A. National industrial research policy, industrial research establishments, aspects of finance, staffing, the application of results of industrial research and technical assistance received in the ECAFE countries

Afghanistan

5. Under the Second Five-Year Plan of Afghanistan (March 1962 to March 1967), a high priority is accorded to industry and mining, which are earmarked for more than one third of the total planned investment. It envisages a tenfold increase in electric power, a threefold increase in coal and a considerable increase in cement. Basic industries, including gas, petroleum and chemical fertilizers, are also to be

developed, as well as a number of light industries such as silk-spinning, shoemaking, glass and cigarette manufacture, with particular attention being given to those industries which process agricultural products and raw materials for export. The Five-Year Plan outlay provides $US114.5 million for industry and $US225 million for mining. However, there is no direct mention in the Plan of industrial research activities, although research work closely related to industry and directed towards such products as wool, silk, honey and carakul sheepskin is being performed under the auspices of the Ministry of Agriculture. For example, the training centre in the Kataghan region for improving the quality of carakul pelts and for introducing modern methods of breeding is charged, among other duties, with the task of undertaking research. The Central Wool Research Laboratory undertakes activities for better technical management of sheep flocks, research in wool production, standardization of wool exports and training of the personnel for the Kabul Wool Laboratory.

6. In addition to the six sericulture stations already established during the first plan period, the Second Five-Year Plan provides for the establishment of new stations for multiplication and distribution of silkworm eggs and improved varieties of grafted mulberry plants. A honey-bee station has been set up in Nangahar for the training of farmers in modern methods of bee-keeping.

Australia

7. In Australia, highly developed industrial research and development activities are being widely carried out both by governmental and non-governmental organizations, while fundamental research is performed by the Australian universities where there has been considerable growth of research facilities in the recent past. The organization of research institutions which aim at comprehensive coverage while allowing great flexibility in day-to-day work appears to have been highly successful.

8. The Commonwealth Scientific and Industrial Research Organization (CSIRO) was established in 1949 in accordance with the Science and Industry Research Acts. The powers and functions of CSIRO include the initiation and carrying out of research in connexion with, or for the promotion of, primary and secondary industries in the Commonwealth; the training of research workers and the making of grants-in-aid for pure scientific research; the testing and standardisation of scientific apparatus and instruments and the carrying out of scientific investigations connected with standardization; the collection and dissemination of information relating to scientific and technical matters; liaison with other countries in scientific research; the establishment of industrial research studentships and fellowships; and the establishment of industrial research associations.

9. Undesirable centralization has been avoided, chiefly, in two ways. First, a policy has been followed of establishing laboratories in different places in the Commonwealth where the necessary facilities, contacts and other suitable conditions could best be found. Secondly, state advisory committees widely representative of scientific and industrial interests have been established in each of the six states of the Austrialian Commonwealth. These committees, appointed for a term of three years, advise the executive board on general matters and on particular questions of investigation and research. CSIRO is governed by an executive board of five members who are appointed by the Commonwealth Government; the executive board is assisted by an advisory council comprising, in addition to members of the executive board, the chairmen of the six state advisory committees and other persons co-opted on account of their scientific knowledge.

10. CSIRO is organized in four major group laboratories and a number of divisions and sections. The four group laboratories are the animal research laboratories comprising three divisions, the chemical research laboratories comprising six divisions, the national standards laboratory comprising two divisions, and the wool research laboratories comprising three divisions. There are seven independent divisions in other research fields which carry out research and development activities under the aegis of CSIRO. In addition, there are about fourteen independent sections which have not reached a stage of development that, so far as the scope and magnitude of their operations are concerned, would justify their designation as divisions.

11. As CSIRO's investigations extend throughout the Commonwealth and as many of the investigations conducted, especially those concerned with problems affecting agricultural and pastoral industries, necessitate experimental work in the field, a number of branch laboratories and field stations have been established in various parts of Australia. The head office of CSIRO is in Melbourne and associated with it are the organisation's central library, agricultural research liaison section and central experimental workshops.

12. Many CSIRO divisions and sections work in close collaboration with Australian universities on particular research programmes and officers of the organisation assist in university lecturing, demonstrating and supervising in specialised fields. Moreover, grants have been made to support a number of university research programmes of particular interest to CSIRO. It is the general policy of CSIRO to work with an industry or public authority in seeking solutions to problems which are of concern to a number of companies or interests; and, from time to time, it undertakes work for individual companies if other help is not available.

13. CSIRO is empowered to recognise "associations of persons engaged in any industry for the purpose of carrying out industrial scientific research", and such an association may be given a grant through the organization of up to 1 Australian pound for every £1 raised by the industry itself. It is the policy of CSIRO to foster the development of strong independent research associations, of which two have so far been sponsored - the Bread Research Institute of Australia and the Australian Leather Research Association. Where the research work involved is much too limited to require the formation of a research association, the organisation makes research facilities available to industries by entering into agreements to undertake clearly defined research projects.

14. An important part of CSIRO's industrial research liaison section relates to patents and patent licences. CSIRO considers it important that inventions arising from research in its laboratories should be applied as widely as possible in industry. Experience has shown that, in many cases, industrial innovations based on these inventions are more readily taken up by industry when the inventions have been protected by patents. Patenting of CSIRO inventions achieves several purposes, such as protecting the public interest by ensuring that the inventions are not patented by others and permitting supervision to be exercised over industrial users to ensure that new products and processes do not become discredited owing to the inventions being incompetently applied. Patenting thus provides a means by which a firm that is prepared to invest a substantial amount in developing an invention from laboratory operation to factory production may be given a measure of priority in its use, and thus permitted to recoup its development expenditure.

15. The industrial research liaison section also publishes a bi-monthly, *CSIRO Industrial Research News*, which contains information about developments from CSIRO research programmes likely to be of interest to Australian manufacturers. The section also prepares other publications aimed at bringing CSIRO research to the attention of industry and the general public.

16. The funds of CSIRO are provided from Commonwealth revenue by parliamentary appropriations from the Wool Research Trust Account, the Wool Industry Fund, and from industry directly and indirectly by way of special grants and contributions. The latter are received from several agencies, associations or institutes for undertaking specific research projects and are recorded in a special account entitled "Specific Research Trust Fund". In addition, miscellaneous income is obtained, such as that from the sale of publications, the sale of produce by field stations and laboratories, royalties from patents, testing fees and the sale of property obtained as gifts from philanthropic Australians. Also, for a number of years CSIRO has received grants from overseas establishments for specific research projects of interest both to them and to Australia. The majority of these awards have come from agencies of the United Nations or the United States of America.

17. The results of CSIRO's research work are made available through various channels. Eight scientific periodicals are published, together with various series of technical reports and semi-technical publications. Formal scientific publication is supplemented by the preparation of films, by continuous and close contact with industry by officers of the divisions and sections, by the provision of facilities for guest workers in laboratories, the publication of trade circulars, news-letters and articles for trade journals, as well as lectures, short courses of specialized training and the organisation of conferences of a specialized nature.

18. In addition to the widespread research and development activities conducted by CSIRO, there are forty non-governmental organizations supported by various private industrial companies which carry out industrial research and development work. These private organizations are financed, administered and staffed on much the same lines as the industrial research laboratories existing in advanced countries. One of their most fruitful research activities is investigation into production processes with the aim of cost reduction, expansion of output per man hour and ability to satisfy expanding markets, all of which may depend upon scientifically organised investigation into methods and processes, which in turn depend upon the formal organization of research procedures.

19. Neither the governmental nor the non-governmental research and development organizations in Australia appear to face any serious problem in acquiring the necessary technical staff, because the Australian universities and relevant training institutions turn out adequate numbers of scientific graduates who enter the field of research.

Burma

20. In Burma, fundamental research is primarily carried on at the Universities of Rangoon and Mandalay; but the Union of Burma Applied Research Institute (UBARI) is at present the sole organization which carries out applied research in science and engineering, and experimentation for the economic development of the country. Complementarity of development in the fields of basic and applied research is maintained by close liaison between the university professors and the technical

staff of the Applied Research Institute. Industrial research consciousness among industrialists and government departments is promoted by the holding of annual science exhibitions in which the universities and UBARI actively participate in order to disseminate scientific knowledge and demonstrate the results of research. No tax exemptions appear to be given as incentives for conducting research, but the universities and UBARI obtain adequate grants from annual budgetary appropriations. French graduates of the universities are taken on the staff of UBARI and, after a few years of practical work at the Institute where they obtain a fundamental knowledge of scientific research, they are sent abroad for further training in their specialized fields. On their return, they generally receive a promotion and these facilities provide sufficient incentive to attract local personnel to work in industrial research. UBARI provides technical services to industries, prospectors, the universities, government departments, boards and corporations, and the Army, Navy and Air Force by carrying out sponsored research projects, analyses, tests, repairs to instruments and consultation. On-the-job training has also been provided in some departments to technicians from industry. UBARI has initiated a number of research projects of great economic significance to the country and followed them up to the pilot-plan stage; the results have been made available to industrialists through the Technical Services Division of the Directorate of Industries. Instances are many in which private industrialists have requested the Institute to set up small manufacturing units on a cost-plus fee basis after having been convinced by the operations of the pilot plants. The Institute continues to expand its facilities for branching out on more lines of research activity, increasing pilot-plant experiments and providing additional technical services to the country. It may thus be said that UBARI is both governmentally and privately sponsored.

21.. UBARI was established by the Union of Burma Research Institute Act passed by the Union Parliament in 1954; it now functions under the Burma Research Board, which was formed to stimulate, co-ordinate and support scientific and engineering research in the Union of Burma. The several departments of UBARI are the metallurgy and geology research department, physics and engineering research department, applied chemistry research department, cellulose, pulp and paper research department, ceramics research department, instruments department, analysis department, and the standards and specifications department. The Union of Burma Atomic Energy Centre established in 1955 in UBARI has six departments, namely the radioactive minerals department, nuclear reactor studies department, health physics department, nucleonic instrumentation department, radio-chemical analysis department, and agricultural and biological applications department.

22. UBARI is a public establishment, administered by the Burma Research Board which is a policy-making body under the Ministry of Industry. The University of Rangoon is represented on the Board through the nomination of some of its professors. The executive responsibility for UBARI is vested with the Director-General, assisted by the head of the various research departments.

23. In the Government's annual budget, the necessary appropriations are made for the organization; the flow of funds may be regarded as regular and smooth.

24. In order to staff the Institute with the necessary technical personnel, the graduate and post-graduate resources of the universities are drawn upon. Expatriate staff are engaged in those departments for which sufficiently qualified local staff are not available. The latter understudy the expatriate staff, who are replaced soon after the local personnel have been adequately trained.

25. Technical assistance received by UBARI takes the form of equipment obtained through the various sources of foreign aid, such as United Nations technical assistance, United Nations Educational, Scientific and Cultural Organization (UNESCO), International Co-operative Alliance (ICA), the Colombo Plan and the Fund for Peaceful Atomic Development.

Ceylon

26. The Government of Ceylon appears to be fully conscious of the need for close liaison between fundamental and applied research in order to achieve the industrial and economic development of the nation. This consciousness has been demonstrated by the formation of the General Board of Studies and Research in the University of Ceylon and the establishment of the Ceylon Institute of Scientific and Industrial Research (CISIR). The latter carries out a major proportion of the industrial research in the country. The principal operations of CISIR are conducted at Colombo and at a Gal Oya Branch Laboratory at Amparai. Established in 1955 by Act of Parliament, CISIR is an autonomous, non-profit industrial institute affording a broad range of practical technical services to Ceylon's manufacturers, public and private production enterprises, government agencies and the general public. Such services are rendered on a reimbursable and confidential basis with assignment of patents to the client.

27. The main work of CISIR consists of:

(a) Specific research projects, such as development of a new process or product, quality improvement, reduction of manufacturing costs, profitable use of new raw materials or waste products of the solution of production problems;

(b) Industrial production counselling, including factory layout, selection of machinery, production costing, efficiency, technical management methods, standards and quality control. In addition, the services include many other aids to the country's productive sectors both public and private, including:

(i) Technical consultations to manufacturers;

(ii) Conducting surveys of existing factories to suggest improvements;

(iii) Advising financial institutions on the technical merits of projects;

(iv) Undertaking technical supervision of processes on certain lines;

(v) Testing of equipment, materials, processes and products;

(vi) Developing processes on its own and proposing new industries;

(vii) Promotion and encouragement of technical research and training;

(viii) Publishing technical information of practical value;

(ix) Maintaining an up-to-date technical reference library not merely for its own needs, but the free use of other accredited technical workers, scientists, officials and private producers whose work it can benefit.

28. The policy-making body of CISIR is its Governing Board which is an autonomous board whose members are businessmen as well as officials. The Director of CISIR has the executive responsibility. The divisions in the organization consist of:

(a) The research and development division, subdivided into the chemical technology, process engineering and rubber technology sections;

(b) The management engineering division staffed by the chief management consultant, management engineer, mechanical engineer, production engineer, sales and market research officer, industrial engineer, industrial relations officer and cost accountants;

(c) The administrative division.

29. CISIR receives part of its income by statutory grant from the Government. The remaining part is derived from fees for services rendered to manufacturers, public and private production enterprises, government agencies and the general public.

30. The technical staff of the organisation consists of both local and foreign personnel. As soon as the indigenously recruited staff are trained up adequately to assume responsibilities, the foreign personnel are replaced.

31. Technical assistance obtained by the organization consists of the outfits received through gifts under bilateral aid from the United Kingdom, Canada and the Asia Foundation of the United States of America; these outfits form the central laboratories, pilot plants and workshops, which are among the first in Asia and the Far East. Furthermore, the International Bank for Reconstruction and Development (IBRD), provided expert assistance during the first five years of its existence.

32. Among the minor research and development activities being conducted in Ceylon, apart from the activities of CISIR, may be mentioned the following:

(a) Research on improvement of coconut, agriculturally and industrially, by the Coconut Research Institute at Lunuwila;

(b) Research on improvement of rubber, agriculturally and industrially, by the Rubber Research Institute at Agalawatta;

(c) Research on improvement of tea, agriculturally and industrially, by the Tea Research Institute of Ceylon at Talawakelle;

(d) Research on improvement of hand-loom textile designs, colour combinations, new weaves and production methods; and on other handicrafts, such as baskets, bamboo industries and papier maché toys, carried on by the Industrial Research Institute, Moratuwa;

(e) Research on improvement of production methods of ceramic wares, including decorative wares, glazed pottery, etc., conducted at the Ceramic Research and Training Centre, Kelaniya.

33. The Government of China, with limited skilled manpower and limited funds available for research and development, has laid emphasis not upon trying to discover new fundamental ideas, important as they are, but upon applying what other nations have already discovered as quickly as possible for the betterment of the living standard of its people and the improvement of its economy. Applied research is mainly directed at reducing the cost of its products and at improving their quality so as to find ready export markets. Nevertheless, there are in China some agencies, such as Academia Sinica, the Atomic Energy Committee, the College of Science and the National Taiwan University, which undertake work in fundamental research.

34. Among the organizations conducting industrial research and development work the following may be mentioned:

(a) The Union Industrial Research Institute at Hsinchu;

(b) The Taiwan Provincial Forest Research Institute at Taipei;

(c) The Taiwan Provincial Sea Products Research Institute at Tainan;

(d) The Taiwan Sugar Experimentation Station owned by the Taiwan Sugar Corporation and located at Tainan;

(e) The Taiwan Aluminium Company Laboratory at Kaohsiung;

(f) The Kaohsiung Research Laboratory, owned by the Chinese Petroleum Corporation and located at Kaohsiung;

(g) The Chia Yi Solvent Works Research Laboratory, owned by the Chinese Petroleum Corporation and located at Chia-i;

(h) The Wei Chuan Food Corporation Research Laboratory at Taipei;

(i) The China Fermentation Industries Limited Laboratory at Taipei;

(j) The Taiwan Glass Research Institute, owned by the Taiwan Glass Association and located at Chu Tung.

35. All but the last three of the above-mentioned research organizations are Government-sponsored. The non-Government research laboratories are organised on the same pattern as those in developed countries; they are sponsored and financed by private sources.

36. Owing to limitations of space, the organisational structure of all the above research institutions will not be discussed in this paper. Description of the organization pattern will be restricted to the Union Industrial Research Institute (UIRI), which is the nerve centre of industrial research and development work. This public institute, which is the outgrowth of the Hsinchu Research Station of the Chinese Petroleum Corporation, was established by the Ministry of Economic Affairs on 1 November 1954. Located near the city of Hsinchu, the Institute aims to intensify industrial technological research, to help develop industry and to co-ordinate the implementation of the four-year economic development plans. Its

scope of research extends to every field of industry, with special interest in manufacturing processes and the uses of by-products. The Institute does not undertake the work of formulating standards for products and raw materials, this field being handled by the National Bureau of Standards established under the Ministry of Economic Affairs. The work of UIRI may be defined in more detail as follows:

(a) To undertake research on industrial products and utilization of by-products, to determine new industrial developments;

(b) To co-ordinate its work with that of all other research and experimental organizations and to fully utilize their equipment to reduce unnecessary duplication to the minimum;

(c) To design and do research work and tests on special problems submitted by public or private industries for the sake of improving their technique;

(d) To furnish technical advice, co-operate with and give technical assistance to public or private enterprise upon request;

(e) To collect industrial data, and to make, repair and check instruments for the enterprises.

37. The policy-framing authority of UIRI is an advisory committee of twenty-one members, chosen from noted scientists, engineers and authorities on related subjects, who plan research projects, study results and formulate future plans for the Institute. The Director of UIRI has the sole executive responsibility for the establishment.

38. There are now under the Institute ten laboratories dealing separately with organic chemistry, inorganic chemistry, agricultural chemistry, fuel chemistry, industrial instruments, electrical engineering, engineering materials, metallurgy, ceramics and atomic energy.

39 The UIRI is partly supported by financial contributions from such government corporations as the Chinese Petroleum Corporation, the Taiwan Sugar Corporation, the Taiwan Power Company, the Taiwan Fertilizer Corporation, the Taiwan Alkali Corporation, the Taiwan Aluminium Works and the Taiwan Cement Corporation; these corporations amount to about 60 per cent of its expenditure. The remaining 40 per cent is met by fees obtained from contracts with public and private clients regarding specific research projects, as well as from technical services rendered by its Industrial Services Department. The flow of funds from government sources is constant and regular, and there is no difficulty in obtaining the remainder of funds through the Institute's own efforts and services.

40. The staff of the Institute consists of university and college graduates who, following recruitment, are put through a training programme to make them competent as research workers. Research personnel still have to be recruited from abroad for certain senior posts, but they are replaced soon after local staff have learnt to perform their work efficiently. In 1961, the number of scientists and technical staff in the Institute was around 160.

41. Through its industrial services department, the results of the industrial research of the UIRI are made available to the ultimate users, both public and

private. In addition, the UIRI publishes technical digests and maintains a technical reference library which is accessible to interested persons outside the Institute.

42. The UIRI does not receive any technical assistance through international or bilateral aid.

India

43. In India, the Scientific Policy Resolution adopted in March 1958 sets out scientific policy, including research. The aims of that policy are stated to be:

(a) To foster, promote, and sustain, by all appropriate means, the cultivation of science and scientific research in all aspects - pure, applied and educational;

(b) To encourage and initiate, with all possible speed, programmes for the training of scientific and technical personnel, on a scale adequate to fulfil the country's needs in science and education, agriculture, industry and defence;

(c) To ensure an adequate supply, within the country, of research scientists of the highest quality, and to recognize their work as an important component of the strength of the nation;

(d) To encourage individual initiative for the acquisition and dissemination of knowledge and the discovery of new knowledge;

(e) In general, to ensure for the people of the country all the benefits that can accrue from the acquisition and application of scientific knowledge.

44. An extensive network of institutions engaged in scientific research has come into existence and pure research, applied research and research in specialized fields are being undertaken at a large number of centres. Some of these research institutions are sponsored directly by the Government through grants while others are supported by contributions from private industrial undertakings, such contributions being subject to certain tax exemptions. It may be said, however, that the contribution of private industries to research does not appear to have reached a level commensurate with the progress of the economy.

45. Research in pure sciences is being carried out mainly in the universities and in laboratories run by scientific societies and associations. In addition, the Council of Scientific and Industrial Research (CSIR) and the Department of Atomic Energy encourage fundamental research in their own laboratories, as well as in universities and in other institutions by providing grant-in-aid.

46. The industrial research and development organizations existing in India may be listed as follows:

(a) Council of Scientific and Industrial Research, New Delhi, founded in 1942, which has twenty-six national and regional laboratories and institutes under its control. It is a Society, an autonomous body registered under the Registration of Societies Act XXI of 1860. The names of the national and regional laboratories under the Society are the National Physical Laboratory of India, National Chemical Laboratory of India, National Metallurgical Laboratory, Central Fuel Research

Institute, Central Glass and Ceramic Research Institute, Central Food Technological Research Institute, Central Drug Research Institute, Central Electrochemical Research Institute, Central Leather Research Institute, Central Building Research Institute, Central Road Research Institute, National Botanic Garden, Central Salt Research Institute, Regional Research Laboratory (Hyderabad), Indian Institute for Biochemistry and Experimental Medicine, Central Mining Research Station, Central Electronics Engineering Research Institute, Birla Industrial and Technological Museum, Regional Research Laboratory (Jammu and Kashmir), Central Mechanical Engineering Research Institute, Central Public Health Engineering Research Institute, National Aeronautical Laboratory, Regional Research Laboratory (Jorhat, Assam), Central Indian Medicinal Plants Organization, Central Scientific Instrument Organization, and Indian Institute of Petroleum. These laboratories were were founded in various years and located in different places throughout the country;

(b) The Indian Lac Research Institute, Ranchi, Bihar, established in 1924;

(c) The National Sugar Research Institute, Kanpur;

(d) The Technical Research Laboratories of the Indian Central Jute Committee, Calcutta;

(e) The Technological Research Laboratory of the Indian Central Cotton Committee, Bombay, founded in 1924;

(f) The Research Laboratories of the Silk and Art Silk Mills Research Association, founded in 1958;

(g) The Central Research Institute for Village Industries at Wardha;

(h) The Central Coir Research Institute under the Coir Board at Kerala, with a branch institute in West Bengal;

(i) Research Institute for Serviculture in West Bengal, Mysore and Assam.

47. In addition, the following research institutes are maintained by the Directorate of Industries, government of West Bengal.

(a) The Bengal Ceramic Institute, Calcutta, founded in 1941;

(b) The Bengal Textile Institute, Serampore, founded in 1904;

(c) The Berhampore Textile Institute, Berhampore, founded in 1925;

(d) The Industrial Research Laboratory and Bengal Tanning Institute, founded in 1919.

48. The CSIR is a public establishment; its administration is vested in the Governing Body, of which the Prime Minister is the President and which is composed of eminent scientists, industrialists and administrators. The Governing Body in turn is advised by the Board of Scientific and Industrial Research, whose members are scientists, industrialists and representatives of government departments interested in industrial research. An expert technical committee assists the Board in its work. The Board offers advice to the Governing Body on proposals for

instituting specific research; study of problems concerning particular trades and industries in scientific institutions and universities; establishment of research institutes; awards of fellowships, studentships and scholarships; and specific studies and surveys of indigenous resources as an essential preliminary to systematic investigation in particularly important fields of research. The Board is also assisted by twelve research committees dealing with various scientific and engineering subjects. A central secretariat has been established at CSIR headquarters, New Delhi, for purposes of administrative co-ordination. Apart from the secretariat, the publications and information directorate, the national register unit, the patents unit and the scientific extension service unit function at the headquarters of the organization. The Ministry of Scientific Research and Cultural Affairs provides the administrative link between the Government of India and CSIR. The Director-General, Scientific and Industrial Research, as the principal executive officer of the CSIR, assumes executive responsibility for the organization. Research work under the Council is carried out in its own laboratories, institutes and other research units and extramurally in universities and research institutes under a grant-in-aid scheme.

49. The twenty-six laboratories and institutes under the control of the CSIR, some of which have attached research stations or extension centres, are distributed throughout the country. Of these laboratories, the National Physical Laboratory and the National Chemical Laboratory stand on a special footing and are engaged on problems of research basic to industrial advancement as a whole. Some of the other laboratories, as their names imply, are engaged in problems of interest to particular industries, such as fuel, food, drugs, glass and ceramics, leather, buildings and roads; while a few deal with engineering research and yet others are concerned with problems of industrial development in various regions. These laboratories are engaged on work which does not come under the purview of universities or industries. They furnish facilities for team-work in research projects and for pilot-plant investigations. Other activities of these laboratories consist of survey of raw-material sources and work relating to standards and specifications. Moreover, they render technical assistance to industry through the provision of testing facilities and through liaison and extension work. Some of them conduct short-term training courses in special subjects for the benefit of technical personnel employed in industry. Each national laboratory has an executive council responsible for its control and general direction within the framework of the rules, regulations, and directions emanating from the Governing Body from time to time. Each laboratory is under the executive control of a director.

50. The Council closely collaborates with the national councils for agricultural and medical research. It also co-operates with the Indian Standards Institution in the work of establishing standards for raw materials, manufacturing equipment and accessories, finished products, methods of testing, etc.

51. Active steps have been taken by the Council for the promotion of co-operative research associations of industries. It assists industries desirous of forming research associations by giving technical advice, preparing plans, framing rules, regulations and by-laws and procuring materials and experts where necessary. It also provides financial assistance towards both the capital and recurring expenditure of the co-operative research associations, of which there are at present six in the country.

52. With the expansion of scientific activities, the expenditure of CSIR has been increasing year by year and reached Rs 67.9 million in 1960-1961. The funds to

meet the expenditure, which come from yearly budgetary appropriations of the Government of India, flow in with regularity.

53. As the Council has established a National Register Unit and maintains a roster on the availability, qualifications and experience of scientists, engineers and medical personnel in the country, it does not face any problem in regard to recruitment or staffing its laboratories and institutes.

54. The Council pays particular attention to the need for developing results of researches and proving their commercial feasibility. Separate industrial liaison units are established for each laboratory. The liaison officers maintain contacts with chambers of commerce and industry, industrial and trade associations, government departments and other users of research. Problems of industry are analysed and identified and brought to the notice of appropriate laboratories for advice and, where necessary, for investigation. At its headquarters, the Council maintains a scientific extension service unit to make use of the available scientific knowledge for the economic betterment of rural and suburban communities.

Indonesia

55. In Indonesia, under the eight-year national over-all development plan (1961-1969), a definite policy has been laid down, namely that, as a prerequisite for a large-scale development, research must be carried out extensively; and all research activities performed by the government departments and higher educational institutes and universities must be expanded. In 1959, Indonesia had about sixty-five separate scientific institutions, two-thirds of which had been founded by the Netherlands while the remaining one-third had been founded by the Indonesians.

56. The great majority of research institutions in 1959 were operated or supervised directly by the various ministries of the Government. A number of large foreign industrial companies had laboratories, but all except one were used almost entirely for routine testing in manufacturing processes or quality control. The only private laboratory operated by a single company performing some original research was that owned by the Standard Vacuum Petroleum Mij at Sungei Gerong in South Sumatra.

57. A Council of Science in Indonesia (MIPI) was established at Djakarta in 1956. The task of the Council is:

(a) To advance and to promote efforts and activities in the field of science serving the interests of the national in particular and the interests of peace and mankind in general;

(b) On its own initiative or upon request, to advise the Government on problems, projects and activities relating to science.

58. MIPI is an autonomous legal entity established by statute under the Minister of Education. The Executive Board of MIPI, which consists of nine members, is the policy-making body. It is assisted by an advisory committee of forty members representing the natural sciences, cultural, social and political sciences, and scientific institutes or government offices operating in scientific fields. The officer with executive responsibility for MIPI is the Executive Director.

59. MIPI, in principal, does not itself administer scientific projects which involve performing research managing institutes, etc. However, if a research institute is not in a position to take any action that is necessary for conducting research, MIPI steps in. It is thus a body to regulate co-operation on a voluntary basis and to activate projects in the field of science in Indonesia. Furthermore, MIPI does not interfere in the internal affairs of scientific and research institutions; and, in turn, the universities and these institutions recognize MIPI as the highest agency in the country in matters of scientific co-operation. MIPI also assists scientific organizations in obtaining needed equipment and publications and serves as a centre for scientific documentation and information. Being a body favoured in budgetary matters, it assists research projects, giving priority to applied research. During the first half of the eight-year plan, MIPI is to establish seven research institutes in the fields of chemistry, physics, geology and mining, metallurgy, electronics, biology and social economics. Their work is to be practically orientated to problems of industrial development.

60. The following are the existing institutions which perform research work relating to industrial research and development:

(a) The Department of Research and Training Institute, established in 1956 at Djakarta under the Minister of Industrial Affairs. Its tasks consist of experiments with industrial goods, in particular concerning the ways of using the raw materials available in Indonesia, the development of semi-processed and finished goods; tests of industrial products for quality; patents and standards; scientific information and consultation; industrial training;

(b) The Industrial Research and Development Institute, Djakarta, which conducts research in industrial goods not within the jurisdiction of other institutes, e.g. wallboard, resins, tools;

(c) The Chemical Research Institute, founded in 1909 at Bogor. It has seven sections, namely, for testing, phytochemistry, essential oils, agriculture, physico-chemistry, cellulose and training of research personnel. Its task is to help promote industry by providing advice concerning processing, by setting standards for products so that industries concerned can make improvements, and by inspecting samples in order that necessary measures can be taken;

(d) The Materials Research Institute, established in 1912 at Bandung. The functions of this institute are to undertake research and to test imported materials for technical application, and Indonesian materials for use in local industry and export; to provide advice on production and utilization of materials for various industries; and to perform research on quality, utilization and development of materials, especially those of Indonesia;

(e) The Textile Research Institute, founded in 1922 at Bandung. It has under its wing various sections, such as spinning, weaving, knitting, ready-made clothes, dyeing and finishing, a technical laboratory, a chemical laboratory, textile printing and a textile college. Its tasks are to provide information and advice to small industries, especially to cottage weavers; to test and inspect textiles, textile fibres and weaving requirements; to develop and promote improvements in the manner of working and in equipment; and to train textile experts and workers;

(f) The Ceramics Research Institute, established in 1916 at Bandung. Its four sections relate to ceramics research, glass research, training and technical assistance and extension. Its functions are to undertake research in the production of various ceramic and glass products; to provide information and advice to new or small industries; and to train ceramic technicians;

(g) The Leather Research Institute, founded in 1913 at Jogjakarta, has six sections, namely, a research laboratory, analysis laboratory, pilot plant, and technical information and training sections. Its functions are to undertake research in the various processes of tanning; to perform chemical and physical analysis of leather goods; to conduct courses on leather tanning and handicrafts; and to provide information and advice to leather companies;

(h) The Batik Research Institute, established in 1949 at Jogjakarta, has a technical section and a laboratory. Its main tasks are to seek ways of perfecting the batik process; to train prospective batik businessmen; and to provide information and advice to batik industries;

(i) The Institute for Rubber Research and Development, founded in 1941 at Bogor, has six sections, i.e., a research department doing general research, basic research, latex research, preparation of rubber and processing of rubber; a development department relating to general development and technical development; and departments of information and propaganda, economic analysis and documentation. It is assigned the tasks of developing through research natural rubber into a competitive industrial raw material conforming to specifications and containing no contaminations; promoting world consumption of rubber by expanding the range of new uses thereof; providing information and advice to manufacturers of rubber products; and conducting a course in rubber technology;

(j) The Standard-Vacuum Petroleum Maatschappij Process Laboratory at Sungei Gerong, South Sumatra. It has a quality-control section and a research section, including a pilot plant. Its tasks are to test samples of crude and refinery products in order to ensure that standards are met; to seek new petroleum products, improvements in existing products and methods of producing products from the varieties of crude available.

61. All but the last of these research institutions are Government sponsored. The executive responsibility of each organization is held by a director, chief or head of the institute.

62. The urgency of national development and the slenderness of the resources available have so far limited Indonesian research activities to areas of direct concern to the Government. Owing to the very fact that the existing research institutions are Government-owned, a regular flow of funds has to be ensured by the Government in order that their work may proceed smoothly.

63. Since the educational system of Indonesia until very recently was not designed to produce professional or scientific personnel, and in view of the relatively great length of time required to train competent research personnel, scientific manpower to staff the research institutions is still very limited in relation to the basic needs of the country. Many of the research institutions are barely able to cope with current programmes of reserach, let alone undertake new research projects. Most such institutes have an adequate number of trained intermediate and skilled personnel, but they lack the vitally important senior, university-trained staff members with experience in the work. However, the situation is gradually improving as new graduates are turned out by the universities, and it has again become possible for some institutions to work on research projects.

64. Mainly because of the shortage of foreign exchange, the research institutions have found it difficult in recent years to import new equipment, chemicals, other laboratory materials and supplies, and reference books; and they have had to look to foreign agencies and international organizations for technical assistance. For this purpose, donations have been received from individual universities, the United States of America, the Asia Foundation, the British Council, the Governments of the Colombo Plan countries, the United States Economic Co-operation Administration - International Co-operation Administration (ECA-ICA) line of agencies, the Ford Foundation, the Rockefeller Foundation, the United States Information Service and several foreign diplomatic and consular posts in Indonesia. Among international agencies, technical assistance has been provided by the Food and Agriculture Agency (FAO), the United Nations Educational, Scientific and Cultural Organization (UNESCO), United Nations International Children's Emergency Fund (UNICEF) and the World Health Organization (WHO).

Iran

65. In Iran, as a sequel to the First Seven-Year Plan (1948-1955), the programme of industrial development implemented by the Iranian Plan Organization resulted in the establishment of many industrial concerns, thirty of which were State-owned and the rest under private proprietorship. Again, under the Second Seven-Year Plan (1955-1962), with an appropriation of 15.1 per cent of the total funds allocated to the development of industries and mines, many new factories were established. By 1960, a wide range of industries, large and small, had been established as follows:

TABLE 1.

Number and types of industries established in Iran

Industry	Number of factories
Fruit drying	44
Canning and preservation of fruit and vegetables	16
Rice-milling	975
Sugar factories and refineries	15
Vegetable oil extraction	27
Tea processing	82
Alcoholic drinks	22
Non-alcoholic drinks	33
Cotton spinning	22
Cotton weaving	32
Integrated cotton spinning and weaving	29
Woollen textiles	14
Gunny weaving	4
Silk weaving	2
Saw-milling, wood creosoting and furniture	382
Plywood	4
Leather tanning	19
Rubber tyres	1
Pharmaceutical	22
Soap	65
Match	21
Petroleum refining	2
Brick manufacturing	395
Cement	8

66. A sum of $US1,686 million was earmarked in the Second Seven-Year Plan for research laboratories; and, recently, an Industrial Research Centre has been established under the Ministry of Economy. Details regarding the organization pattern of this centre are not yet available. Some fundamental scientific research work pertaining to industries appears nevertheless to be undertaken by the Faculties of Science and Technology of the University of Teheran. The National Iranian Oil Company also owns and operates extensive research laboratories in the field of petroleum.

Japan

67. In Japan, owing to the limited amount of technical research done during the Second World War, there was, at the end of hostilities, a wide gap between the research activities of Japan and of the advanced countries. To bridge this gap in the early post-war years, industrial development was accelerated by utilizing the scientific and technological resources of the highly industrialized countries through a system known as the "induction of foreign technology into Japan" which involved contracts for technological assistance. This induction was done by purchase of plans and drawings, employment of foreign technicians and procurement of technical information and data; it contributed substantially towards the technological development of the country. Such technological tie-ups opened up new spheres in production techniques to bring about improvement in the quality of products, economy in raw materials, increase in yield rates, simplified processes and lower costs. Gradually, as the Japanese enterprises grew larger, increasing importance was attached to the promotion of research. Existing research facilities have been improved and adjusted in order to raise the nation's over-all standards, with the result that a new and creative research system has been established, thereby permitting the previous practice of inducting foreign technology to be abandoned stage by stage.

68. Thus, in present-day Japan, industrial research organizations have been sponsored not only by the Government but also by many large industries. With the growing economy and strengthened industrial foundation, Japanese industrial circles are becoming very anxious to further improve the nation's technology by stages, for it is on its newly developing technology that Japan's hope for a higher rate of economic growth depends. During the present boom, attempts are being made to establish research laboratories, increase the number of research workers and seek materials for future use. Research investments for technological development totalled about $US675 million in 1961, registering a remarkable sixfold increase over the 1955 figure. This figure, however, compares unfavourably to the amount spent in the United States of America, namely $US12,389 million; and it is still 1-2 per cent of the total sales, though many enterprises hope to bring this rate up to 2-5 per cent in the near future.

69. For the first time in the history of Japanese industry, the Hitachi Co., Ltd., established in 1941 a central research institute under private sponsorship; today almost every large manufacturer has its own research organization. In these organizations, engineers, scientists and technicians are engaged not only in research work to improve the quality, performance and design of products, as well as the technology and manufacturing processes, but also in basic research in industry so as to establish a consistent research system in each enterprise. The expansion of the research and development activities of these research institutions is chiefly aimed at improving the quality as well as the quantity of manufactured products, so as to place Japanese products on a competitive footing in the world's export markets. The research laboratories of Japanese industrial undertakings are patterned very much on the same lines as those of the United States of America. It may be said that Japan has caught up with other advanced countries in the field of research for technical development and that the country is now ready to engage its scientific and technical talents in cultivating and developing even unknown fields.

70. Owing to lack of space, it is not possible to describe in detail the organizational pattern of all the research laboratories in Japan. But, to give a general picture, the organization of the Central Research Laboratory of Tokyo

Shibaura, Ltd. (TOSHIBA) and that of the NHK Technical Research Institute will be cited as examples of industrial research sponsored respectively by private industry and the Government. The Central Research Laboratory of TOSHIBA was completed in November 1961 and is an all-round research institute which is said to be the largest of its kind in the world. It is housed in a four-storey main building with a total floor-space of 27,028 square metres and contains all sorts of research rooms with various experimental apparatus and appliances. The entire building is perfectly air-conditioned at a temperature of 25°Centigrade and a humidity of 55 per cent. Secondary air-conditioning is conducted for eleven special rooms requiring strict control of air condition, including the physical measurement room, spectroscopic room, sound experimental room and electron tube research room. The TOSHIBA laboratory includes research sections dealing with such subjects as properties of matter, metallic minerals, inorganic chemistry, organic chemistry, applied physics, electron tube, electronic appliances, guided missiles, atomic energy, machinery and instruments. The research laboratory also has a well-stocked library and mechanical engineering room.

71. The Technical Research Institute of NHK (Japan Broadcasting Corporation), the sole non-commercial broadcasting organization in Japan, was established in June 1930 so that the results of its researches could be utilized by manufacturing companies concerned with the production of electronic appliances. The five-storey research institute comprises six sections, viz., the sound research section, radio research section, electron tube section, television section, development section and investigation section. The sound research section is engaged in the study of sound-emitting equipment, including microphones, loud-speakers, earphones and other electrophonic instruments. The radio research section conducts studies of wireless communication, including radio and television broadcasting, radio-receivers, etc. As regards the latter, the Institute has been making efforts to develop cheap, high-quality receivers in the interest of listeners. The results of studies have been made public to assist in the improvement of radio technology. The electron tube section is engaged in the study of image-receiving tubes and the development of transistor television. The television section is conducting research on magnetic recording of pictures and television transmission, television transmitting equipment, walkie-talkie equipment, etc.

72. In addition to the large number of research laboratories maintained by private undertakings, Japan possesses many Government-sponsored research organisations, some of which are as follows:

(a) The Agency for Industrial Science and Technology, Tokyo, whose main duties are the co-ordination, propagation and practical application of results of research conducted by attached laboratories and institutes; encouragement of research activities; and other services in the scientific promotion and improvement of manufacturing and mining industries. It was founded in 1948 as an independent agency directly under the Ministry of International Trade and Industry;

(b) The Government Mechanical Laboratory, Tokyo, whose chief functions are trial manufacture of machines, technology of machining and forming and researches on improvement in durability of machinery;

(c) The Government Chemical Industrial Research Institute, Tokyo, which is mainly engaged in research on analytical chemistry; on high-pressure chemistry and on chemical reactors; on the utilization of sea-water; and on disposal of industrial waste waters;

(d) The Osaka Industrial Research Institute, Osaka, whose main tasks are to develop fundamental techniques for synthesis and polymerization of synthetic resin and fibre; to conduct research on special optical instruments; on refractory coatings and materials for nuclear reactors;

(e) The Government Industrial Research Institute, Nagoya, which deals with research work on the utilization of radio-isotopes; on ceramic materials; pottery and procelain; on foundry technology and on the utilization of solar energy;

(f) The Fermentation Research Institute, Tokyo, engaged in research on alcohol production; on new useful micro-organisms and on the prevention of mold growth;

(g) The Textile Research Institute, Tokyo, which conducts research on the manufacture of synthetic fibres; on spinning and weaving;

(h) The Electrotechnical Laboratory, Tokyo, is the largest institute in the Agency for Industrial Science and Technology; it is engaged in research on electronics; and in research on the establishment and maintenance of standards;

(i) The Industrial Arts Institute, Tokyo, whose main functions are research on industrial design; basic research on industrial art techniques; research on packaging techniques and on merchandise analysis.

73. The many universities in Japan, including the technological universities, produce scientists, technicians and engineers in such large quantities that no problem is being encountered by the research organizations in staffing the various research departments.

Malaysia

74. By virtue of the fact that Malaysia's wealth is derived primarily from the plantation and mining economy of the previous Federation of Malaya and from the forest resources of North Borneo, research activities are mainly canalized to the development of such products as rubber, tin and timber. Rubber is of particular importance to Malaysia's economy, employing the largest number of workers, producing the largest proportion of the national income and yielding the largest profits, with tin running a close second. Manufacturing industries are of some significance and are focused on the processing of rubber, tin and food-stuffs; and on the manufacture of such consumer goods as dry-cell batteries, aluminium products, industrial gases, paints and varnishes, rubber and leather footwear, cigarettes, cigars, biscuits, metal cans, soap, confectionery, bricks, soya bean sauce, sago flour and sago pearl, coconut oil milling and refining, pottery, glass- and bottle-making, motor vehicle assembling, cotton spinning, textile weaving, brewing and soft-drinks bottling, pineapple canning, rattan furniture making and shipbuilding. The majority of these are conducted on a small or medium scale and can ill afford to invest in research and development work, so they depend chiefly on imported techniques already developed in advanced countries.

75. Governmental organization for scientific research is still rudimentary, because few funds are available to support an elaborate structure for scientific research; Malaysia has still to depend on research facilities provided by research organizations in other countries of the British Commonwealth. However, compared to the 1939 level, research facilities in Malaysia had expanded by perhaps 80 per cent by 1959.

76. To describe in more detail the existing research organizations related to industry. the Rubber Research Institute of Malaya, founded in 1925 and situated at Kuala Lumpur, may first be mentioned. The only private research body in the country, it is run under a director with funds obtained by an export cess on all rubber produced by rubber plantations; it maintains liaison with the British Rubber Producer's Research Association and the British Rubber Development Board of London. The Institute includes soils, botanical, pathological and chemical divisions, an experiment station, a statistics section and small holder's advisory services. It keeps in close touch with the larger estate companies, such as Dunlop, Socfin and United States Rubber, which have their own laboratories for routine quality control and fundamental research. It is engaged in such tasks as research on production, including that of the physical environment of the rubber tree, of the rubber plant and of its pests: research on products, including latex and dry crude rubber, testing and modifying natural rubber to meet consumer needs; and technical advice to rubber estates and small holders. The Institute is an autonomous organization established by government enactment.

77. The Forest Research Institute at Kepong, Selangor, was established in 1926 with the chief research officer as the executive head. It has several research branches, namely, botany, ecology, silviculture, mensuration, entomology, chemistry, wood technology, timber research, timber mechanics, woodworking, wood preservation, composite wood and seasoning. Its functions are to solve the basic problems of: (a) how to produce the greatest possible amount of economic timber in the shortest possible time under a sustained yield system; and (b) how to use the timber produced to the best possible advantage.

78. In the field of mining development, there exists a research laboratory established in 1955 and maintained by the Geological Survey Department at Ipoh, headed by a director within the Ministry of Natural Resources. It is financed by the Colonial Development and Welfare Fund and performs such tasks as preparing a geological survey of Malaya and assaying ores. The excellent physical plant consists of a new building and laboratories with valuable equipment from various countries.

79. Owing to the Government's policy of appointing Malaysian nationals to these positions, the expatriate personnel which staffed the research institutions were sent away, with the result that, in 1959, every institute faced the problem of under-staffing, especially as regards senior staff personnel. Though few qualified Malaysians are as yet available, the situation is expected to improve as the universities and technical institutes produce more qualified Malaysians who choose scientific careers. But at present some of the institutes are finding it difficult to recruit Malaysians. A solution to the problem of under-staffing was partially found by recruiting a few nationals other than United Kingdom through such international organizations as the FAO and the Colombo Plan.

80. Assistance from outside was sought by the research institutions by way of obtaining foreign scientific periodicals through an exchange of publications and by subscriptions. Prior to independence, important capital grants had been provided by the United Kingdom Colonial Development Fund; whereas, since the attainment of independence, increasing assistance has been obtained through the Colombo Plan. Aid to technical libraries, including the contribution of scientific works, has been provided by the Asia Foundation and the United States of America Information Service.

New Zealand

81. The rate of expansion of research in New Zealand had been slow and it is significant that in 1961 its Government spent only half as much as Australia on research and development, representing 0.163 per cent of gross national product. Recently, however, a policy for intensifying the industrial research programme has been adopted, accompanied by the provision of additional funds and facilities for research.

82. The central organization for the conduct of scientific and technological research is the Council of Scientific and Industrial Research, established under the Minister-in-Charge of the Department of Scientific and Industrial Research (DSIR). The Council consists of a chairman and not more than eight members, two of whom are government officials, while the secretary of the council bears the executive responsibility.

83. Under the Council are twelve divisions dealing with animal ecology, the Antarctic, botany, crop research, entomology, fruit research, geophysics, grasslands, geological survey, plant diseases, plant chemistry and plant physiology. Laboratories, research stations and institutes relating to industrial research and development have also been established under the aegis of the Council: an applied mathematics laboratory, the Auckland Industrial Development Laboratories, the Dominion Laboratory, the Dominion Physical Laboratory, a fats research laboratory, a hop research station, a tobacco research station, an institute of nuclear sciences and a wheat research institute.

84. In addition to the research work carried out in the above institutions, the Council recommends annual grants to research workers in the universities and the eight incorporated research associations, so as to encourage research, frequently in subjects ancillary to the main programme of the Department of Scientific and Industrial Research. These grants, although met from the vote of DSIR, are outside DSIR's regular programme of research and scientific services.

85. The expenditure arising from the activities of the Council are met by annual budgetary appropriations to DSIR. Moreover, the Council receives contributions from industry for specific projects undertaken on a contract basis, such funds being credited to a special deposit account.

86. In recent years, there has been a steady improvement in the educational qualifications of the scientific officers. The proportion with doctoral degrees increased from 8.8 per cent in 1950 to 25.3 per cent in 1963, and over 40 per cent of scientific research personnel now have a doctoral degree or first-class honours.

87. The results of research conducted by the research institutions are published by the Information Bureau, which is responsible for the editing and publishing of all the scientific publications of the Council and its subsidiaries. In addition, the Bureau provides a central library service which includes reference facilities, an index of scientific translations, cataloguing, inter-library lending, book ordering and assistance to branch libraries. The Bureau also maintains a technical information section, a public relations section, a photographic section, a photocopy service and a cartographic section. Moreover, a scientific liaison service is maintained under the senior scientific liaison officer, who keeps in close touch with scientific research organizations both at home and abroad, national and international.

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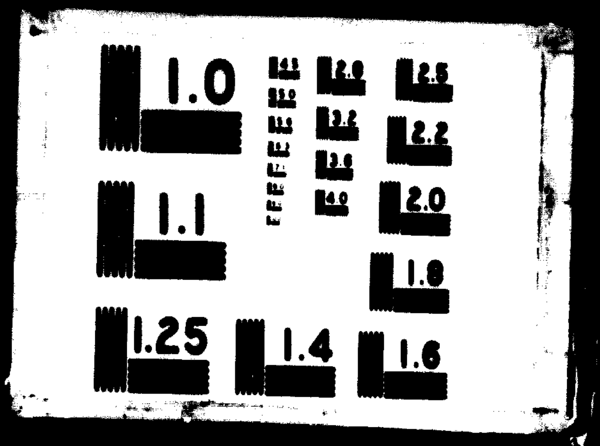

Pakistan

88. In Pakistan, the production activity of industries, both private and public, was largely hampered by the lack of facilities on research relating to industrial materials and processes at the time Pakistan launched its First Five-Year Plan (1955-1960). The plan therefore provided for the further development of the laboratories of the Pakistan Council of Scientific and Industrial Research (PCSIR), with emphasis on applied research; in order that, for the most part, the work of these laboratories should consist of obtaining the results of the latest and best investigations of research centres in other developed countries and adapting those results to 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 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.

89. The Second Five-Year Plan (1960-1965) also stressed the need for industrial research in the nature and use of raw material resources, and for the development of new products, processes and improved techniques for the most economic use of these resources. In a review of the work of PCSIR, it was reported that a number of new processes had been developed to a stage where they were ready for commercial exploitation and that private enterprise would be encouraged to develop the processes evolved commercially. The plan envisages the expansion of existing activities in industrial research, where possible in concert with private industries which are expected to finance research of special interest to them. While a number of research institutions related to the industrial field have been established in Pakistan, the question of industrial research still does not appear to occupy the place it deserves. It is intended that, during the second plan period, an industrial research and development centre will be established in East Pakistan, to supplement research and advisory services by collecting and disseminating information on the latest technical discoveries and industrial developments occurring in other countries.

90. 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 degree as a result of the successive five-year plans. Thus, with the exception of the Fazl-i-Omar Research Institute, which was founded in 1926 with the object of promoting the study of science and the development of industries in the country, the existing research institutes are all organized as governmental institutions. They are as follows.

91. PCSIR, founded in 1953 and located at Karachi, is the nerve centre of industrial research under the guidance and direction of the Department of Industrial Planning and Development in the Ministry of Industries. It promotes the progress of science and its applications to the development of the national industries as well as the utilization of the natural resources of the country. The executive responsibility is borne by its director. There are four regional laboratories under its control:

(a) The Central Laboratories at Karachi, which have seven divisions, i.e., physical, chemical, biochemical, pharmaceuticals and pest infestation, building materials, fuel and engineering research;

(b) The East Regional Laboratories at Dacca, which have [illegible] fuel, food, fruit, leather, glass and ceramics research divisions;

(c) The North Regional Laboratories at Peshawar, which have [illegible] fruit and vegetable technology, mineralogical and wool research divisions;

(d) The West Regional Laboratories at Lahore, which have six divisions, namely, metallurgical, industrial fermentation, oils and fats, glass, ceramics and food technology research.

92. These laboratories do not normally undertake work on standardization, but they co-operate with the Pakistan Standards Institution to promote standardization and quality control in industry.

93. PCSIR had under its supervision the Pakistan National Scientific and Technical Documentation Centre (PANSDOC), established as a documentation centre for all branches of science and technology.

94. Among the research institutes dealing with research in specific products may be mentioned the Institute of Cotton Research and Technology at Karachi and the Pakistan Central Jute Research Institute at Dacca, established under the Pakistan Central Jute Committee, each institute being headed by a director. The former carries out research work on cotton production, fibres, textiles and marketing, while the latter undertakes agricultural, technological and economic research on jute.

95. The results of research are disseminated to the interested public through such publications as the <u>Pakistan Journal of Scientific and Industrial Research</u>, <u>Science and Industry</u>, the <u>Science Chronical</u>, <u>Annual Reports of PCSIR</u>, <u>Quarterly Journal of the East Regional Laboratories</u> and the <u>Annual Report of Pakistan Central Jute Committee</u>.

96. Regarding staffing of the research institutes, no problem appears to be encountered in view of the large number of scientific and technical graduates produced by Pakistan's universities, technical institutes and colleges. Furthermore, since the reconstruction of the National Register of Scientific and Technical Personnel maintained under the Essential Personnel Registration Ordinance, it has become possible to locate and recruit easily from indigenous sources the required personnel for staffing the research institutions.

<u>Philippines</u>

97. It is the policy of the Philippines Government to promote scientific and technological research and development, foster invention and effectively use scientific knowledge for the promotion of national progress. To implement this policy, the National Science Development Board (NSDB) was formed with the following objectives:

(a) To stimulate and guide scientific, engineering and technological efforts towards filling the basic and immediate needs of the people;

(b) To furnish incentives to private and individual initiative in scientific work as a fundamental basis for the advancement of science;

(c) To strengthen the educational system of the country so that it will provide a steady source of competent scientific and technological manpower;

(d) To promote and encourage the dissemination of the results of scientific and technological research and the general application thereof;

(e) To foster co-ordination and co-operation in research in order to secure concentration of effort, minimize duplication and thereby achieve maximum progress;

(f) To initiate and bring about the establishment of standards, quality control measures and documentation facilities;

(g) To encourage studies in the pure and fundamental sciences.

98. To facilitate the carrying out of the above functions the Board has two agencies under its supervision, the National Institute of Science and Technology (NIST) and the Philippine Atomic Energy Commission. The Industrial Research Centre of NIST undertakes industrial research, which term in the Philippines connotes research with regard to processing of agricultural products, forest products, minerals, fish and other marine products, as well as the more complex operations of fabricating industries. The main objective of the centre is to conduct industrial research and development in any field of applied science that will favourably affect the industries of the Philippines. In more detail, the functions of the Centre cover utilization of local materials, creation of new industries, improvement of industrial products and processes, ceramics research, physics and electronics research, engineering research, aero-industrial research, chemical research, mechanical research, structural and material research, technical information and consultation services, and establishment of pilot plants to show industry or financial interests the practicality of a process as well as its economic feasibility. In other words, the centre undertakes scientific studies in industrial, chemical and engineering researches to develop, among other things, a greater use of local materials by conducting continuous analysis into these materials, new processes, techniques and devices for the manufacture of new commercial products, and by finding new use for unutilized materials occurring in abundance.

99. The Centre is in charge of a director who, in turn, is supervised by the Commissioner of NIST. The central policy-framing body of NIST is the Governing Board of NSDB, which was created in 1958. In its work, NSDB is assisted by advisory committees made up of renowned scientists.

100. Prior to the formation of NSDB, the scientific and technological research activities of the Government were connected with the specific programme responsibilities of its various departments and agencies without much over-all integration. However, after the organization of NSDB, positive steps were taken to co-ordinate such activities in the Government. To develop the co-operation of the scientific community, NSDB requests assistance in carrying out its programme of activities from the scientists and technologists of many universities, government research institutions and private groups. To achieve additional collaboration, the NSDB sponsors conferences and seminars at which constructive discussions are contributed by research people representing all sectors of the economy. The incentive given to research takes the form of an exemption from the marginal fee which is granted in the case of scientific and technical equipment and materials imported exclusively for use by the end-users in research and scientific work, as certified by NSDB.

101. In the fiscal year 1959-1960, a sum of $US[illegible] was [illegible]ted for NSDB out of the Government budget. In subsequent years, these funds have been gradually increased and they have flowed regularly. To augment them, NIST is empowered to accept industrial research contracts from industries where the latter bear the [illegible].

102. NSDB has embarked on a manpower development programme to ensure a steady supply of future scientists. The Board encourages the intensification of scientific education by offering science scholarships to talented students at the secondary, collegiate and graduate levels. A training programme developed for the technical personnel of the Board and its agencies is aimed to meet the needs of the Board's programme of research and development. Under this programme several technical men were sent abroad on various fellowships, observation tours and on-the-job training under the auspices of such international agencies as the Colombo Plan, IAEA, UNESCO and ICA.

103. For disseminating the results of researches carried out, NSDB began utilizing the printing equipment received from the Colombo Plan in carrying out a comprehensive programme of publishing scientific literature and promotional brochures. One of these is the very highly regarded Philippine Journal of Science, published quarterly by NIST, which contains the results of the scientific and technological researches in the NIST laboratories. In addition, NSDB and its agencies exhibit to the public through demonstrations the development projects of the Industrial Research Centre; offer technical services to the Government and private sectors; and undertake the work of testing and analysis of samples of products made by government agencies and private industrialists, the latter work being done by the division of tests and standards. The scientific library of NIST, the only one of its kind in the country, possesses a stock of over 16,000 scientific books.

104. Apart from the research organizations under NSDB, there exist the following governmental institutions devoted to research work on specific lines:

(a) The Philippine Coconut Administration (Philcoa) at Manila, which is engaged on copra improvement research, so that copra can command higher prices for producers and strengthen its competitive position in the world market. It is run under a general manager as the executive head;

(b) The National Development Company, Manila, is in charge of a general manager. Its technical department carries out industrial research on rice oil extraction, fertilizer deposits, pulp and paper, food canning, leather board, cassava flour projects, etc.;

(c) The Philippine Sugar Institute (Philsugin) at Manila is run under a commissioner and financed by taxes received from sugar producers. It serves the sugar industry by undertaking research work on the agricultural and industrial phases of sugar cane and its products. It also co-ordinates research work with the University of Florida, United States of America, on the utilization of sugar-cane bagasse for paper and paper-board manufacture;

(d) The Forest Products Laboratory at Manila, which is under the Bureau of Forestry, is headed by a director. It devotes its research activities to forest products research to help industrialists obtain lumber, stimulates manufacture of exportable wood products, and determines the suitability of forest species as raw materials for pulp;

(e) The [illegible] at Manila has a commissioner as its executive head; it carries out research work on utilization of marine products as well as on the preservation, [illegible] and processing of fresh fish and other aquatic products.

105. In certain other specialized fields of industry, the following private industrial firms carry out research work with their own funds:

(a) The San Miguel Brewery, Manila, conducting research on glass and brewery industries;

(b) Elizalde and Co., Manila, conducting research on hemp rope-making industry;

(c) A.T. Sauco and Co., Manila, conducting research on pharmaceutical industry;

(d) Cia de Celulosa de Filipinas, Manila, conducting research on paper industry;

(e) The Philippine Manufacturing Co., Manila, conducting research relating to canning industry;

(f) The Superior Gas and Equipment Co., Manila, conducting research on fuel industry.

The Republic of Korea

106. In the Republic of Korea, the First Five-Year Economic Plan (1962-1966) definitely states that the ultimate course of the Korean economy lies in industrialization. During the plan period, the period of preparation for industrialization, emphasis will be placed *inter alia* on technological advancement. To achieve this, a unique First Five-Year Plan for Technical Development (1962-1966) has been drawn up, which is designed as a complement to the economic development plan, the successful implementation of which will depend upon the creation of a sound technological basis. The basic objectives of the technical development plan are:

(a) To develop the technical manpower resources necessary for the implementation of the First Five-Year Economic Development Plan;

(b) To improve the level of existing technology in an endeavour to increase productivity and accelerate industrial development.

107. Among the policies of the plan, the following deserve to be mentioned:

(a) In the area of technological improvement, the practical aspects of scientific and technical training will be actively promoted and technical research will be encouraged;

(b) Advanced foreign [illegible] will be introduced into the Republic Korea where appropri[illegible]

(c) Public understanding of modern technology will be promoted by a positive programme for the dissemination of technological information;

(d) To ensure successful implementation of the plan, pertinent legislation will be amended, and/or new laws enacted, and technical level promotion institutions and agencies will be either reorganized or created, as required.

108. Private investment in research is virtually non-existent in South Korea: research activities in private industries are extremely limited in scope, and it is largely confined to the testing or inspection of finished products. In [illegible], the Government allocated a sum of about $US2 million for the operation of national and public scientific and technological research agencies. However, only a small portion of these funds was earmarked for fields directly linked with industrial activities. The only existing governmental research organizations relating to the field of industry and mining are:

(a) The National Industrial Research Institute, Seoul, whose task is to develop industrial techniques under the supervision of the Ministry of Commerce and Industry. This Institute has under it an inorganic chemistry section, organic chemistry section, ceramics section, textile section, mechanical engineering section and food industry section;

(b) The Institute of Mining and Metallurgy, established in 1962, devotes itself to the solution of such mining and metallurgical problems as the study of coal washing, study for the utilization of brown coal and anthracite; processing of low-grade wolframite, treatment of finely ground ores of iron, copper, gold and silver; study of floatation and steel-making from low-grade iron ores.

109. It is owing to this absence of industrial research facilities that investment in research has been made a pronounced investment feature of the Five-Year Plan for Economic Development; during the plan period, the over-all scale of research activities will be gradually expanded to promote rapid technical progress. It is also planned that specific responsibilities will be assigned to the various research agencies of colleges and universities, state research organizations, special corporations and private industries, and that special attention will be paid to the need for modernization of research facilities and equipment to keep pace with the rapid scientific and technological progress of the world.

110. To encourage private technical research activities and give incentives to research, the following tax measures will be put into effect under the plan:

(a) As the outlay of research funds by private industry can greatly fluctuate with the business situation, research expenditures within certain limitations will be regarded as losses for taxation purposes;

(b) Contributions and donations for the development of science and technology will be considered as losses.

111. Since research investment by private industry has been negligible and is expected to remain so for some time to come, the following targets of investment in research by the Government have been set:

TABLE

Research investment goals, Republic of Korea

Year	Research investment (millions of US dollars)	Percentage of Gross National Product
1962	4.9	0.30
1963	5.5	0.32
1964	6.7	0.37
1965	8.3	0.43
1966	10.4	0.5

112. The encouragement of information exchanges for the dissemination of scientific technology will be actively promoted under the plan, through a systematic reorganization of information agencies, the training of information specialists and the acquisition of advanced information and data-processing techniques. For this purpose, a centralized technical information centre will be established to gather and consolidate technical information, both domestically and abroad, and to distribute valuable or required information and data to appropriate individuals and organizations so as to promote improvement of technical standards and development of local industries.

Thailand

113. In Thailand, up to 1963, there was little research activity; the laboratories established by various government departments and agencies merely provided facilities for chemical analysis and physical testing pertinent to the operations of the Ministry concerned. Thus, the Department of Science in the Ministry of Industry possesses facilities for chemical testing and some investigations in the chemical field; the Department of Mines in the same Ministry possesses chemical and ore-dressing laboratories; the analytical laboratory of the Customs Department in the Ministry of Finance possesses facilities for chemical and physical testing from the standpoint of customs administration; the chemical laboratories of the Police Department, Ministry of Interior, make tests related to crime, while the laboratories of the Preserved Food Organization deal only with testing work for quality control of its canned or preserved-food products. Most of these laboratories are run on a relatively small scale. A few large private industrial enterprises, such as the sugar factories, cement factories, starch factories, breweries and chemical plants, possess control laboratories but do not engage in any scientific research.

114. Staffing of research laboratories has also been difficult. Among the three universities which are concerned with teaching scientific disciplines, the only potential source of recruitment of science graduates is Chulalongkorn University, which turns out a number of science graduates, three-quarters of whom are women. In the universities, attempts to carry out research have been very limited and there are virtually no post-graduate science students. The reason for this paucity of scientific manpower resources is mainly attributable to the small salaries offered to scientists working in existing scientific laboratories, so that graduate scientists are lured away to more remunerative administrative posts in the

[illegible]rnment. To alleviate these [illegible] [illegible] grants to individual staff [illegible] to undertake basic research so that [illegible] to the students. Several [illegible] scientific libraries [illegible] country.

115. Against this unsatisfactory background, the Government of Thailand, realizing the importance of science and applied scientific research for its programme for economic development, has requested the United Nations Bureau of Technical Assistance Operations (BTAO) for a survey to be made of existing research facilities and for recommendations to be prepared on the co-ordination and improvement of scientific research work in the country. An expert assigned for this purpose by BTAO worked in Thailand from June 1960 to June 1961 and produced a comprehensive report embodying the following recommendations for stepping up industrial research activities:

(a) That a scientific and industrial research institute be established under the National Research Council with the laboratory facilities of the Department of Science in the Ministry of Industry as its nucleus;

(b) That, in the initial stages, the Institute be organized in four groups, namely, industrial chemistry, minerals and metallurgy, food technology and forest products; and that, as the Institute develops, other groups be formed, such as fibre technology, microbiology, road technology, physics and engineering;

(c) That an industrial liaison service be established in the Institute to bring the latest technological information to end-users in industry and to furnish technical advice for economic production of quality industrial goods at a minimum cost. The industrial liaison service should work closely with the documentation centre when established and canalize testing work to the National Testing Service after its formation. It would thus form a link between the possible industrial user and the research activities of the Institute by disseminating information in a suitable form to the user;

(d) The Institute should maintain close liaison with the other government agencies concerned with its work, such liaison to be made through its Advisory Committee consisting of scientists, industrialists and specialists from concerned Ministries.

116. The Government of Thailand, after considering the expert's report, accepted the recommendations in principle and passed an Act of Parliament in May 1963 establishing the Applied Research Corporation of Thailand with the Prime Minister as the Chairman. For forming this corporation and building up the research facilities, the United Nations Special Fund contributed a sum of about $US1 million, while the Government contributed counterpart funds amounting to about $US2.5 million in addition to the buildings. From the start, the Corporation will have the following agencies under its supervision: a technological research institute, an agricultural research institute, and a nutritional and food science institute. Some new buildings have been constructed recently and are in the course of being equipped with apparatus and appliances to undertake the scientific research activities of these institutes.

117. An instrument-repair and calibration centre, which will repair and calibrate scientific instruments for all laboratories in the country, is being established.

The Documentation Centre is already in existence under the auspices of the Corporation.

118. Liaison groups for economic appraisal of industrial and agricultural projects are also being formed to perform liaison work between the Corporation and industry and agriculture.

119. Already the Corporation in its formative stage employs a staff of about fifty, technical and non-technical, personnel. Soon after the necessary laboratory equipment has been installed, many local scientists will be recruited. It is envisaged that no problem will be encountered in recruiting the right type of personnel, as the Corporation is prepared to offer attractive salaries to those technically qualified.

B. Summary

120. Industrial research and development activities are not evenly spread among the countries of the ECAFE region, on account of the wide differences in their levels of economic and technological development. At one end of the scale are such countries as Western Samoa and Mongolia, which are but little developed economically and, at the other, are such countries as Japan and Australia, which have developed outstanding research organizations in the firm belief that the application of scientific research to practical ends will result in more efficient techniques and methods of production. India is outstanding among the low-income countries by reason of the number and variety of its research institutions, many of which are charged with bringing science to bear on specific aspects of the country's development problems.

121. Many countries in Asia and the Far East are newly independent and, in embarking on their development plans, have shown a new awareness of the vital importance of science and technology to their economic development, and of the need to draw upon the vast reservoir of scientific knowledge accumulated in developed countries for immediate utilization by making such modifications or adaptations as local conditions require. The media selected for such adaptation are the central or national research organizations, some of which have the prime ministers as chairmen and all of which have affiliated research laboratories under their control to undertake co-ordinated research and development work in line with the national policies for development. The research programmes of these organizations are directed more towards applied or oriented-basic research than toward pure fundamental research. This does not mean, however, that purely basic research has been ignored, for it is particularly necessary in the study of raw materials peculiar to the respective countries. A salient feature of the organizational pattern of research activities in the ECAFE region is the predominance of government sponsorship, with the private sector contributing mostly by way of fees paid for research work undertaken on a contract basis for particular research projects. It may thus be said that industrial research consciousness, though significant in government circles, has not in general filtered down to the private sector of the economies.

122. It is true that tax exemptions have already been provided in certain countries, that training in research personnel is already going forward in many others, and that in some countries incentives have been given to attract local personnel into the realm of industrial research and development; nevertheless, the situation still

leaves room for very [illegible] complacency.

123. In comparison with the ratio [illegible] cent in the United Kingdom [illegible] ratio is regrettably low in the case of ECAFE countries. [illegible] Japan, where research facilities are the most advanced [illegible] investment/sales ratio has not [illegible] reach the target of 2-3 per cent in the near future. For the [illegible] the economies of the developing ECAFE countries and those of advanced countries outside the region to be bridged effectively and speedily, it will obviously be necessary to increase the above ratio.

124. It has been conservatively estimated that there are ten scientists per million people in the less-developed areas of the world, compared with a thousand per million in the developed areas. As a result, the number of research scientists and technologists engaged in research activities in the countries of Asia and the Far East is comparatively very small. This number may be adequate to staff existing research organizations in some countries, but the scientific and technical manpower has to be increased many-fold in the face of the expansion of research activities envisaged for the future.

125. Technical assistance through international and bilateral aid has inevitably to be sought in the ECAFE region for the implementation of industrial research programmes. This assistance can best take the form of provision of equipment and expert scientific personnel, and/or of scientific and technical books and publications to stock the many emerging scientific libraries that are being established.

C. Conclusion

126. A quick means by which developing countries of the ECAFE region can catch up with advanced countries in research and development activities is by drawing upon the world store of scientific and technical knowledge and transferring it to the individual countries. When techniques are so transferred, some adaptive invention is likely to be necessary, i.e. either a minor or major adaptation brought about through research work. This adaptive research can be looked upon as a special type of applied research peculiarly useful in newly developing countries; it is the kind of research which deserves the greatest emphasis in the countries of Asia and the Far East.

127. Several of the latter countries in the early stages of development, though cognizant of the importance of industrial research in general economic development, often are unable to establish elaborate research organizations owing to limitation of resources and to the large amounts of capital and scientific personnel required for the effective implementation of research programmes. For such countries, the obvious answer would be to follow a programme of regional or subregional co-operation in research from which a number of benefits can be derived. Thus, considerable savings in resources could be achieved, complex and costly research work could be increasingly taken up by pooling research facilities available in various countries, and the obtaining of technical and financial assistance from sources outside the region under bilateral or international aid would be facilitated. In the initial stages, it would [illegible]

or sub-regional co-operation to give more attention to the question of exchange of information between existing research institutes or universities, so as to avoid duplication of work and to encourage the exchange of scientists between them.

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XIX. INDUSTRIAL RESEARCH IN THE PHILIPPINES

Prepared by Canuto G. Manuel*

Introduction

1. The disastrous impact of the Second World War on Philippine agro-industrial growth and development and the then concomitant socio-economic dislocation in the country provided the crucial challenge that spurred greater determination and efforts on the part of the Filipino people not only to rehabilitate what was damaged and to regain what was lost by industry, but also to work harder together to attain a higher level of economic self-sufficiency.

2. The bitter lessons of adversity and the demands of being an independent nation focused national attention on the vital necessity for systematic techno-economic planning and programming in order to restore economic stability and to establish a dynamic basis for future advancement. The leaders in Government and in industry realized the need for balanced agro-industrial development and expansion, for with the increasing rate of growth of the Philippine population, agriculture alone could not provide the desired economic stability.

3. Likewise, the spectacular and rapid development of post-war science and technology in the more developed countries of the world made their heavy imprint on national economic policies. There was a deepening awareness of the fact that the highest standards of living invariably characterize the economies of countries where science and technology have been supported and developed to an intensive degree; that industrialization is the key that could unlock the country's untapped natural resources; and that positive action towards these ends could primarily be attained through "self-help" in improving and modernizing the country's own scientific research resources and through adaptive acquisition from industrially advanced nations.

4. Consequently, three significant events in the history of Philippine science resulted from these developments. The first was the creation by the Philippine Congress in 1954 of the Committee on Science and Technology in the House of Representatives and the Committee on Scientific Advancement in the Senate. This legislative action bridged the long-existing gap between the scientific sectors and the top policy-makers and projected science into the orbit of public policy. The second was in July 1958 when the Science Act was enacted and implemented. This law created the highest national science policy-making and co-ordinating body of department level. The third was in 1959, when the Philippine Atomic Energy Commission's (PAEC) $US500,000 research reactor and its auxiliary nuclear energy laboratories were installed with the assistance of the Government of the United States of America. These events led to the formulation of more realistic national

* Commissioner, National Institute of Science and Technology.

policies on scientific and technological research, and the establishment and/or expansion and strengthening of the existing scientific agencies in the country. These steps brought Philippine science abreast with the atomic age.

A. National policy stands on industrial research

5. On 15 July 1958, Republic Act No. 2067, also known as the Philippine Science Act of 1958, took effect. This Act is entitled "An Act to Integrate, Co-ordinate, and Intensify Scientific and Technological Research and Development and To Foster Invention; To Provide Funds Therefor; and For Other Purposes".

6. This Act created the National Science Development Board (NSDB), thereby providing an over-all organization for the co-ordination, integration and support of the scientific and technological research activities of the Government and of private entities in the country. The eleven-member Governing Board, under the chairman with cabinet rank, acts as the policy-making body on scientific matters. The Board prepares the national programme for the science and technology sector to be submitted to the Philippine National Economic Council for inclusion in the over-all socio-economic development programme of the Government.

7. The Act also created the Philippine Atomic Energy Commission and reorganized and expanded the old Bureau of Science into the National Institute of Science and Technology (NIST). These two research agencies are the implementing arms of NSDB, the first on nuclear sciences and the second on conventional (non-nuclear) sciences.

8. Through NSDB the country hopes to eliminate wasteful duplication in research and to promote the more effective allocation of research funds, to provide financial assistance and direction of research efforts, to promote science consciousness and to improve science education, and to provide more efficient technical services to private industries - all aimed at solving the basic problems of the country in the areas of food, clothing, shelter and medicines.

9. The basis of the national policy on scientific and technological research was originally formulated in general terms by the Philippine Congress as stipulated in Republic Act 2067. In the implementation of the provisions of this Act, NSDB formulates the specific policies to achieve the aims of Congress and the office of the President. The guidelines and policy instructions adopted by NSDB in carrying out the over-all scientific objectives are, in many instances, influenced by the consensus of selected resource persons consulted from time to time; these persons are leaders representing the sciences and engineering, industry, education, scientific and technological societies, and business groups in the country. They are consulted because economic planning involves the choice of various alternative sectoral areas of production and production techniques, and of identifying the role of science in both the aspects of producing and creating wealth.

10. The development and scope of scientific research in the Philippines have been characterized by two main shifts in orientation and direction. During the pre-war period it was oriented more towards survey and fundamental research, while during the post-war period it has become increasingly oriented towards applied, industrial or economic research.

11. The more immediate needs of the country [illegible] development shall be given higher priority in the [illegible] programme of NSDB and its agencies, as well as in those of [illegible] of the Government. Many other socio-economic factors and problems [illegible] developing nations, like increasing productivity and employment [illegible] unfavourable foreign trade, increasing the *per capita* income etc., [illegible] to the necessity of a crash programme in addition to a long-range [illegible] applied research and the next important step leading to the commercial [illegible] industrialization scale - pilot plant or development aspect - should be [illegible] priority.

12. The above-mentioned priority concepts are the policy stands on industrial research of the Government and, particularly, of NSDB. However, pure research and oriented fundamental research have not been altogether neglected.

13. While NSDB and its implementing agencies, NIST and PAEC, as well as other governmental offices engaged in agro-industrial research, have given more emphasis to applied research, the undertaking or support of fundamental research has remained the major activity of public and private universities and colleges and of the National Research Council of the Philippines (a semi-governmental organization that also serves the Government in an advisory capacity on scientific matters).

14. Another post-war necessity which is considered of equal importance to applied research, in terms of expenditures and activities, is the establishment of a better reservoir of highly trained scientific and technological manpower.

15. In the light of these policy stands, NSDB adopted the following guidelines as to the priority areas of industrial research in the formulation of the country's five-year research and development programme planned for 1962-1967:

(a) Area I: Research directed at increasing the utilization of natural resources to produce substitutes for imports;

(b) Area II: Research directed at upgrading and expanding the nation's export products;

(c) Area III: Research directed at processing the waste products in agriculture and industry to develop consumer goods and export commodities;

(d) Area IV: Measures intended to develop scientific and technological manpower, and to promote social science research and science consciousness.

16. Likewise, in the system of priorities for the allocation and distribution of research and development funds provided by the Government, NSDB adopted, in July 1963, the following guidelines for the division of funds for applied research and development work among various fields:

(a) Agriculture and natural resources, 20 per cent;

(b) Industry and engineering, 20 per cent;

(c) Medical and allied science, and food and nutrition, 10 per cent;

d) [illegible] per cent;

e) [illegible] per cent:

f) Promotion, publication, survey, conferences and other services, [illegible] per cent.

17. In order to create industrial research consciousness among the private industry and governmental sectors, the following policy stands and responsibilities of NSDB and its agencies were established:

(a) To encourage and facilitate the active participation of domestic and foreign sectors in furnishing financial, technical and other forms of assistance for scientific and technological activities;

(b) To initiate and bring about the establishment of standards, quality control measures and documentation facilities;

(c) To co-ordinate and promote co-operation in the scientific research and development activities of government agencies and private enterprise;

(d) To establish a system of priorities for scientific and technological projects;

(e) To initiate and facilitate arrangements for scientific and technological aid from domestic private sectors and foreign sources and for the exchange of information among local and foreign institutions and scientific investigators;

(f) To offer to, and accept from, public and private sectors, specific project proposals of scientific and/or technological research and development, and to provide appropriate financial technical and other support thereto;

(g) To establish and/or provide incentives, including financial and technological support, for the establishment of scientific and technological centres;

(h) To disseminate the results of scientific and technological research and to encourage their practical application;

(i) To grant scholarships in mathematics, science, technology, and science teaching to deserving citizens;

(j) To grant financial or other awards, bonuses and/or prizes to deserving scientific, engineering and technological researchers and inventors;

(k) To pay additional compensation to scientific, engineering and technological researchers and inventors employed by the Government or its subdivisions and instrumentalities under such terms and conditions as may be most conducive towards the attainment of maximum efficiency in scientific research and studies;

(l) To extend travel grants for scientific and/or technological purposes, to send delegates and observers to scientific and technological conferences or conventions, and to promote and assist scientific [illegible] and conventions in the Philippines;

(m) With the approval of the President of the Philippines, [illegible] more than five science attachés with the proper scientific [illegible], whenever necessary, to send scientific and technological missions abroad.

(n) To approve and facilitate the procurement of radioactive materials [illegible] instruments for use in nuclear laboratories, and to issue licenses for the use of radioactive materials.

B. Other incentives to industrial research

18. With respect to tax exemptions, the Science Act of 1958 also provides that NSDB and its agencies, as well as the University of the Philippines, are authorized and empowered to receive grants, bequests and donations, made or given for the purpose of aiding scientific and technological investigations or establishing scholarships in the fields of science, engineering and technology. Such grants, bequests and donations shall be tax-exempt and deductible from the income-tax returns of the donors upon certification of the Board or the University that said grants, bequests and donations are dedicated to the purposes mentioned above.

19. The Board shall promote and, at its discretion, assist in the establishment of private foundations for scientific advancement as well as specific research and development projects by private individuals, firms and institutions. All funds contributed to the support and maintenance of such foundations and their projects, as well as of specific research and development projects undertaken by private individuals and educational institutions, shall be tax-exempt and deductible from the donor's income-tax returns, upon certification by the Board that such foundations and funds are dedicated to scientific pursuits.

20. The Government, through certification of NSDB, also grants tax exemptions, like import duties and compensating taxes on imports of scientific research apparatus, equipment, facilities, materials, etc., to be used exclusively for research and development and/or science education purposes.

21. Among the important laws enacted granting tax exemptions, subsidies or grants in order to promote industrial research and its application to industry are the following:

(a) Republic Act No. 2707: an Act to exempt the International Rice Research Institute or its successors from the payment of gift, franchise, specific percentage, real property, exchange/import, export and all other taxes. Members of its scientific and technical staff are also exempt from payment of income-taxes on salaries and stipends in dollars received solely and by reason of service rendered to the Institute;

(b) Republic Act No. 3127: an Act authorizing the exemption of new [illegible] industries from the payment of special import tax, compensating tax, foreign exchange margin fee and tariff duties with respect to the importation of [illegible], spare parts and equipment. Basic industries include: basic iron, nickel, aluminium, and steel industries; basic chemical industries; antibiotics; fungicides; cement manufacture; fertilizers; pulping and/or integrated manufacture of paper products; logging and manufacture of veneer and plywood; products and manufactures of textiles, cotton, ramie, synthetic fibres and coconut coir; and the manufacture of ceramics, furnaces, refraction glass, etc.;

(c) Republic Act No. [illegible]: an Act to exempt the Ford Foundation and its grants from the payment of gift, franchise, specific percentage, real property and all other taxes, duties and fees. The exemption extends to goods imported under the Ford Foundation grants for scientific, educational and training purposes;

(d) Republic Act No. 3050: an Act exempting local fertilizer companies from payment of special import tax, margin fee on foreign exchange, sales and compensating taxes and customs duties on their importation of capital goods, equipment, spare parts, raw materials, supplies, containers and fuel until 31 December 1965.

22. Also, through three public abaca agencies, the Government appropriated 10 million pesos for abaca research, seed production and distribution, improvement of fibre extraction methods and development of foreign trade in abaca. A full research project to determine new uses for abaca has been launched. It was found that abaca is an ideal raw material for the manufacture of fine cigarette paper.

23. NSDB has adopted incentive policies on the following: the giving of awards, bonuses and prizes to deserving inventors and researchers; the giving of financial grants for the printing of scientific and technological publications; the giving of travel grants to Filipino scientists for attendance at foreign international science conferences; and the giving of financial assistance to educational institutions for the undertaking of basic research.

24. Another important technical activity of NSDB and its agencies, especially NIST, that provides a close tie-up and collaboration with private industries and manufacturing plants are the NIST testing and standardization services and the technical enquiry and field consultation services.

25. NIST operates its own testing and standards laboratories for product or material quality control and to ascertain if imported or local products comply with standard specifications. These laboratories co-operate with the industry-supported Philippine Standards Association in the formulation and establishment of standards for locally manufactured products.

C. Scientific manpower development programme

26. The scientific manpower development programme of NSDB covers a wide area. This five-year programme, which was initially implemented and financially supported in 1958, embraces the following areas:

(a) Regional summer science institutes for selected elementary teachers from both private and public schools;

(b) Regional summer science institutes for selected secondary science and mathematics teachers, also from both public and private schools;

(c) A Graduate study/training [illegible]

(d) An undergraduate study/training [illegible] research);

(e) In-service training programmes of [illegible] of NSDB, NIST [illegible]

(f) The establishment of the Philippine Science High School (free scholarship basis) for selected young boys and girls.

D. Industrial research establishments of the Government

27. The principal agencies of the Government undertaking industrial research and development projects are described below.

National Institute of Science and Technology

28. This Institute is under the supervision of NSDB. Its predecessor was the former Bureau of Science established on 1 July 1901 and reorganised in July 1958 into what is currently NIST. Its buildings and laboratories are located in a three-hectare lot in Manila. The scope and nature of its functions and research activities may be gleaned from its organizational structure, composed of the following eight technical operating units: (a) agricultural research centre; (b) biological research centre; (c) food and nutrition research centre; (d) industrial research centre (largest unit), consisting of the chemical research and the engineering research laboratories; (e) medical research centre; (f) tests and standards laboratories; (g) scientific instruments and technical services division; and (h) science documentation and library division. It has also an administrative division and a legal division.

29. The directors of research centres and the chiefs of divisions exercise delegated executive and administrative authority over their respective centres or divisions for flexibility in administration and programme execution. Policy-making and over-all executive responsibility rest on the NIST Commissioner who is assisted by the Deputy Commissioner. The Commissioner is also an ex officio member of the NSDB Governing Board.

30. NIST mainly undertakes industry-oriented research projects dealing with problems involving the discovery of new or improvement of existing industrial processes, consumer products, equipment designs etc., utilising to the utmost indigenous raw materials. It gives technical consultation services to private industrial establishments and to other government agencies. Its research activities can be distributed approximately as follows: basic research, 5 per cent; applied research, 70 per cent; and development, 25 per cent. Through NSDB, it undertakes contractual research and technical consultation services for interested private enterprises and collaborates with universities and private industries in giving on-the-job or pre-service technical laboratory training to selected graduates or graduating students in the sciences and engineering. It assists other government agencies, like the Bureau of Commerce, in the establishment of local product standards.

31. Financial support for NIST comes primarily from government appropriations, which have averaged P5 million, 1/ about $US770,000 at the present rate of exchange, during the past three fiscal years.

Philippine Atomic Energy Commission

32. The Philippine Atomic Energy Commission was created by the Philippine Science Act of 1958 as the implementing agency of the National Science Development Board on atomic matters. The Commissioner and Deputy Commissioner are the principal executive officials of PAEC. As a member *ex officio* of NSDB, the Commissioner participates in the formulation of policies not only on nuclear energy matters, but also on other scientific endeavours.

33. In the formulation and development of policies in atomic energy, surveys and studies are made concerning the undertaking of research projects designed to contribute to the solution of pressing agricultural, medical and industrial problems, and with promotion and co-ordination of atomic energy use and application in the country. Surveys and studies are also made on the availability of the needed manpower and the specialized facilities and equipment.

34. The activities of PAEC are financed from funds appropriated by the Philippine Congress, mainly under the General Appropriation Act, which are used for the operational expenditures (personnel and other services) and equipment outlay. In addition to this, Congress authorized expenditures from the public works funds for the construction of the nuclear research reactor building.

35. The most important applications of radioisotopes in research, outside PAEC, are being carried out by the University of the Philippines, the Philippine General Hospital Radioisotope Laboratory, the University's College of Agriculture, the Bureau of Plant Industry and the National Institute of Science and Technology.

36. To assist users of radioisotopes and researchers on atomic energy, PAEC makes it a policy to render technical advice to researchers, to provide training opportunities and facilities, locally or through fellowship grants, and to obtain research grants from foreign technical assistance programmes. PAEC also extends the services of its electronic staff for the repair and servicing of instruments free-of-charge and helps facilitate the importation of radioisotopes of research organizations.

University of the Philippines

37. This is the largest government-supported university. In 1959 it established its Office of Research Co-ordination. This office implements research and development projects through its Natural Science Research Council and Social Science Research Council, both policy-making bodies for research activities whose members (representatives of the various colleges of the University) are appointed by the University's Board of Regents. Most of the industrial research is undertaken by the Colleges of Agriculture and Forestry (at Los Baños, Laguna Province), and by the Colleges of Pharmacy, Engineering and Fisheries. The executive responsibility of the University is exercised by its president, a presidential appointee. Other colleges mainly undertake basic research. Its large campus is located in Diliman, Quezon City.

1/ Excluding current fiduciary funds.

Philippine Coconut Administration

[illegible]. This government agency was created in [illegible] under the [illegible] of the Department of Agriculture and Natural Resources. Its research [illegible] confined to the improvement of the copra industry and trade and the industrial utilization of coconut by-products. Its policy-making body is a five-man [illegible] of administrators. The executive responsibility rests on a board chairman, who is concurrently the general manager.

Philippine Sugar Institute

39. This is a semi-public corporation organized in [illegible] and financed jointly by the Government and by sugar planters and millers. Research on the utilization of sugar-cane by-products and wastes and on the agricultural aspects is undertaken co-operatively with large sugar centrals in the country. The policy-making function is vested in a five-member board of directors; the executive function, in a general manager. The majority of the board members represent the National Federation of Sugar Cane Planters, a private organization.

Forest Products Research Institute

40. This research institute is located in the compound of the College of Forestry of the University of the Philippines, in Los Baños, Laguna. It was created by law in July 1959. Its main function is to undertake an extensive research and development programme to improve present techniques of wood processing and production, to promote the utilization of forest products wastes and to develop new forest product industries. It undertakes co-operative projects with private wood processors and manufacturers. It is governed by a five-man Board of Directors, the chairman of which is the Dean of the College of Forestry. Executive responsibility falls on its director and assistant director.

41. Two other government-supported agencies which are undertaking industrial research projects are the Abaca Development Board and the National Cottage Industries Development Authority. Their research activities, however, are centred on the utilization of indigenous raw materials for small-scale handicrafts manufacture to promote cottage industries in the rural areas. Two new government entities recently created by statutes and still in the process of being organized are the Philippine Coconut Research Institute and the Philippine Inventors Commission.

E. Private industrial research establishments

42. There is no privately owned or endowed and financed industrial research institute of national stature undertaking pure research and development activities in the Philippines. However, the larger industrial plants and manufacturing enterprises conduct their own research and maintain laboratories primarily for quality control, to serve the needs of the respective company. Little information and data are available regarding these private industrial laboratories because of trade secrets.

43. Among the larger companies that support and operate their own laboratories to improve the quality of their products, or to search for new products, or

by-products, and the San Miguel Brewery Corporation in Manila, which operates a brewery, a glass factory, a frozen-food products company and an animal-feeds plant; the [illegible] of the Philippines in Bais, Negros Oriental, which operates a pulp and paper plant using [illegible] as raw material; and the Philippine Refining Company and Procter and Gamble (Philippines), both located in Manila and both engaged in the manufacture of copra and coconut oil by-products and synthetic detergents.

44. A privately endowed research institute, one of the best equipped of its kind in the world, is the International Rice Research Institute established three years ago in Los Baños, Laguna (near the College of Agriculture) through grants donated by the Ford and Rockefeller Foundations. The research projects of this Institute are centred on the problem of rice and are mainly agricultural in nature. The Ford Foundation gave a grant of $US7,150,000 for the buildings and laboratories and for the development of the 200-acre Philippine land grant, while the Rockefeller Foundation grants $US500,000 per annum for maintenance and operating expenses.

F. Aspects of financing

45. Financial support of government research agencies, whether scientific and technological, economic, or agricultural, comes from government funds appropriated by Congress every fiscal year (the fiscal year in the Philippines begins 1 July and ends 30 June of the succeeding year). After the President approves the national budget passed by Congress, funds are released on a quarterly allotment basis by the Budget Commission. Some agencies, like NSDB, the University, NIST and PAEC, are occasionally recipients of donations or grants in the form of funds or equipment from private sectors for the undertaking of specific research projects suggested by the donors. These agencies are also authorized by law to have fiduciary funds to which such donations, their incomes and unexpended balances accrue for use in research contingencies. Special funds are occasionally appropriated by Congress for specific research projects, like the abaca research and development fund, and the rat control research fund.

46. A survey conducted by NSDB in 1960 on research expenditures by private industry showed that private industrial firms spent P7.7 million for research and development activities, P6.9 million of which was for applied research and development and P750,000 for basic research. Research and development expenditures in the government sector, on the other hand, totalled P29.5 million, of which the University of the Philippines, the Department of Agriculture and Natural Resources, NSDB and the Department of Health were allocated the greater portion of the amount.

G. Staffing and personnel recruitment

47. The recruitment of highly qualified and well-trained scientists and technologists has remained one of the problems of the advancement of science in the country. Hence, there is need for a more intensified programme of developing the necessary talented manpower for the sustained industrialization of the Philippines.

48. The experience of the writer as administrator of an industrial research institute has shown the dearth of well-trained scientists and technologists at the graduate levels who can pursue independent research work or can effectively

serve as team or project [illegible] ... [illegible] salary scales offered to them [illegible] and more so to the very high salary [illegible] usually hired by contract through [illegible] already quite old. A concomitant problem [illegible] scientists, most of whom are trained abroad, [illegible] better salaries and opportunities, when [illegible] government scientists who are nearing retirement [illegible].

[illegible]. To help solve these technical personnel problems, NSDB [illegible] five-year technical manpower training programme [illegible] training: improvement and upgrading of science teaching in the [illegible] secondary schools, and scholarship grants at the undergraduate level [illegible] graduate studies level (M.S. and Ph.D.) in local and foreign universities.

50. NSDB and its agencies have intensified their in-service and pre-service training programmes to attract talented young men to work in research and to provide skilled technicians for private industry in such fields as chemical, biological, food and engineering research, analytical chemistry, and in the uses of radioisotopes in industry, medicine and agriculture. Foreign-sponsored fellowships are being obtained to enable technical personnel already in the service to study or train abroad. Vocational courses in glass-blowing, fine mechanics, optics and electronics are being offered by NIST in its Scientific Instruments Repair Centre, a project assisted by the United Nations Educational, Scientific and Cultural Organization (UNESCO).

51. Another incentive given to attract better men to work in research laboratories was the raising of the pay scales (now ranging from [illegible] to [illegible] per annum for scientist/technologist levels) of technical personnel of NSDB and its agencies equivalent to twice those given in 195[illegible]. The University of the Philippines has also raised the salary scales of its faculty.

52. A recent amendment to the Science Act of 195[illegible] exempts researchers from compulsory retirement at the age of sixty-five (they can continue in the government service if physically fit) and from the rules and regulations on nepotism.

53. The yearly observance of Science and Technology week, started in [illegible], is also a science incentive activity. Outstanding Filipino scientists are given plaques of merit. The truly productive scientists are awarded cash and in [illegible] were also extended "Presidential Distinguished Science Service Medals".

H. Application of results of industrial research

54. The main objective of the principal industrial research establishments of the Government is to pass on the results of their applied and development research projects to the ultimate users in the country, more particularly to private industry sectors. It has been a standing governmental policy that research agencies supported with public funds shall only undertake the first three main aspects of research: (a) fundamental; (b) applied; and (c) development (pilot-plant scale). The Government refrains from competing with private entrepreneurs.

55. Thus, after the pilot-plant stage, the NSDB and its agencies, for instance, apprise interested private investors or manufacturers of the techno-economic feasibility of commercializing the results of its development projects. This is usually done through personnel liaison, through writing or through technical information bulletins. These extension activities are performed by a co-ordinating team in the agency, or by the public relations and field extension unit of each research agency. If results are patented (such patents, as in the case of NIST, are in the name of the actual researchers/discoverers, but are assigned to the agency), the interested private parties who express desires to exploit the patent and are capable of commercializing the patents or results, will be given the rights to license the patents under contract and to pay the agency not less than 1 per cent of the gross sales of products per annum for a certain period of time. One example of this Government and private-industry joint venture is the integrated processing of the coconut pilot-project of NIST. The researchers/inventors will be given a share of the royalty to be derived.

56. Technical consultation services are part of the activities of Philippine research agencies. Each office also maintains publication and information units. NIST publishes the well-known Philippine Journal of Science and other scientific information media.

57. Early in 1963 NSDB organized nine regional science promotion offices. These offices are manned by field extension personnel who disseminate the results of research projects, give demonstrations and promote science consciousness in the rural areas. In the international scene, it has established foreign stations in and detailed science attachés to Washington, D.C., United States of America; Bonn, Federal Republic of Germany; and Tokyo, Japan.

I. Technical assistance received

58. The Philippines, as a Member of the United Nations and its specialized agencies, has availed itself of foreign technical assistance, mainly in the form of equipment, expert services and study or training fellowship grants in the various disciplines of science. The country has to resort to this assistance to augment the limited funds allocated for industrial research and foreign training, in order to modernize its research and development facilities and to upgrade the professional background and skills of its researchers.

59. Most of the foreign technical assistance which the research agencies initiate and request through the Philippine National Economic Council is obtained under the aegis of the Colombo Plan, the United States of America Agency for International Development, the Food and Agricultural Organization, the United Nations Educational, Scientific and Cultural Organization, the World Health Organization, the United Nations Children's Fund and the International Atomic Energy Association; and from the Governments of such friendly countries as the Federal Republic of Germany, India and Israel, among others. The Philippines research reactor was given to the Philippine Government through a bilateral agreement with the Government of the United States of America. In many instances, the Philippine Government provides counterpart funds for these foreign aids and for foreign-assisted research projects.

[illegible]. The universal concept of science, now [illegible] various United Nations specialized agencies [illegible] in broader perspective and in a spirit of [illegible] the developed and developing countries of the world. It is [illegible] tangible exchange of scientific knowledge and resources, through [illegible] seminars like this one and through technical assistance given by the [illegible] countries to the less developed, has a long-range impact upon [illegible] progress.

XX. INDUSTRIAL RESEARCH AND DEVELOPMENT IN THAILAND

Prepared by Charlio Surasiti*

1. Though industry and research are not new to Thailand, their developments have been practically independent of one another. In recent years, hundreds of factories have been built, many of them using imported capital and technology. At the same time there have been more laboratories carrying out research with but little attention to industrial applications. Several industries have begun to realize, however, that without modification imported technology is not always suitable to local conditions. They face numerous technical problems that can be solved only by research carried out locally. Many times they seek the assistance of foreign experts only to find out later that those experts can be of little help. Yet only few industries ever turn to research. Some research scientists also have had problems of their own. Believing that no fundamental research is worth doing in a developing country, they have selected topics based on their industrial applications. So far, however, most of their works have not been put into actual use. For these and other reasons, industrial research and development in Thailand are still in their initial stages. Undoubtedly they will survive, but the question is how fast they will grow. To obtain the answer to this question, one should first examine the matter more closely.

A. National industrial research policy

2. It is not very easy to find out what a governmental scientific research policy is meant to be. The State finances the education of scientists and several laboratories in which some research projects have been conducted. However, the effort to improve the competency of science graduates and the productivity of those laboratories has not been clearly seen, although the incompetency of science graduates and the non-productiveness of various government laboratories are important obstacles to the progress of scientific research.

3. There is little fundamental research in progress in the universities. Only one out of the existing seven universities offers graduate courses in the sciences. Most graduate students are employees of the Government who have permission to take courses on a part-time basis. They carry out fundamental research to fulfil a requirement for their Master's Degrees. Other than this, there are virtually no research projects carried out by the university staff themselves. Reasons for the lack of research activity in the universities are numerous. It begins with science as a career being less attractive when compared with medicine and engineering. Only in an exceptional case will a very good student major in science. As a result, first-rate scientists are rare. The second reason is the lack of incentives for the scientists. Unlike those in many other countries, the universities in Thailand do not award promotions to their staffs on their scientific achievement. The scarcity of facilities for research is also an equally important reason for the lack of scientific activity among the staffs.

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* Ministry of Industry, Department of Science, Research Division; Bangkok, Thailand.

4. Applied research is usually carried out in the laboratories of governmental departments. There have been only a few scientific achievements resulting from the research efforts of these laboratories, despite the large sum of money allocated for equipment and supplies. Several reasons may be given. The most important is that all the laboratories operated by the various government departments face a serious shortage of adequately trained personnel. There are very few scientists with research qualifications working in the laboratories. The others would rather do routine work than research, because they do not find it pays to put in special effort to overcome the various difficulties normally encountered in research, while they can get the same promotion doing simpler routine work.

5. Choosing research topics is another problem that the government laboratories should reconsider. Very often the finished works remain useless, because they are not significant enough for publication, or practical enough to be used in the industry. The lack of collaboration between various departments has resulted in duplication of work as well as expensive equipment. Many of the instruments kept by the various departments are now inoperative owing to the lack of spare parts or of proper maintenance.

6. To improve the situation, Thailand established the National Research Council in 1956. In 1959, the scope of the Council's activities were broadened. The present National Research Council has the Prime Minister as the President, and according to the National Research Council Act B.E. 2502 (1959), the Council has the following functions:

(a) To make recommendations to the Council of Ministers on national policies and programmes relating to research;

(b) To establish and support research groups and institutes in accordance with instructions from the Council of Ministers;

(c) To co-ordinate research activities in various branches of science;

(d) To promote and support public and private research;

(e) To register investigators and scholars who are engaged in various branches of science;

(f) To establish additional divisions of the Council;

(g) To assign investigators to work on research projects;

(h) To suggest ways and means for financing research;

(i) To make grants and awards in support of research;

(j) To co-operate with other countries in research;

(k) To submit an annual report to the Council of Ministers.

7. The National Research Council may obtain the following income for grants and awards in support of research:

(a) Government allocation;

(b) Fees charged by the Council;

(c) Interest on investments and other income from property under the control of the Council;

(d) Gifts from various sources.

8. Since its establishment, the National Research Council has carried out several primary projects, including a survey of research works in Thailand, the compilation of a register of scientific and technical personnel and a survey of the scientific equipment available in the country. The Council has given research grants to university professors, as well as several graduate fellowships to individual graduate students.

9. With regard to research policies, the National Research Council still leaves much to the various departments themselves. The Council has not been able to exercise any control. It was then recommended that the Council be made into a body which could undertake scientific research and investigation by itself.

10. The major scientific research activities of the Council were to be carried out through three research institutes yet to be established: an agricultural research institute, a medical research institute and a scientific and industrial research institute. Facilities for these three institutes were to be transferred from various departments. These recommendations were strongly opposed; they were therefore replaced by new proposals.

11. Following the new recommendations of a United Nations expert, an Applied Scientific Research Corporation has been established instead of changing the structure of the National Research Council. If completed as planned, the activities of the Corporation will be grouped into:

(a) A technological research institute;

(b) An agricultural research institute;

(c) A medical research institute;

(d) Other auxiliary groups, including a documentation centre, a national standards laboratory, and an instruments repair and calibration centre.

12. The Corporation is currently concerned mainly with the building up of the research facilities and staff of the Technological Research Institute. The details on the proposed scope and operation of the Institute are given elsewhere.

13. As can be seen from the foregoing discussion, the Government has made certain efforts to improve the atmosphere for the development of applied scientific research through the establishment of a new organization. What the outcome will be remains to be seen. As the matter now stands, the situation seems to be too complicated to be solved by this or any other means in a short period of time.

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14. The creation of industrial-research ... is long overdue. Even large undertakings, such as cement factories, ... ries, paper mills, sugar factories, breweries and ... engage in scientific research, though there is much ... research. Each industry has its own reasons for not ... Some industries are doing so well that they ... not reduce the price of their products. Some industries survive because of subsidy or monopoly. There is no need for them to do anything besides ... the management and cutting production costs blindly. As a matter of fact, ... industrialists do not realize what research could offer. Among those who ... something about research, the belief is still held that young economies cannot afford the "luxury" of research. This seems to be quite natural. First, most top managements in those industries know little about science or scientific research. If they finance a research project, a favourable result must be attained in a short time; otherwise, the project will be considered a failure.

15. Scientists and various government laboratories have helped to create this unfortunate attitude. Not only have they achieved slight success in their research projects, but they also have made few of their findings known to the public. Furthermore, many research projects have nothing useful to offer to the existing industries that can be appreciated by those industrialists.

16. Few incentives to research, e.g. exemptions, subsidies or grants, have been offered by the Government. Tax exemption for this purpose is not granted. A number of research grants and fellowships are given to professors and students, as already mentioned, but there are certainly not enough of these to promote the proper incentive needed in research.

B. Industrial research establishments

17. Currently, there are no institutions responsible solely for industrial research. The newly established Technological Research Institute of the Applied Scientific Research Corporation of Thailand and the Department of Science of the Ministry of Industry are supposed to deal with industrial research more than any other institutions.

18. The Technological Research Institute is now busy building up research facilities and recruiting scientists with research qualifications. In this early stage of development, the Institute faces so many difficulties that some changes have to be made in the original plan. It is therefore impossible to include in this report the evaluation of its present roles or the details of its ultimate management, function and scope.

Department of Science

19. Although the Department of Science does not devote itself entirely to industrial research, it has been successful in a number of industrial research projects. A number of industries are now making use of its findings.

20. The Department of Science is one of four departments of the Ministry of Industry. It is situated at Rama VI Road in Bangkok. The Department of Science had its origin in 1891 as a small laboratory of the Department of Mines and ... It was transferred to the Royal Mint in 1903. Over the years the laboratory widened its functions and finally became the Department of Science in ...

21. The Department, which is under the control of a Director-General, currently consists of six divisions which are further subdivided into sections: (a) Secretary's Office; (b) Division of Chemistry; (c) Division of Biological Science; (d) Division of Physics and Engineering; (e) Division of Analytical Chemistry Training; (f) Division of Research.

22. The functions of the Department of Science are specified as:

(a) To serve as the Government's central laboratory and a scientific centre to satisfy all governmental requirements in technical matters;

(b) To assist general public and private industries in technical matters, including analysis, technical information and consulting services;

(c) To certify locally manufactured products so as to promote their popularity;

(d) To control the quality of foods and beverages for taxation purpose and for the public welfare;

(e) To train scientific personnel in analytical chemistry to satisfy the Department's own need and those of the Government and private agencies.

23. Since its establishment, the Department has finished several industrial research projects, for example:

(a) The development of an alum production process;

(b) Quick processes for the manufacture of fish sauce and vinegar;

(c) Fruit-juice concentrates and preservation of food;

(d) Oils and fats, including rice-bran and kapok-seed oils;

(e) The preparation of special glue and starch paste;

(f) Drying oils;

(g) Raw materials for ceramics wares;

(h) Paper pulp from various sources, including rice-straw and bagasse;

(i) A water-repellent used in shaving-board production;

(j) The improvement of the quality of solar salt.

24. In the past few years, the Department has increased its capability to serve the public and industries. Several necessary instruments, such as an infra-red spectrophotometer, a gas chromatograph and a polarograph, have been acquired. The major portion of the Material Section of the Division of Physics and Engineering, which has been testing Portland cement for sometime is now in the process of installing several material-testing instruments. Installation of food-processing equipment is also in progress in the Division of Biological Science. When completed, the equipment will be used for research in food processing on a pilot-plant scale.

[illegible]. With these increased facilities and capability, it is felt that the Department of Science should be able to serve industry better than it [illegible] now. [illegible] is under study as a result of the National Economic Development Board's [illegible]. The Board has made three recommendations concerning the Department of Science:

(a) New and expanded activities of the Department of Science should be related to industrial development and should be of assistance to industrial enterprises;

(b) The Department of Science should design a programme to expand such service functions as testing and certification to industrial establishments;

(c) Specific projects of an applied research nature should be continued in the Department of Science and should be related to industrial requirements to the extent feasible.

C. Aspects of financing

26. All research expenses of the Department of Science are included in the annual budget appropriated for the Department by the Government. The Department does earn certain fees charged to private bodies for services, but all these earnings must be handed over to the Ministry of Finance. Occasionally, the Department's research workers receive small sums of money as an award from the industry which makes use of their works. Other institutions have considered the possibility of carrying out research by contract. It is doubtful that this idea will be practicable in the near future. The reasons for this are the same as those explaining the lack of interest in industrial research among industrialists.

D. Staffing

27. Staffing is a serious problem that the Department of Science and other scientific institutions have to face. Relatively few of those who graduate in science have the ability to conduct satisfactory research work. Those who have research qualifications are usually foreign-trained graduates with higher degrees. The Department of Science has a number of such scientists. Unfortunately, most of them are engaged in administrative work. This is because the general environment is not attractive enough to keep them in the tedious activities of research. Therefore, it is not unusual that some scientists in Thailand have never become involved in any research work other than that required for their degrees. Another reason is that the civil service promotion system is planned in such a way that the best staff members must usually be transferred to administrative posts in order to have opportunities for advancement. It is true that in their administrative posts, they have little time to spare for doing research work themselves. But though it would mean harder work, it surely might be possible for them to lead a few research projects.

28. It is generally believed that the scientists' low incomes are responsible for their lack of incentive to do research. This belief may disappear in the near future. The unfavourable financial status of scientists does keep students from choosing science as a career, if they are qualified for other courses. The scientists themselves, however, do not consider money their one and only goal.

[illegible] has been trying to [illegible] scientists to serve on its research staff by paying as much as three to four times what they now earn; thus far none of the scientists who already have secure positions, although with only small incomes, have been attracted. It may be, of course, that they do not like research work at all in any circumstances.

29. Most research scientists are government officials. Like those of other civil servants, their salaries are based upon their qualifications, positions and the number of years in the service. On the average, they earn about one-half to one-third of what they could earn by working for private concerns or industries. With some exceptions, these scientists live fairly well on their earnings but, of course, they cannot afford much luxury.

30. Technical training programmes beyond the undergraduate level are very rare. Some lectures on the various aspects of sciences are given from time to time. Usually the scientists take their refresher courses abroad under various foreign-aid projects.

E. The application of results of industrial research

31. The results of industrial research undertaken by the Department of Science are made available at all times to anyone who wishes to make use of them. The Department sometimes even provides the necessary training for the personnel of private bodies who wish to utilize the Department's findings. In many cases, the extension service is made through the Department of Industrial Promotion or other appropriate departments of the Government.

32. The industry may acquire general technical information from the library of the Department of Science, which is the largest technical library in Thailand. The services of this library have proved invaluable to industries, as well as to other governmental and private organizations. The compilation of bibliographies, the search for the answer to a particular technical question and the procurement of publications are normal services of the library. Occasionally the library obtains assistance from research scientists of the Department in providing such services.

33. As to the publication of the Department's own works, there are two reports: one issued annually and the other quarterly. In these reports, brief discussions of the Department's works are presented. The public, if interested, may request more details of the works reported.

F. Technical assistance received

34. Thus far, Thailand has received little technical assistance in industry or in industrial research from international organizations. The only sizable aid known is that given recently to the Applied Scientific Research Corporation of Thailand by the United Nations Special Fund.

G. Conclusions and recommendations

35. In conclusion, it can be rightly said that industrial research and development in Thailand are still in their early stages. The serious difficulties to be faced are the lack of a well-trained staff and of the selection of research topics, as

well as the non-recognition of the importance [illegible].
If these obstacles are not removed industrial research [illegible]
will remain in its initial stage for a long time.

56. As a solution, the writer wishes to make the following recommendations:

(a) Any institution engaged in industrial research [illegible]
should select a research topic in such a way as to be of immediate [illegible]
existing industry, rather than to an industry yet to be developed;

(b) Industrialists should be induced to appreciate industrial research by
an offer to solve their problems free-of-charge initially. The benefit they
would receive from the research work would eventually convince them of the
importance of research to industry;

(c) As long as industrial research is in the hands of government
organizations, all efforts should be made to encourage those persons who earn
their living as research scientists.

XXI. INDUSTRIAL RESEARCH AND DEVELOPMENT IN SINGAPORE[1]

Prepared by Ai-Kim Kiang*

Preface

With the encouragement of the Director of the Economic Development Board, the author applied for participation in this United Nations Inter-Regional Seminar. As he is an organic chemist with interest in phytochemistry, this report deals rather with the scientific and technological aspects than with the social and economic.

Working in a university situated in Singapore, the author has the privilege of coming in contact with a large number of people concerned with the industrial development of Singapore and with many of the experts who come either on survey missions or to work for Singapore. Many of the chemistry graduates of the University are, and more will be, working in industry. Hence his interest in industrial development and research. This report has been made possible mainly through discussions with various officials of the Economic Development Board, as well as through reading publications and news items, especially obtained from the Board.

The author has also been following with interest the industrial development and the various research activities in Malaya, through occasional travels to the mainland and contacts with Malaysian scientists who have formed the Malaysian Scientific Association. However, his knowledge of the industrial development and research organizations in Malaya is rather too meagre to warrant making a full report, and of those in the Borneo Territories is even less. Hence, no attempt is mad to cover the activities in these areas, although a brief mention of the activities in Malaya is made in the concluding section in the hope that they may be of interest to some participants at the Seminar.

A. Industrialization policy of the State of Singapore - economic planning and industrial development

State of Singapore Development Plan 1961-1964[1]

1. With the attainment of self-government in 1959, the Government of Singapore applied itself to the task of a planned economic development of the State and its resources. An economic development division was set up in the Ministry of Finance under Dr. Goh Keng Swee, Minister of Finance, and its first task was to draw up a plan of development to solve some of the problems that faced and would be facing Singapore. A careful analysis of the problems and detailed proposals for development projects and expenditures were made and incorporated in the State of Singapore Development Plan 1961-1964. 2/

* Chemistry Department, University of Singapore.

1/ Now the independent State of Singapore.

2/ State of Singapore, Ministry of Finance, State of Singapore Development Plan 1961-1964 (Singapore, Government Printing Office, 1961).

2. Some of the most significant findings are:

(a) Most of the problems facing Singapore [illegible] population growth.

(b) *Entrepôt* trade, associated with [illegible] possibilities of expansion;

(c) There is probably a considerable amount [illegible] be canalized into industrial development. Commercial capital, however, [illegible] easily adaptable to industrial investments without deliberate measures of inducement by the Government. Besides legislative measures, there would have to be an organization for industrial financing and the provision of technical know-how.

United Nations Mission - Survey of industrial potentials

3. While the Plan was being formulated, a United Nations Technical Assistance Board Mission under Dr. A. Winsemius was requested to visit Singapore in 1960 to help survey the industrial potentials. The mission estimated that by 1970 a total of 214,000 new jobs would have to be created to achieve full employment. Out of these, 98,000 jobs would have to be found in the industrial section. A total investment of the order of $800 million was suggested over the ten-year period, as it was estimated that the investment capital necessary to create one primary job in manufacturing industries was $12,000, and for one in serving industries, $6,000. The mission's report (1961) contains an impressive list of industries considered viable in Singapore and recommends basic market research in each.

United Nations Mission - Feasibility of iron and steel mill

4. At the same time another UNTAB team was invited to investigate and report on the feasibility of an iron and steel mill in Singapore. The report (1961) was very favourable. The head of the mission was quoted as saying: "Singapore has a lot of privileged advantages; its fantastic geographic location, an educated, cultured and hard-working population and great trading experience... A basic industry such as iron and steel plant would have far-reaching effects on Singapore's economy by the ancillary industries which would spring up with it." 3/

Proposed capital development expenditure by the Government

5. As Singapore will continue to be very greatly dependent on international trade, the Development Plan recognized that a great deal of future industrialization would have to be left to private enterprise, both local and foreign. The Government's task in the Plan was mainly to create a favourable investment climate and a basic industrial infra-structure. The Plan was therefore only concerned with capital development expenditure in the public sector and contemplated a total investment of $871,020,000 for the four-year period as follows:

(a) Economic development, $507,0[illegible]5,000 ([illegible] per cent)

(b) Social development, $34[illegible],[illegible]80,000 (40.[illegible] per cent)

3/ Peter Absalom, "Singapore Steel Makes its Debut", [illegible], pp. 14-23 and 41.

(e) Public administration, $13,1[illegible]0,000 (1.51 per cent).

6. The estimates under economic development were subdivided into the following main categories:

(a) Land and agricultural development, $53,270,000;

(b) Industry and commerce, $337,360,000;

(c) Transport and communications, $117,320,000.

Economic Development Board

7. It may be seen that the greatest amount would be spent on economic development. In order to guide and stimulate existing industries and attract new ones, and to show the Government's earnest desire to promote rapid industrialization, the former Singapore Industrial Promotion Board (formed in 1957 with a capital of $M1 million) was replaced in August 1961 by the Economic Development Board with a capital of $M100 million (over three years).

8. The Economic Development Board (whose first and current chairman is Mr. Hon Sui Sen, a graduate of Raffles College and a former civil servant) is an autonomous body directly responsible to the Minister of Finance. It is endowed with wide powers: (a) to provide financial assistance by loans or participation in the equity capital of new industries; (b) to assume responsibility for the active promotion of industrial investment, both at home and abroad, the provision of technical assistance, and the undertaking of feasibility studies for prospective industrialists; (c) to assume responsibility for the over-all planning and execution of schemes to provide facilities to industrialists in the form of industrial estates with all the requisite services; and (d) to administer certain ordinances, e.g. the Pioneer Industries (Five Years' Income Tax Relief) Ordinance 1959 and the Control of Manufacture Ordinance. The organization and functions of the Board are further outlined below; it may be seen that it is a huge development institute with functions involving industrial research.

9. The Board's first and current Chairman, Mr. Hon Sui Sen, is a graduate of Raffles College and a former civil servant. Its Director is Mr. Lim Ho Hup. The Board's divisions and their respective functions are as follows:

(a) Secretariat;

(b) Finance, which is responsible for:

(i) Management of board funds;

(ii) Budgeting;

(iii) Accounting;

(iv) Loan negotiations, financial analysis, credit-worthiness, disbursement and management,

(v) Equity participation;

(c) Projects, responsible for:

(i) Board projects, e.g. industry information [illegible] studies;

(ii) Evaluation of loans, pioneer applications and [illegible];

(iii) Control of manufacturers ordinance;

(d) Technical information service, including the:

(i) Industrial research unit;

(ii) Light industries services unit;

(iii) Standards unit;

(iv) Industrial design;

(v) Management training programme;

(vi) Library and documentation and technical information;

(e) Civil engineering, responsible for:

(i) Jurong project;

(ii) Port facilities;

(iii) Standard factory buildings, "flatted" factories;

(iv) Board civil engineering projects;

(v) General engineering requirements;

(vi) Engineering survey;

(f) Lands, survey and planning, whose duties include:

(i) Inspection and mapping;

(ii) Planning;

(iii) Layout;

(iv) Survey;

(v) Site allocation;

(vi) Estate management;

(g) Investment promotion, which is responsible for:

(i) Home promotion;

(ii) Foreign promotion;

(iii) Publications;

(iv) Visitors.

B. Progress of the 1961-1964 Development Plan

10. A review of progress for the three years ending 31 December 1963 has been carried out by an economic planning unit, now set up under the Prime Minister. 4/ This unit has as its planning adviser, Dr. C.R. Krishnamoorthy, an officer of the Indian Administrative Service seconded to the Singapore Government under the Colombo Plan. It is already drawing up the State's Second Development Plan.

11. A number of changes have necessarily been made in the original schmes. The result of these changes has been a net increase in the size of the Plan for the four years by $184,340,000 as shown below:

Table 1

Increases in 1961-1964 Development Plan
(in dollars)

	Sector	Original provision	Revised provision	Increased provision
I.	Economic development	510,160,000	594,090,000	83,930,000
II.	Social development	348,120,000	445,290,000	97,170,000
III.	Public administration	12,740,000	15,980,000	3,240,000
	Grand total	871,020,000	1,055,360,000	184,340,000

12. The actual expenditures for the first three years' operation of the Plan are as follows:

Table 2

Expenditures during first three years of 1961-1964 Plan

	Sector	Plan provision (in dollars)	Actual expenditure (in dollars)	Performance percentage
I.	Economic development	381,[illegible]40,000	286,030,000	74.9
II.	Social development	258,400,000	184,110,000	71.3
III.	Public administration	10,680,000	10,180,000	95.3

4/ State of Singapore, Prime Minister's Office, Economic Planning Unit, First Development Plan 1961-1964, Review of Progress for the Three Years Ending December 1963 (Singapore, Government Printing Office, 1964).

13. In the economic development sector, the progress of expenditure of the schemes under industrial development for the years 1961-1965 is shown below:

Table 3

Expenditures in economic development sector, 1961-1965

Scheme	Plan provision (in dollars)	Actual expenditure (in dollars)	Percentage
Economic Development Board	80,000,000	80,000,000	100.0
Kallange Project	25,000,000	20,000	0.1
Jurong Project	30,000,000	32,350,000	107.8
Land acquisition and other development costs for industrialization	5,600,000	5,280,000	94.3
Electricity	55,620,000	67,450,000	121.3
Water	40,280,000	18,410,000	45.7
Gas	10,180,000	8,400,000	82.5
Total	246,680,000	211,910,000	85.9

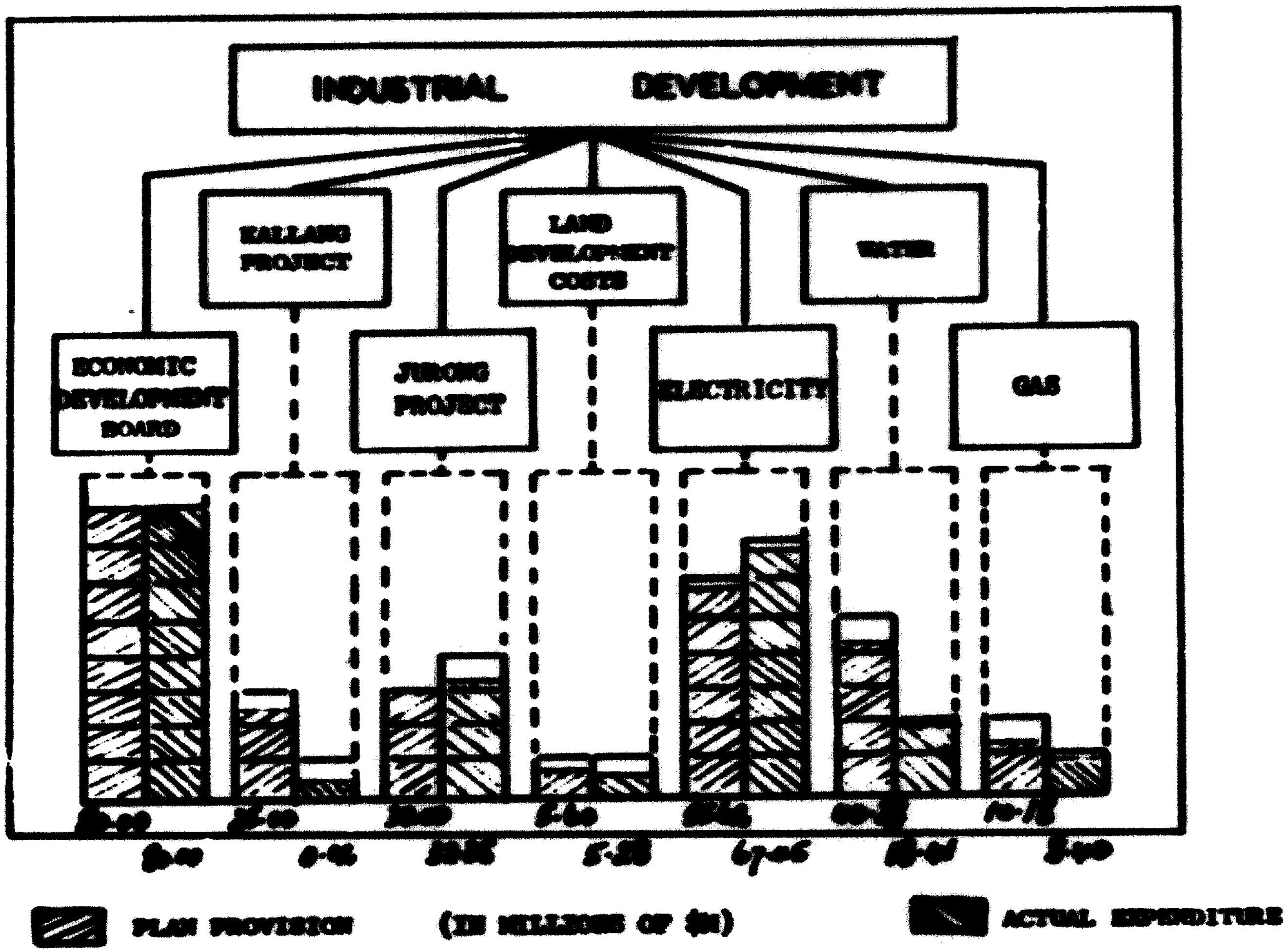
Electrical power

14. It is not possible to discuss all the achievements under industrial development. Some of the achievements and manifold activities under the Economic Development Board are best described in another section.

15. It will be of interest to look at the expenditure under electricity as the amount of electrification is a good index of industrial activity. According to the "Review of Progress", the tempo in the plan for industrialization and the consequent growing demand for power far in excess of the original expectations necessitated the increase of the total 1961-1964 provision from $78.5 million to $143,040,000. 4/ The generating capacity has increased from 152 megawatts in 1961 to 177 megawatts in 1962 and to 224.5 megawatts in 1963, being supplied by Pasir Panjang Power-Station A (202 megawatts) and by St. James Power-Station (22.5 megawatts). The first phase of the construction of two of four generators of 60 megawatts each has started at Pasir Panjang B, so that the total generating capacity at the end of 1965 is expected to be 344.5 megawatts.

FIGURE I - CHART

INDUSTRIAL DEVELOPMENT, 1961-[illegible] PERFORMANCE



C. Projects of the Economic Development Board

16. The formation of the Economic Development Board in 1961 with [illegible] of $100 million provided by Government with the main aim of promoting the establishment of new industries and the Board's main functions [illegible] above.

17. The members of the Board comprise a full-time chairman, a director, the chairman of the Singapore Housing and Development Board and representatives of banking, manufacturing, commercial, labour, and professional and academic interests. The Board has a staff of economists and accountants, engineers and industrial technologists, surveyors, designers and research personnel, recruited locally and abroad, including United Nations, International Labour Organisation (ILO) and Colombo Plan (CP) advisers.

18. The organization and functions of the Board are summarized in the foregoing section. There is a great deal of liaison between the various divisions of the Board and government departments, other public and statutory bodies, e.g. the Public Works Department, the Public Utilities Board, the banking and other commercial communities, the universities and colleges, etc.

19. The activities of the Board up to 1962 have been reviewed 5/ and the annual report for 1963 is being completed.

20. Some of the more significant activities and achievements, based on the author's conversations with a few officials of the Board and a considerable amount of literature kindly made available to him by the Board, including some copies of press releases, are described below.

Staffing

21. A rough idea of the expansion of activities of the Board for 1961/63 may be obtained by studying its staffing during this period, shown below:

Table 4

Number and allocation of personnel of Economic Development Board, 1961-1963

	1961	1962	1963
Senior officers (local)	10	23	[illegible]
Senior officers (expatriate)	3	3	3
Senior officers (United Nations) a/	1	1	1
Senior officers (TAB)	-	5	6
Senior officers (ILO)	-	-	2
Senior officers (CP)	-	2	2
Junior officers	35	65	[illegible]
Subordinate division officers	4	15	25
Daily rated	29	[illegible]	[illegible]

a/ Programme for the Provision of Operational, Executive and Administrative Personnel (OPEX).

5/ State of Singapore, Economic Development Board, Annual Report, 1962 (Singapore: Malaya Publishing House, 1963).

Granting of pioneer certificates

22. The first certificate was issued to Shell Refining Company on 24 September 1960. The refinery in Pulau Bukom was completed in record time and has just celebrated its third birthday. Up to the end of 1963, 113 pioneer firms were issued 119 pioneer certificates. The total estimated authorized capital is $650.7 million and the subscribed capital is $225.4, local capital amounting to 69 per cent. The firms will provide 8,851 jobs at initial production and 18,800 jobs at full production. Some details of pioneer firms are given in table 5. At the end of June 1964, twenty-nine pioneer firms had commenced production and another twenty-five were due to commence operations by the end of the year.

23. In addition to the pioneer firms, a number of non-pioneer factories have also been opened.

<u>Table 5</u>

Some details of pioneer firms

Industry group	Pioneer firms	Estimated authorized capital	Estimated subscribed capital	Estimated direct employment (Number of persons) Initial Production	At full production	Estimated annual output
	(number)	(in millions of dollars)				(in millions of dollars)
1. Building	9	29.6	16.0	672	730	37.3
2. Chemical	27	156.9	74.6	1,766	2,674	261.5
3. Electrical	8	18.5	3.8	297	525	3.3
4. Food	15	115.0	30.8	1,037	1,558	108.6
5. Leather and leather manufactures	1	1.0	0.6	90	265	n.a.
6. Mechanical and metal working	22	183.5	52.8	1,489	2,889	54.3
7. Rubber products	3	23.0	10.8	457	597	10.7
8. Textiles	23	56.7	22.9	2,250	7,895	66.8
9. Wood and paper products	5	66.5	8.1	793	867	8.0
Total, all industry groups	113	650.7	225.4	8,851	18,000	550.5

<u>Source</u>: Economic Development Board.

The National Iron and Steel Mills Ltd.

24. An illustration of the great speed at which new factories are set up is the opening of the mills of the above company. Following the favourable United Nations report in June, the firm was formed in August 1961 with a subscribed capital of $50 million, 80 per cent of which was contributed by local entrepreneurs and 20 per cent by the Economic Development Board. The opening of the mills was performed by Dr. Goh Keng Swee, the Minister of Finance, in January 1964 and the factory began full production, with the expected output of 50,000 tons of steel ingots in 1964 and 60,000 tons in 1965. With the installation of a second furnace the output is expected to be 120,000 tons per annum. The rolling mill has an annual capacity of 100,000 tons and the re-rolling mill, 50,000 tons. A brief history of the development of the factory is given in Annex I.

Industrial estates - Jurong Industrial Estate

25. The Economic Development Board, through the development of estates provided with industrial facilities and utilities, also aims to provide fully serviced factory sites and even complete standard factory and flatted factory buildings.

26. The largest project is the Jurong Industrial Estate. The Jurong area situated in the south-west corner of Singapore island was, only a few years ago, covered with hilly jungle and mangrove swamps. In the Singapore Master Plan, 1957 the Government had reserved this area to be developed as one of the industrial sites. Following the visit of a team of Japanese site engineers in 1959 and of the United Nations Mission to survey industrial potential in 1960, it was at first proposed to develop this area into a 9,000-acre new town, including an industrial estate of 1,500 acres. Soon after the beginning of the development, the plan was revised to a 15,000-acre new town for a population of 500,000 and an industrial estate of 3,000 acres. The industrial estate embraces a part of the eastern half of the Jurong New Town and will be the largest industrial estate in South-East Asia. The area of 3,000 acres is zoned as follows: light industry, 415 acres; heavy and general industry, 1,450 acres; residential, 191 acres; reserves, 359 acres; war department land, 164 acres; roads, canals, drains and railway, 422 acres. It will have a harbour for handling industrial cargo and an eight-mile railway line linking it with Malaya.

27. An interesting and informative account of the Jurong development by Andrew Nathan appears in the Far Eastern Economic Review, 1964. 6/ Mr. Hon Sui Sen, chairman of the Economic Development Board, at a press conference held in June this year, gave the following information on the progress of the Jurong Industrial Estate:

(a) Since the first bulldozer had moved into Jurong in September 1961, 17 million cubic yards of earth had been excavated and used to prepare 1,500 acres of land at Jurong. In the process, sixteen hills had been levelled and another seven hills were being flattened;

(b) Eleven miles of road had been metalled and surfaced and another five miles were nearing completion;

6/ Andrew Nathan, "The Jurong Story", Far East Economic Review, vol. XIL, Supplement, 1964, pp. [illegible].

(c) The total area prepared as of that [illegible] 50 acres had been allocated to industry;

(d) Nine factories were in operation and twenty-[illegible] to be in production by the end of the year or in early [illegible];

(e) The thirty-eight factories would provide employment for about 7,200 persons in 1964. As more and more factories went into production, this figure would increase to 15,000 in 1965 and [illegible] by the end of [illegible];

(f) A 66-kilovolt substation had been built and another one was being built;

(g) Industrial water had originally been planned to be provided at [illegible] million gallons a day by damming of the middle reaches of the Jurong River. This amount was later considered inadequate and the Board had issued tenders for a $9.8 million plant to purify effluent water from the Ulu Pandan sewerage works. It was expected that this project might be completed at the end of [illegible] and would provide 10 million gallons of industrial water per day, with a possible increase of capacity to 20 million gallons per day.

(h) Railway: initial earth works were completed, and the construction of seven bridges and five tunnels involved in the eight-mile railway from Bukit Timah to Jurong was well in hand. The first train to Jurong was expected in early 1965.

(i) Wharves: the plan had been to develop the deep-water facilities available in Jurong for the construction of a 9,000-foot deep-water wharf and a 3,000-foot lighter wharf. The first stage of the wharf construction, consisting of 3,000 feet of the deep-water wharf and 2,000 feet of the lighter wharf, would be completed at a cost of $16 million before the end of the year;

(j) Housing: 221 units of houses and shops had been completed in 1963. Another 1,200 units were nearing completion. A primary school would be ready for occupation in early 1965.

Industrial estates - others

28. Singapore's Kallang Basin is being reclaimed at the rate of one-third of an acre a day, and this area will be another industrial estate second only to Jurong in size and importance. Six million tons of earth are being transferred from Toa Payoh to this area, which is going to be another satellite town. The Kallang Basin will contain 300 acres for labour-intensive industries employing 100,000, and 100 acres for the building of 150,000 units of flats.

29. Other industrial estates (approximate areas in parentheses) that have been developed are as follows: Tanglin Halt (thirty); Tanjong Rhu (six) and Kallang marine industrial estate for boat building and repairs (twenty).

30. The Board, in conjunction with the Housing and Development Board and a private company, has also been engaged in the development of a number of smaller industrial estates at Bukit Timah, Alexandra Road, Redhill, Bendeemer Road and Kampong Ampat.

D. Economic Development Board - Technical Consultant Services Division

31. The objective of the Technical Consultant Services Division is to help industry to achieve maximum productive efficiency. The services are provided through the following sections or agencies:

(a) Industrial research unit;

(b) Standards unit;

(c) Light industries services;

(d) Management development and consulting unit;

(e) Industrial design;

(f) Technical information service.

Industrial research unit

32. Mr. T.R. Pollard, Director of the Industrial Research Department at the University of Canterbury, New Zealand, was responsible for the idea and planning of the unit. He came to Singapore in 1960 on a Colombo Plan assignment and recommended the establishment of the unit along the lines of his unit in Canterbury. To this unit, the New Zealand Government made a generous contribution of $370,000 in essential research and testing apparatus and provided the services of two engineers from New Zealand to act as director and deputy director during the early years of the unit's operation.

33. The unit, which was officially opened by Dr. Goh on 16 May 1963, is situated in the new Workshop Block of the Polytechnic, in an area of 12,000 square feet.

34. The unit aims to render a wide variety of services:

(a) It will help in the introduction, development and adaptation to local conditions of new processes and methods;

(b) It will undertake research into locally available materials with a view to discovering new applications, as well as improving current applications;

(c) It will help in the transfer of laboratory processes to industrial purposes by undertaking pilot-plant operations or otherwise;

(d) It will undertake for local factories the testing of their raw materials and finished products to ensure that the right quality is being achieved;

(e) It will help in the maintenance of accurate standards;

(f) It will undertake to service a wide range of complicated optical, mechanical, electrical and electronic instruments for Singapore's more sophisticated industries;

(g) It will act as a repository [illegible] science and technology in various part[illegible].

[illegible]. The main sections of the unit are: (a) electrical and [illegible]; (b) mechanical engineering; (c) chemical engineering; (d) [illegible]; (e) instrument repair and adjustment; and (f) administration and [illegible].

[illegible]. The present senior staff includes a director, Mr. [illegible] (a civil engineer), a deputy director, Mr. F.D. Roper (an electrical engineer), [illegible] mechanical engineers, one electric/electronic engineer, one chemical engineer, three chemists, one physicist and one instrument technician.

57. The unit has been strongly biased towards engineering. With increasing demands for chemical testing and for developmental research, especially from the Economic Development Board, the chemistry section has been strengthened. An industrial chemist from Taiwan, Mr. Huang Tat Ho, has been seconded to the unit to help plan, organize and co-ordinate research work in the chemical sections.

58. Since its establishment, the unit has already undertaken a large number of jobs for industry, government departments and statutory bodies.

59. Some of the projects done or in progress are given below:

(a) **Instruments:** Testing, repairing and calibration of universal and conductivity bridges, a barometer, radiation dose-rate meter and various electrical and electronic test instruments;

(b) **Electrical:**

(i) **Servicing and calibration:** analytical and test instruments, electronic spray gun and frequency standard;

(ii) **Consulting:** design and specifications modifications for a large industrial installation of electrical machinery and controls;

(iii) **Survey:** prospects and local competence for manufacture of television sets in Singapore, and estimate of future electrical demand in Jurong Industrial Estate.

(c) **Mechanical:**

(i) **Testing:** radiography of engineering structures and weld samples; tests to standard specifications of locally made plywood, flexural tests of pre-stressed concrete beams, hydraulic testing of plastic piping and dynamic balancing of high speed rotors and crank-shafts;

(ii) **Consulting:** design and specifications for two Malayan manufactures supplying pipes to Singapore.

(d) **Chemical:**

(i) **Analysis and preparation:** preparation of chemicals for cloud seeding for the Public Utilities Board, chemical analysis and firing tests on brick samples; chemical and physical tests on rigid PVC pipes, chemical and physical tests of local clay and analysis of Jurong river-water for use as industrial water;

(ii) Research: method developed for the estimation of traces of tin in iron ores; bleaching of rattan; use of rubber-seed oil and manufacture of ceramics from local clay:

(iii) Specification: survey of capacity and competence of local paint industry. A paint testing laboratory has been set up under a paint chemist, Mr. Ho Bo Lum, who was trained in a large local paint factory and who visited Israel and Europe to learn the testing methods employed. The laboratory will also test local and foreign paints. Mr. Ho and Dr. E. Markowicz of the Economic Development Board are now preparing an acceptance specification for decorative paints for use in Singapore.

Standards unit

40. Recognizing the importance of industrial standards, the Economic Development Board has now set up a standards unit under Dr. Cheng Poh Seng, a senior chemical engineer. The related testing and laboratory services required for setting up such standards and specifications are being carried out by the Industrial Research Unit. As mentioned above, standards work has already started on paint and varnish, with the assistance of Dr. E. Markowicz, a United Nations expert and on building materials. This will be followed by work on other important industrial commodities.

41. The preparation of standards and specifications involves costly and laborious processes. The Board has therefore contacted all standard organizations in the world in order to make use to the fullest extent of their experiences and research results. Most Governments and standards institutes have responded favourably to the request of the Board for technical co-operation. Standards have been received from Australia, Denmark, Japan, Pakistan and Switzerland.

Light industries services unit

42. A 1961 survey of existing industries showed that of some 2,300 factories, about [illegible] per cent were establishments employing less than ten workers each and 15 per cent were establishments employing between ten and twenty-five workers each. With the help of a mission from the International Labour Office, a comprehensive service programme was drawn up to cater for the special needs of the large number of small manufacturers. The light industries services unit, which has now been set up is being financed jointly by the Economic Development Board ($2.7 million) and the United Nations Special Fund ($1.6 million).

43. The unit was officially opened by Dr. Goh on 17 May 1964. It is temporarily housed next to the industrial research unit and will be moving to another building in River Valley Road.

44. According to Mr. Lan [illegible], the ILO project manager, the United Nations Special Fund will be used for: (a) providing experts; (b) funds for equipment, laboratories, workshops and machine shop; and (c) training scholarships for local personnel. An ILO extension adviser, Mr. Jacob Levitsky, has joined the staff and another expert in industrial engineering is being appointed. The rest of the staff is local. The services provided by the unit are discussed below.

Extension service

45. This provides advice and assistance to small industries on technical [illegible] such as methods and techniques, equipment, plant layout, production, product design, etc. Its activities include regular seminars, training courses in specific technical subjects, demonstration of machinery and techniques [illegible] and dissemination of information through bulletins and audio-visual means.

Loans service

46. A loan fund of $3 million created by the Economic Development Board is operated by the unit through local commercial banks. Loans are given to help small enterprises to modernize and expand provided these show good promise of development and growth. Priority is given to companies employing less than fifty workers and with fixed capital assets of less than $250,000.

Site planning service

47. This helps to find alternative sites in various light industrial areas and flatted factories for small enterprises which are expanding or are affected by the Government's urban renewal programme.

Economic planning and investigation service

48. To keep the small manufacturer abreast of current trends, the unit undertakes market surveys, growth potential and investment opportunities.

49. The unit is expected to be fully operational early next year, when more staff are recruited and trained, and machinery and equipment for demonstration workshops arrive. In the meantime, it has already undertaken surveys of a number of small industries, including electroplating, foundry work, tool and die making. Several industrial loans have been made.

50. Some courses including demonstration shops for upgrading the skill of workers have been planned. A workshop for woodworking accompanied by exhibition is planned, which will be held in the Singapore Vocational Institute, which possesses excellent equipment for this purpose. With the close collaboration of the unit, the formation of a trade association for woodworking is being actively studied.

51. The unit will have a food-testing laboratory which will be closely associated with the proposed food technology and research institute to be established in Malaya with possible United Nations Special Fund assistance. 7/ A workshop for the food industry is also being planned.

7/ Federation of Malaya, Ministry of Agriculture and Co-operatives, The Situation of Food Production and Consumption in Malaya, by A. Sedsky (Report series [illegible] Malayan food commodities, No. 1. Kuala Lumpur, 1962), p. 61.

Management development and consulting unit

52. Another step taken to help industry raise productivity is the training of managers. In conjunction with the Supervisory and Management Training Association of Singapore, the Singapore Manufacturers' Association, the University of Singapore, the Nanyang University, the Singapore Polytechnic and the Adult Education Board, the unit has run a series of courses on business and industrial management, most of which are held in the evenings. A Singapore Institute of Management is being set up.

Industrial design unit

53. Promotion of a high standard of product design, packaging and marketing techniques is encouraged and a product display and design centre will be established soon.

Technical information and document centre

54. A nucleus has been formed, and this is being expanded.

E. Training for industry

55. Considering that the industrialization programme began only in the last two or three years, the progress has been quite substantial. This progress has been achieved with a great deal of assistance, both in planning and implementation, by experts seconded to Singapore by several international agencies like the United Nations Technical Assistance Board, the International Labour Organisation and Colombo Plan countries, as well as other friendly countries.

56. Training for industry is essential for industrial growth and the Government has paid a great deal of thought to this problem.

57. The 1961-1964 Plan includes a crash programme of upgrading the skill of existing workers and improving the standard of management. Several orientation courses to this end have been held by the co-operation between the Economic Development Board, trade associations and educational bodies like the universities and the Adult Education Board. In addition, under the sponsorship of the Economic Development Board, a number of recruited personnel at various levels have been sent for further studies and training in the more advanced countries.

58. In the light of the industrialization programme, a Commission, with Mr. Chan Chieu Kiat as chairman, was appointed in 1961 to inquire into vocational and technical education in Singapore. The Commission found that most of the craftsmen and technicians in industry had been trained within industry and, generally speaking, the instruction given to the learners had not been satisfactory, as there was no uniform practice in training. In most cases, learning a skill was done by observation and doing the job itself. The senior craftsman had come up in the same way and most of the learners and the experienced craftsmen had a low level of education.

59. In its report the Commission recommended that more secondary vocational and technical schools should be established in Singapore; that the [illegible] Trade School be reorganized as a "vocational institute" for the training of craftsmen; and that the Singapore Polytechnic, opened in 1958 with courses at professional, technican and craft levels, be reorganized and developed into a college of advanced technology, while its craft courses should be transferred to the new "vocational institute". 8/

60. Most of the proposals have been accepted and implemented. There are now six secondary technical schools. The craft courses in the Polytechnic were transferred in 1963 to the Balestier Junior Trade School, which is now the Singapore Vocational Institute, where courses are offered to full-time and part-time students, the latter category including day-release workers from industry.

61. In support of the Government's industrialization policy, a course in applied chemistry was begun at the University of Singapore in May 1963. With the generous aid of Canada under the Colombo Plan, a course in business administration was started in 1961 at the University of Singapore and the University of Malaya by a team of Canadian experts led by Professor Leslie Wong.

62. With the aim of furthering and providing for higher technological education, a committee, under the chairmanship of Mr. B.V. (now Lord) Bowden, was jointly appointed by the Government and the University of Singapore to study the feasibility of establishing a faculty of technology in the University and to study the possibility and method of the University awarding degrees to students of the Singapore Polytechnic. The committee, in its report of September 1963 recommended that: (a) a faculty of applied science and technology should be set up in the University; (b) a very close relationship should be established between the University and the Polytechnic; and (c) degrees of the University should, under certain conditions, be awarded to students of the Polytechnic.

63. At the same time, the Singapore Polytechnic made a request to the Council for Technical Education and Trading Overseas (TETCC) for a team of experts to be sent to Singapore to advise on the ways of raising the Polytechnic to university status. As a result, Dr. G.E. Watts was sent in April 1963 to gather background information and a team, under the leadership of Dr. G.A. Hart, arrived in Singapore early in 1964 to study the further development of the Polytechnic. The team found the committee's report a useful starting point, and in its report of April 1964 drew up a detailed set of recommendations as how the Polytechnic might develop.

64. The two reports were accepted in principle by the Government, the University of Singapore and the Singapore Polytechnic. A Board of Studies has been appointed by the University to study the implementation of the faculty of applied science and technology, and another board is studying the award of degrees to Polytechnic students.

65. In addition to the University of Singapore and the Singapore Polytechnic, two other higher institutes of learning are Nanyang University and Ngee Ann College. The former begun a course in chemical engineering this year, and the latter is a vocational and technical college.

8/ State of Singapore, Report of the Commission of Inquiry into Vocational and Technical Education in Singapore (Singapore, Government Printing Office, [illegible]).

66. A survey of manpower requirements is being carried out by the Public Services Commission, Singapore, with the assistance of the Economics Department at the University of Singapore. In the meantime, more local and overseas scholarships are being given to students studying science and technological subjects. On the initiative of Dr. Phay Seng Whatt, the Chairman of the Public Service Commission, a Scholarships Co-ordinating Committee has been formed under the wing of the Commission. Among the functions, the Committee will relate the award of the various types of scholarships to the future needs of certain classes of personnel in the State, will review the training programme annually, and will provide information to the various ministries on the availability in any one year of persons who are undergoing training and further studies and who will be returning to the State.

67. Table 6, extracted from the Annual Report of the Commission for 1963 shows the position of scholars/fellows and other trainees offered courses of study by various countries. 9/

9/ State of Singapore, Annual Report of the Public Service Commission for the year 1963 (Singapore, Government Printing Office, 1964).

Table [illegible]

Summary of scholarships/fellowships and training courses offered to Singapore

Country	Medicine	Science	Engineering/Technology	Humanities	[illegible]
			By country		
(a) Commonwealth					
United Kingdom	11	5	25	10	-
Canada	-	6	12	4	-
Australia	7	3	4	1	1
New Zealand	1	5	10	[illegible]	-
India	3	-	-	-	-
(b) Non-Commonwealth					
United States of America	-	17	6	4	-
Japan	-	-	11	3	2
Others	1	-	-	3	3
Total 1963	23	36	68	33	6
Total (1962)	(31)	(50)	(26)	(4)	(12)
Scheme			By scheme		
Commonwealth scholarships and fellowships plan	1	11	11	10	-
Colombo Plan	12	8	44	9	5
British Council/Sino-British Trust	3	-	1	5	[illegible]
Technical Assistance Scholarship Board	-	13	6	-	-
World Health Organization	7	-	-	-	-
Others	-	4	6	9	1
Total 1963	23	36	68	33	6
Total (1962)	(31)	(50)	(26)	(4)	(12)

F. Co-ordination of economic development policies between Malaya, Singapore, Sabah and Sarawak

68. Before the Second World War, the territories of Malaya, Singapore, Sabah (formerly named North Borneo) and Sarawak were united through the Colonial Office and up to this writing, they have used a common currency system. They were separated after the war into three entities, Malaya, Singapore and the Borneo Territories, and were integrated once again with the birth of Malaysia on 16 September 1963. The formation of Malaysia envisaged, among other things, the integration of the different economic activities of each State and the establishment of a common market.

69. A mission from the International Bank for Reconstruction and Development, headed by Mr. Jacques Rueff, was invited in late 1962 to make an economic survey of the Malaysian territories and to make recommendations on the integration of the economic activities in the various States.

70. In the Bank's report the following important differences in the structure of economic activity were noted. "In both Borneo States, 80 per cent of the economically active population is engaged in agriculture, forestry and fishing, as compared with 58 per cent in the Federation (Malaya) and only 8 per cent in Singapore. Conversely manufacturing and construction occupy 20 per cent of the labour force in Singapore but only about 11 per cent in Malaya and less than 6 per cent in the Borneo States. Trade, transport and other services account for nearly 70 per cent of employment in Singapore, about 70 per cent in Malaya and 15 per cent in the Borneo States." 10/

71. The report contains detailed recommendations on: (a) co-ordination of development programmes; (b) industrial policy; (c) establishing a Malaysian common market and the organization of a tariff board; (d) harmonization of tariff policies; (e) the application of non-protective duties of the new States of Malaysia; and (f) the preservation of entrepôt trade. The various Governments have accepted the report and are in constant consultation with one another.

72. Industrial development has progressed very well in Malaya, as judged by the opening of many industries in several new industrial sites in Petaling Jaya, Tasek, Johore Bahru, Port Swettenham, Butterworth and Batu Tiga. Many research organizations existed before the war and are currently expanding their activities. Attempts are being made by the central Government to co-ordinate these activities. A list of research organizations in Malaya appears in annex II. This has been compiled from "Malaysian Scientific Directory 1964", produced by the Malaysian Scientific Association, which includes in its membership scientists and technologists from all parts of Malaysia.

10/ International Bank for Reconstruction and Development, Report on the Economic Aspects of Malaysia (Singapore, Government Printing Office).

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ANNEX I

A BRIEF HISTORY OF THE NATIONAL IRON AND STEEL MILLS LTD.

(1961-1964)

1961: June: United Nations report.

August: National Iron and Steel Mills Ltd. formed by Economic Development Board (20 per cent) and local entrepreneurs, (subscribed capital of $M50 million; first call-up of $M5 million).

December: Extensive world tour by some directors and Mr. Jang Bir Singh (OPEX recruit) to buy modern equipment and also seek technical assistance.

1962: April: Mr. Marcel Cabane, a French expert in metallurgy sent by French Government, arrived to advise on purchase of equipment, and worked on plant layout, problems of manufacture and possible sources of supply for raw materials.

September: (a) Six locally recruited engineers sent to Australia and one to India for six months' specialized training in iron and steel production techniques. Others were sent later;

(b) Two United Kingdom engineers came to Singapore to supervise the installation of equipment; and (c) a number of Formosan technicians were engaged to train a nucleus of local workers.

On 16 September, Dr. Goh Keng Swee laid the foundation stone of the new mill at Jurong and construction work began.

December: Building foundations were complete and work was in progress on the building proper. Equipment including the twenty-ton electric melt-shop furnace (made by Lectromelt of the United States of America) and a scrap shear.

1963: August: Dr. Goh opened the melt-shop; the first of Singapore's home-made steel ingots poured into the moulds.

1964: January: Dr. Goh opened the rolling mill.

Dr. Goh stated: "This steel mill is already providing direct employment to about 400 people, and the allied ship-breaking yard employs 200 people. With the growth of other industries around this nucleus, we can look forward to more opportunities for workers as well as investors."

Current capacity: The mill is fully operational. The melt-[illegible] twenty-four hours a day on a three-shift system. It [illegible] a shift. The expected output in 1964 is [illegible]. With the installation of a second furnace, the expected output will [illegible] per annum. The rolling mill will turn out [illegible] from ingots from the melt-shop and another 50,000 tons from imported [illegible]. The re-rolling mill has a target of five tons per hour or 50,000 tons per annum.

Future plans: Installation of: (a) an additional re-rolling mill with a capacity of 30,000 tons per annum; (b) 2 x 10,000 KVA electric smelters with total capacity of 60,000 tons per annum; and (c) a 300-ton blast furnace with [illegible] and oxygen injection.

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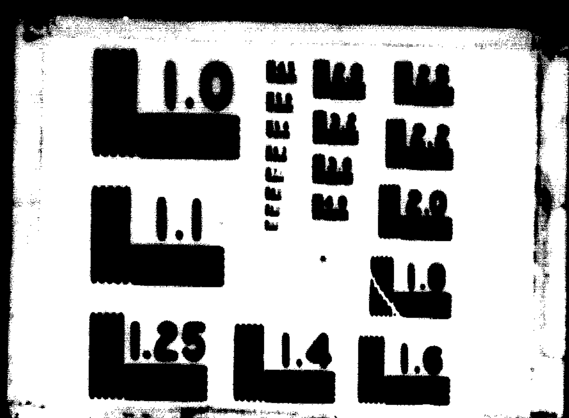

ANNEX II

ORGANIZATIONS POSSESSING FUNCTIONS CONNECTED WITH INDUSTRIAL DEVELOPMENT AND RESEARCH a/

Government

Prime Minister's Department

Department of Statistics: Kuala Lumpur

Ministry of Commerce and Industry

National Productivity Centre, Federal Government Offices
Petaling Jaya, Selangor

Ministry of Agriculture and Co-operatives

Department of Agriculture

Soils-water research station:	Tanjong Karang, Selangor
Federal experimental station:	Serdang, Selangor; Jerangan, Trengganu
Padi experimental station:	Lundang, Kelantan; Telok Chengai, Kedah; Pulau Badong, Malacca; Bumbong Lima, Province Wellesley
College of Agriculture:	Sungei Besi, Selangor

Drainage and Irrigation Department

Research station:	Ampang, Selangor

Fisheries Division

Headquarters laboratories:	Glugor, Penang
Branch laboratories and stations:	Kuala Kangsar, Perak; Tapah, Perak; Bukit Tinggi, Pahang

Malayan Forest Research Institute

Experimental station:	Kepong, Selangor

Ministry of Interior

Department of Chemistry

Government analytical laboratory with some routine and investigational work which involves industrial development projects, Petaling Jaya, Selangor

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a/ Compiled from "Malaysian Scientific Directory, 1964", Malaysian Scientific Association.

Federal Department of Town and Country Plan[illegible]

<u>Ministry of Rural Development</u>

Geological Survey Department)	
)	Research Division, Ipoh, Perak
Department of Mines)	

<u>Statutory Organizations</u>

The Malayan Pineapple Industry Board

Pineapple research station:	Alor Bukit, Johore
Laboratory, Tampoi, Johore	

Rubber Research Institute of Malaya

Laboratories:	Kuala Lumpur
Experimental station:	Sugei Buloh, Selangor

Tropical Fish Culture Research Institute

(An autonomous body supported by the Commonwealth Technical Co-operation Scheme, Batu Berendum, Malacca)

Technical College:	Kuala Lumpur

University of Malaya (with faculties of agriculture, arts, engineering, medicine and science, and a School of Education, Pantai Valley, Selangor)

<u>Commercial</u>

Chemara Plantations Limited

Research stations:	Seremban, Negri Sembilan; Layang Layang, Johore
Dunlop Research Centre:	Batang Maleka, Negri Sembilan

Harrisons and Crosfield

Oil palm research station:	Banting, Selangor

Malayan American Plantations Ltd.

Plantation research department:	Bedong, Kedah

Prang Besar Rubber Estates Ltd.

Research branch:	Kajang, Selangor

Wilkinson Process Rubber Co. Ltd.

Research facilities:	Batu Caves, Selangor

XXII. REPORT ON INDUSTRIAL RESEARCH IN INDIA

Prepared by Baldeu Singh*

Introduction

1. Most of the institutions undertaking industrial research in India are of comparatively recent origin. Although even before India became an independent Republic, some universities and teaching institutions in the country had departments of technology carrying out teaching and research. These were, however, of little consequence since their work bore very little relationship to the practical problems of the country. Such Indian industries as were in existence - textiles, jute, chemicals, iron and steel - had not attained their present status and importance and were mostly dependent on imported technology. A large proportion of the country's requirements of consumer goods, industrial and strategic items were met by imported goods.

2. The Second World War found the country in a difficult position because of the cutting off of imports owing to the interruption of the communications with the sources of supply. Even the urgent defence and civilian needs of the country were affected. This gave impetus to industrial research to develop indigenous substitutes for the imported materials. The Council of Scientific and Industrial Research (CSIR), the main organization for civil research in India, was set up in 1942 with the purpose of promoting, organizing and co-ordinating scientific and industrial research. Its aims and objectives are given below:

(a) The promotion, guidance and co-ordination of scientific and industrial research in India, including the institution and the financing of specific researches;

(b) The establishment or development and assistance to special institutions or departments of existing institutions for scientific study of problems affecting particular industries and trade;

(c) The establishment and award of research scholarships and fellowships;

(d) The utilization of the results of the research conducted under the auspices of the Council towards the development of industries in the country;

(e) The establishment, maintenance and management of laboratories, workshops, institutes and organizations to further scientific and industrial research and to utilize and exploit for purposes of experiment or otherwise any discovery or invention likely to be of use to Indian industries;

(f) The collection and dissemination of information in regard not only to research but also to industrial matters generally;

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* Research Co-ordinator, Council of Scientific and Industrial Research, New Delhi.

(g) Publication of scientific papers and a journal [illegible] and development;

(h) Any other activities to promote generally the objects of the resolution.

3. With the termination of hostilities, the research activities of the Council were oriented to needs of industrial development and economic progress of the country. With the attainment of national independence in 1947, the organization of scientific and industrial research made much faster progress.

4. While in 1947, only two national laboratories dealing with the disciplines of physics and chemistry started functioning in the campus of the Delhi University, in the seventeen years since independence twenty-nine laboratories or institutes have been established by the Council of Scientific and Industrial Research. These include research laboratories dealing with such major disciplines in science as physics, chemistry, electro-chemistry, biology and aeronautics; institutes oriented to the needs of important industries and the exploitation of such raw materials as fuels, metals, glass and ceramics, drugs, food, leather, etc.; regional research laboratories with emphasis on the research and utilization of raw materials and resources of the region; and organizations dealing with research, development and training on scientific instruments, cultivation of medicinal plants, as well as a scientific documentation centre and a directorate of scientific publications and dissemination of the results of research. A list of organizations of CSIR and their principal executive officers is given in annex I.

5. In addition to undertaking research in its own institutions, CSIR supports research in industry by encouraging the setting up of co-operative research associations of industry by organized groups of industries. It gives support by providing financing to meet 50 per cent of their capital and recurring expenditures. Research associations of industry are active in textiles, silk and art-silk, plywood, rubber paints and tea industries. A list of the co-operative research associations of industry, showing the support provided by CSIR, is given in annex II. The Council also supports research in universities in the form of grants-in-aid for approved research schemes under the guidance of investigators who are on their teaching and research staff. Grants for fellowships and scholarships are also given to deserving students. CSIR also helps research by setting up research centres in universities and sponsoring teaching and research in specialized fields. Details about grants for fellowships are given in annex III.

6. Apart from institutions of CSIR, or those financed and supported by CSIR, the Government of India also gives financial assistance to other teaching and industrial research organizations, e.g. the Indian Institute of Science, Bangalore; and the Institutes of Technology in Kharegpur, Bombay, Kanpur and Madras. A few of the industrial companies have also set up research institutes financed and managed by them, although some of these receive substantial support by way of sponsored schemes and grants from CSIR funds. Among these are the Indian Jute Manufacturers' Research Institute, Shri Ram Institute for Industrial Research, CIBA Research Centre, Hindustan Lever, Rubber Research Institute, Tata Institute, Bengal Immunity Research Institute and some others. Some State-sponsored public sector industrial organizations have their laboratories for industrial research, for example, Hindustan Insecticides and Hindustan Antibiotics of the Ministry of Petroleum and Chemicals, Railway Research and Design Organization of the Ministry of Railways, Defence Research and Development Organization of the Ministry of Defence, National Sugar Research Institute of the Ministry of Agriculture. Some university departments

[illegible] have established active schools of applied research, e.g. Department of Chemical Technology, University of Bombay; Applied Chemistry Department of Calcutta University; College of Technology, Banaras; Madras University, etc.

6. India's industrial research policy

7. Under the leadership of India's late Prime Minister, Mr. Jawaharlal Nehru, the Government of India has been acutely conscious of the role of scientific and industrial research in raising the standard of living of the people and the building up of a modern society. With this end in view, the Government has followed an enlightened policy of active encouragement and support of all kinds of scientific activity and research. It has built up an entirely Government-supported organization for scientific and industrial research (CSIR) and has looked upon this expenditure as an investment for the future. It is as a result of this far-sighted policy that India has today built up a scientific and technological potential in the form of well-equipped laboratories with scientifically and technically qualified and trained staff, instrumentation services, extensive pilot plant facilities, documentation and publication and dissemination services. Furthermore, the Government, through CSIR, has set up organizations for the collection of data on scientific and technical manpower, the survey and planning of scientific research, research co-ordination, industrial liaison and extension services, and design and engineering, whose activities form the basis of research planning and assist in the formulation of a national science policy. The Government of India adopted a resolution declaring its policy on science and technology in 1958 (see annex V).

8. Most of the research in India, whether fundamental or applied, is Government-sponsored. Apart from being responsible for the administration of industrial research institutes, the Government also provides the main financial support for the teaching institutes and the universities. Until now, there has not been a clear-cut demarcation in respect of the organizations which should carry out fundamental research and those which might be devoted exclusively to industrial research. Science departments of the universities do take up some research problems having an applied bias. In some universities, the departments of technology and engineering have built up flourishing schools of industrial research and have active contacts with industry. On the other hand, most of the laboratories and institutes under CSIR also take up purely basic and fundamental research along with applied research, and some of the laboratories have vigorous schools of fundamental research which have important contributions to fundamental science to their credit.

9. However, there is a growing opinion in favour of a broad delineation of the areas of research. The dominant trend is that fundamental and purely basic work should be the domain of the teaching institutes and the universities, while applied and industrial research should be the main concern of Government-sponsored industrial research laboratories. The latter should develop close links and active liaison with industry in the public and private sectors. Industry should also be encouraged to set up research institutes of its own and to take increasing responsibility for research of direct benefit to it.

10. That the Government-supported research institutes under CSIR should orient their programmes as to be of direct application for industrial development has been expressed by successive Reviewing Committees of CSIR which were appointed by the Prime Minister of India in 1947, 1954 and 1963. The First Reviewing Committee, under the chairmanship of Sir Ardeshir Dalal in 1947, while not recommending any hard and fast division of expenditure on fundamental and applied research emphasized that "the greater part of the activities of the Council should be directed to scientific research which could be applied directly towards the industrial development of the country". To achieve its objective, the Committee counselled expansion of pilot-plant facilities so that laboratory research projects could be tried at pilot-plant scale before being passed on to industry. They also emphasized that for every scheme "... its scope and purpose should be clearly defined and it should also fit in the plan of development of the country".

11. The Second Reviewing Committee, under the chairmanship of Sir Alfred Egerton in 1954, pointed out the need for a central research intelligence to bring about exchange of information between the different laboratories under CSIR and closer co-ordination and co-operation with other research organizations and the universities. The Committee made suggestions for closer liaison with the industries and government departments and the setting up of machinery for effective utilization of the results of research. The Committee welcomed the support given to the setting up of research associations of industry and advised the industry to make full use of the facilities provided by the national laboratories.

12. The Third Reviewing Committee, under the chairmanship of Sir. A. Ramaswami Mudaliar, which submitted its report in September 1964, has made a strong recommendation that the proportion of applied research in the laboratories under CSIR should be increased as to form approximately 80 per cent of their research effort, the remaining 20 per cent being of the nature of "basic objective" research undertaken in order to fill a known gap in basic scientific knowledge in the field of potential practical importance or to extend the area of understanding and application of an industrial process.

13. The Committee has recognised the importance of "pure basic" or "fundamental" research as being the principal source from which major departures from orthodox practice arise. Fundamental research, to be of any significance, must be up to world standards and the firm establishment of such standards is essential to the maintenance of a high level in all types of research. Such research should be the primary function of the universities. Universities train people for the future and the students not only must know what is a proper standard of research, but must also, in some fields, be thoroughly up-to-date; that is one important reason why pure basic research and universities should go together. Moreover "pure basic" research thrives better in the atmosphere of a healthy university where it does not have to be related to economic objectives.

B. Creation of research consciousness in industry and government departments

14. With a few striking exceptions, industry in India, whether public or private, is less research-minded than industry in the countries which have advanced as a result of science and technology. It is a paradox in all countries that backward industries are commonly those which both are unwilling and do not know how to progress. Appreciation by responsible persons in authority in the Government and in industry (but primarily in the Government) of the vital role of research, is important to permit a rapid establishment of the facilities for research and of its making its contribution to industrial development.

15. The leaders of the Indian National Movement for independence, who were later at the helm of the Government, were acutely conscious of the fact that science and technology were vital to the economic and industrial development of the country and to the raising of the standard of living of the people. Having witnessed at first hand the achievements of scientific research in the advanced countries, they sought to build up a network of research laboratories, institutes of technology for advanced technical education and training, and a system of graduate and post-graduate teaching in science, engineering and technology.

16. In the initial stages, when most of his countrymen were not sufficiently conscious of its importance, the late Shri Jawaharlal Nehru foresaw its role in the country's future development and gave his powerful support and patronage to all types of scientific activity. By associating himself actively with science organizations, he repeatedly emphasized in word and deed the importance the Government of India attached to the development of science in the country. By providing generous finances and giving social respect and honour to the men of science, he created a climate favourable to the growth of science.

17. It is of great value that science have the appreciation and support of the Government at an early stage in order for it to take root and grow.

Research utilization

18. Application of the results of research is a problem in every country. In India, the problem is made more acute by various factors, some of which are discussed below:

Foreign collaboration versus indigenous know-how

19. The importation of technical know-how from the more advanced countries is essential and has several advantages for the speedy progress of industrial development of the country. There is need, however, for a judicious discrimination of what need be imported and what is capable of development within the country. Since Indian research organizations do not have sufficiently close links with government departments responsible for industrial development and planning, there is a feeling that indigenous know-how is by-passed in favour of foreign collaboration.

20. Indian entrepreneurs are not prepared to take the calculated risk necessarily involved in using results of indigenous research - particularly since the foreign collaborators are prepared to offer technical and economic guarantees, and financial participation.

21. Research is a time-consuming process. Before the laboratory research is ready for industrial application, it must pass through pilot-plant trials to obtain technical, economic and market data.

Design and engineering

22. Know-how forms a relatively minor portion of the total investment on plant and equipment. Since the setting up of an industry involves heavy investments, the entrepreneurs would prefer to entrust it to those who can supply design and engineering know-how and bring in their share of the capital in the form of plant and equipment, for which foreign exchange would otherwise be needed.

23. Design and engineering consultant facilities are meagre in the country. There are a few firms, but they would prefer to take up well-tried conventional processes rather than invest in something new.

Research programmes

24. Research programmes, as set up by the laboratories, are framed without sufficient consultation with the industries and are not related to their requirements. The results of research do not take the economic factors into consideration and hence are of little value to industry.

Dissemination of the results of research and industrialization

25. Some of the laboratories have not paid sufficient attention to making the users aware of their results of research. There has been little publicity for the good work done by them. An efficient organization of liaison with industrial companies and their technical and managerial personnel would facilitate the application of the results of research.

C. State support of industrial research

26. In most of the advanced countries, the responsibility for financing and carrying out of industrial research rests with the industries themselves. Even in these countries, the participation by the State in industrial research is on the increase. The argument is that in modern times, the economic health of the country is of as great an importance as the military defence of the country and in fact the two are inseparable.

27. In the less advanced and developing countries, the argument is even stronger. Without active participation by the State, in industrial research and development, neither the speed nor the scale of investment would have been possible as it is in India today and the country would need both of these for economic survival.

28. In the case of a developing country like India, the problem is how to close the gap between the level of research and development in the more advanced countries and itself. The most economic use would have to be made of the limited number of qualified research and technical personnel and effort that the country is capable of. This can be achieved by identification of the problems, narrowing down the area for research investigation and concentrating the research effort on these. Formulation of research in the forms of projects with clear-cut scope and objective, and with fixed time targets for completion is an effective method. Applied research can and should be planned to a substantial extent.

29. From a long-range view, research, education and industrial development are interdependent. Industrial research would gain in effectiveness in application by close association with industrial development. This is possible by ensuring a constant impact on the minds of the scientists of the economic and technical factors relating to industrialization. The Government can help in three ways:

(a) By making available detailed data on imports, exports and the plans and programmes of the Government and private industrial companies;

(b) By ensuring the close association of indigenous scientists and technologists with the projects set up with foreign collaboration; this would enable indigenous research to catch up quickly thereon for future development and improvement;

(c) By ensuring that research becomes a part and parcel of the over-all planning and industrial development of the country. This would mean that identification of problems and research investigation would be carried out in relation to the programmes for industrial and other development.

D. Organization of research and industrial development

User participation

30. Research carried out in the laboratories of the user industry, unlike that of the Government-sponsored laboratories, does not have to surmount difficulties of its application. However, it can suffer from a surfeit of problems of trouble-shooting and *ad hoc* assignments. It would benefit by insulation from the day-to-day operational problems of the concerned industry. Research in the Government-supported laboratories, on the other hand, while providing a better research atmosphere conducive to an undisturbed pursuit of research, would need to be brought closer to the user.

31. Most of the research in India is State sponsored, industrial companies doing little or no research and making insufficient use of that done in the government laboratories. The Third Reviewing Committee examined the problem of bringing the user close to research in great detail and has suggested a number of useful measures. Some of these are already in operation but will have to be further emphasized. Others have been or are at the stage of being introduced. These are briefly described below.

Co-operative research associations

32. Research associations whereby a group of firms in industry are enabled to run a research organization to meet the research requirements of their specialised field were first organized in the United Kingdom and have been followed with remarkable success in a number of European countries (a report on the structure of industrial research associations is to be published shortly by the Organization for Economic Co-operation and Development). This ensures their interest and participation in research and the results are of benefit to a number of firms who would not be able to have a research set-up of their own. The Government gives financial and other assistance, which may vary from one-fifth or one-third to one-half of their expenditure on research.

33. In India, the textile industry has three research associations, while the plywood, silk and art-silk, rubber, paint and tea industries have one each. The Government, through CSIR, helps by meeting half of their recurring and capital expenditure and also in other ways by advising on rules and regulations and organizational set-up, procurement of experts and helping in foreign exchange. This is scope for further expansion of research associations to other industries. The Government could give a greater share of expenditure in the beginning and decrease it gradually as the organization grew stronger and was able to bear a larger share of expenditure.

Participation by industry

34. The Committee has also recommended that where a full-fledged research association may not be possible, other forms of user-participation should be experimented with. Some of the well-established laboratories of CSIR conduct research in a specified field of industry. In such cases, industry could be invited to come in for a share of the control and direction of programmes of the institutes or of some of its research divisions. Industry could share in financial participation of a part of the programme of direct interest while the long-range and "basic objective" programmes could be supported by CSIR. The industry could form an association which could take the responsibility of parts of the programme in the CSIR research laboratories and could also sponsor research in other institutes and universities.

User government departments

35. A number of institutes and laboratories of CSIR work in a field of public utility like the Central Public Health Engineering Research Institute, Central Road Research Institute, and Central Building Research Institute, where the user is a department or a Ministry under the Government of India. From the standpoint of application of research results, these research institutes would be benefited by being under their user ministries, but the conditions for creative research may not be obtained in government departments for some time to come.

36. The present collaboration with these departments is in the form of their representation on the executive councils and scientific committees of these institutes. The Third Reviewing Committee considers that representation on the executive councils is not enough and suggests that these departments should share in taking a responsibility for the control and financing of the programmes of these institutes. They should also appoint staff in their own departments charged with the responsibility of utilization of the results of research of these institutes.

Incentives for research

Financing research in industry

37. In Canada, the Government, through the National Research Council, has initiated a scheme for encouragement of industry to undertake research. It provides funds for research by the industry on approved projects on a shared basis - expenditure on scientific staff being met by the Government while the equipment etc. are provided by the industry. No strings are attached to the utilization of the results of research which become the property of the firm.

38. In India, there is no such scheme at the current time, but the Third Reviewing Committee has recommended that the case for the Government of India to encourage research in industry is far stronger. It has recommended that staff appointed by CSIR might be seconded to work in research institutes of the industry on specific projects. CSIR should also share in expenditure on capital equipment and let the results be used by industries exclusively or preferentially for limited periods.

Development contracts

39. Development contracts are a powerful tool in the United States of America and the United Kingdom to stimulate technological progress. Although started during

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the Second World War by the defence departments, when they were intended to be followed by purchases, they have been extended to civilian departments and have nothing to do with purchases. It currently takes the form of a contract to produce a first working model by the industry, at times accompanied with financial participation. In return, the company gets the exclusive right to the use of the results over a number of years with proper safeguards.

40. In India, some of the CSIR laboratories have associated private industrial companies or public sector industrial concerns with the development of the pilot plants, based on the result of laboratory research. The industrial companies get either exclusive rights or preferential terms in the exploitation of the results of research.

41. The Third Reviewing Committee has recommended that CSIR, through its laboratories, should place developmental contracts with firms which should include compensation for the financial risk involved in case of failure or loss.

The problem of the first user

42. In the development and utilisation of any discovery, it is the first user who runs all the risk and has all the headaches. It is he who risks his capital in case of a failure and has to put up with all the delays and uncertainties of a new venture. Those who follow have none of these. He must be given special incentives which should cover a clause for compensation of part of the loss, and exclusive use for a limited period.

Tax exemption

43. In India, expenditure on research undertaken by a firm is exempt from income-tax and is counted as a part of the developmental expenditure of the firm. However, this exemption does not apply to expenditure incurred on sponsoring research in other laboratories and organizations. The Third Reviewing Committee has recommended the removal of this distinction so that all research expenditure may be exempted from tax.

Subsidies and low-interest loans

44. The Third Reviewing Committee has recommended that firms making use of research and participating in development may be granted subsidies and low-interest loans subject to proper safeguards.

Training programmes for industry

45. A number of institutes of CSIR run training courses for personnel from industry. Some of these courses are financed by international aid programmes and include training of personnel from other countries in South and South-East Asia.

46. The Central Food Technological Research Institute, Mysore, runs classes for food technologists on processing, preservation and packaging of foods; the Central Scientific Instruments Organization on training of instrument mechanics and technicians; the Central Electro-Chemical Research Institutes on electroplating, etc. Laboratories of CSIR also undertake training of representatives of industry on specialized techniques in their own field.

Other measures

47. Apart from increasing the representation of industry in the executive councils of the research institutes, the Committee has suggested that "panels of experts" drawn from scientists from industry and universities should be associated with research divisions of laboratories to help in framing the programmes of the institutes.

48. Mobility of scientists between research and industry should be ensured. Scientists from the research laboratories might be permitted to work in industry for limited periods and then return to their posts without detriment to their economic position. Similarly, scientists from industry should be able to avail the facilities of the government laboratories by working on a specialized problem of their interest.

49. All research laboratories in CSIR carry out a certain amount of research sponsored by industry. This should be encouraged by offering liberal terms, subsidies and exclusive use of results for limited periods.

50. The rules of CSIR permit consultation by the research laboratories for the benefit of industry. The industrial firms can also indicate the individual scientist whom they would like to consult. The Committee has recommended the liberalization of the institution of consultation both by the institutes and by individual scientists.

E. Financial aspects

51. Funds for industrial research in India arise almost entirely from the central Government. The Council of Scientific and Industrial Research, the main organization for civilian research, has its allotment for expenditure every year out of the grants of the Ministry of Education - Department of Science, by the Government of India.

52. The laboratories and institutes of the Council prepare estimates of capital and recurring expenditure in keeping with their activities by way of research schemes, pilot plants, etc.; and their needs of buildings, equipment, library facilities and other requirements. These estimates are consolidated by CSIR, together with such other items as grants to universities for schemes and fellowships, grants to research centres, the expenditure for deputations for training abroad and other activities of the headquarters.

53. The consolidated budget estimates, which form a part of the budget of the Ministry, are scrutinized by the Ministry of Finance, which sanctions an amount, keeping in view the over-all financial position. The sanctioned estimates are then broken down laboratory-wise and conveyed to the respective laboratories as their sanctioned budget. The laboratories, through the executive councils, have considerable freedom in incurring expenditure within the sanctioned budget in keeping with their requirements. The growth of expenditure by the Council is shown in annex V.

54. Although the central Government is the major source of funds, there are other sources of lesser substance which are listed below.

Contribution by user-departments

55. In the case of the Central Mining Research Station of CSIR, the Coal Board under the Ministry of Mines and Fuel shares 50 per cent of the expenditure. It has representation in the form of nominees on the Executive Council of the Institute, who actively help in framing and direction of research programmes.

56. Indian Tea Research Association receives 25 per cent of its recurring and capital expenditure from the Indian Tea Board, which is represented on its Council of Management. The rest of the expenditure is met by the members of the Association of the Tea Industry.

Co-operative research associations

57. Fifty per cent of the funds of the co-operative research associations are met by the members of the associations of the industry concerned. These are raised by the members, in the form of membership fees and, in addition, sometimes by way of a voluntary levy on units of production.

Testing and certification fees

58. All the industrial research laboratories carry out a certain amount of testing and analytical work for the industry against payment. In the case of co-operative research associations of the textile industry and, more particularly, of the Silk and Art Silk Mills' Research Association, it forms an important part of their activity and brings in substantial revenue, since this is linked with export promotion of these commodities. Some laboratories like the National Physical Laboratory do type-testing to ensure maintenance of standards for which they receive payment. A certain amount of testing involving specialized techniques or equipment is also done by some of the laboratories, since facilities of this type are not available elsewhere. Thus, the Central Mining Research Station carries out tests of the flameproofing of electrical equipment on behalf of industry and receives fees for it. Some testing as a service to industry is done by most of the laboratories.

59. Earnings from testing and analytical work are substantial in the case of the co-operative research associations referred to above, but they do not form a significant part of the funds of the other laboratories.

Developmental research - participation by industry

60. At times, industrial companies evince interest in the results of laboratory research and are prepared to participate in the pilot-plant studies with a view to receiving preferential consideration for the industrial exploitation of the results of research. They may help by providing facilities by way of land, buildings and services, or may make a financial contribution to cover a part or the entire expenditure on developmental work. In other cases, the firms have borne the entire investment or a part of it for the setting up and operation of a pilot or prototype plant.

Premia and royalties

61. CSIR receives income by way of payments in the form of lump-sum premia and royalties accruing out of industrial utilization of the processes worked out in the laboratories. This income has been increasing steadily, but it yet does not form a significant part of the CSIR funds.

Donations from industrial houses and state governments

62. Periodically, industrial concerns have made donations of substantial amounts to CSIR as a token of their appreciation of and support to industrial research and in its setting up of an institute or a laboratory. State governments and industrialists have also made donations of land, building and property for use in the establishment of institutes. Some industrial concerns have founded scholarship schemes for research workers in the laboratories.

Funds for research

63. One aspect which is of concern is the amount of funds available for research in India. Owing to the need for heavy investment in capital intensive industries to build up the country's industrial base and economy, the funds available for education, health and scientific research are not commensurate with their needs. Ideally, a less-developed country should be spending more on research than the advanced countries, but paucity of resources does not make this possible. India spends barely 0.32 per cent of its income on scientific research, which is far below that of the developed countries. The table given below gives the idea of expenditure on scientific research in different countries:

Table 1

Expenditure on scientific research in selected countries

Country	Year	Expenditure on scientific research (millions of rupees)	Population (millions)	Per capita research expenditure (rupees)	Per capita national income (rupees)	Research expenditure as percentage of national income
Australia	1958-59	400	9.9	40.00	5,780	0.70
India	1961-62	469	440.0	1.07	334	0.32
Norway	1958	124	3.5	35.00	4,540	0.70
Sweden	1961-62	1,088	7.4	146.00	8,649	1.70
United Kingdom	1961-62	8,467	52.0	162.00	6,010	2.70
USSR	1958-59	20,700	209.0	99.00	3,303	3.00
United States	1961-62	72,580	174.0	410.00	14,190	2.90
Yugoslavia	1958	76	18.0	4.20	1,810	0.22

64. Another major bottle-neck is the shortage of foreign exchange. Import of equipment, instruments and books and journals for scientific and technological research are seriously affected and sometimes costly items lie unused due to the inavailability of a spare part which is to be imported. This shortage also prevents a number of younger scientists who would like to go abroad for higher studies in scientific and technological subjects.

F. Staffing matters

Shortage of scientific and technical personnel

65. India is passing through a phase of rapid industrial development and a number of industries are being set up, either based on foreign collaboration or entirely with indigenous initiative and enterprise. Steel plants, non-ferrous metallurgical industries, ceramics, chemicals, textiles, jute, coal, petroleum refineries and petro-chemicals and a large number of capital and consumer goods industries are coming up throughout the country. Government departments responsible for industrial development and planning also need increasing numbers of scientific and technical personnel for handling planning, formulation and evaluation of programmes of development. Scientists and technologists are also required for manning teaching and research in the universities and the institutes of technology. Industrial research organizations of CSIR have to compete with other employers for purposes of recruitment and retention of their scientific and technical personnel.

66. In the absence of any reliable data, it would be safe to assume that there are more jobs than competent technical personnel to fill them. In 1963, it was estimated that as many as 30 per cent of scientific and technical posts had remained unfilled in the CSIR laboratories. This could have been caused partly by the ban on recruitment to even the sanctioned posts consequent to the emergency declared in 1962, owing to the conflict with China (Mainland). Delay in recruitment because of procedures might also have been a contributory element, but there is no doubt that the shortage of competent trained and qualified personnel is currently a major factor. This shortage is particularly acute in certain specialized fields: mechanical and electrical engineering, metallurgy, fuel technology and chemical engineering, etc.

Dilution of standards and staff movement

67. One danger in the above situation is that the posts in research institutes may be filled by persons of mediocre talent, resulting in a lowering of the standards and quality of research.

68. There is also a considerable problem in that the universities and teaching institutions are not able to get or retain in service qualified and experienced scientists in view of the higher emoluments offered by the government research laboratories and more so by the industrial companies. Loss of staff, particularly those belonging to the fields of engineering and technology referred to above, from the teaching and research institutes to industry and from one institution to the other with quick jumps in emoluments have been heavy. The denuding of the teaching and training institutions of their trained scientific staff is affecting adversely the entire system of communications in education, research and industry. The final solution would lie in increasing the number of scientists and engineers being trained by the teaching institutes. However, an effort at improving the

grades and salaries in the teaching and research institutions might mitigate the situation to some extent.

Training programmes

Fellowships and scholarships

69. CSIR makes available a large number of senior and junior fellowships of Rs.400 and Rs.250 per month respectively (Rs.500 and Rs.300 for engineering subjects) for higher training of personnel of post-doctorate and post-graduate qualifications. These fellowships are tenable in universities, institutes of technology and the CSIR research laboratories. The University grants Commission, the Atomic Energy Commission and the Defence Research and Development Organization also have similar fellowship schemes. All in all the number of scholarships and fellowships available is considerable.

70. In addition to these fellowships, a number of scholarships are made available by such industrial companies as ESSO, Burmah Shell, Imperial Chemical Industries, etc. for training in the institutes of technology in India and in fields of geology, petroleum engineering and petroleum technology in the United Kingdom and the United States of America. A large number of scholarships are also available under educational and cultural exchange agreements with a number of advanced countries in Europe and North America for training in specialized fields of science and technology and humanities.

Training of technicians

71. Some of the laboratories of CSIR also organise training programmes for scientists and technicians for the industries. The CSIR Institute of Petroleum runs a training programme for technicians and technologists from the petroleum refining industry. The Central Electro-Chemical Research Institute has a programme for training in electroplating; the Central Food Technological Research Institute runs a training programme on food technology for personnel in the food industries in India and South and South-East Asia.

Deputation for advanced training and studies

72. In addition to these programmes, CSIR and other research and technical organizations used to depute their scientific and technical personnel to institutions in Europe and North America for specialized training. Owing to a shortage of foreign exchange, these programmes had been suspended since 1957 and were revived in a restricted manner only recently. Whereas it would be of great advantage to research workers in industrial research organizations to be able to visit and exchange ideas with their corresponding numbers in other countries and also to visit research organizations and industrial concerns making use of advanced technology, this is not possible because of the shortage of foreign exchange.

Scientists' pool

73. The loss by their not returning, of the scientific and technical personnel sent abroad for higher studies and advanced training, has been considerable in the case of India. It is estimated that as many as 4,000 Indian scientists are

staying abroad and efforts are being made to persuade them to return by offering them attractive conditions in India, thus enabling them to participate in the country's industrial and economic development.

74. One of the methods which has bee extremely useful is the creation of the "scientists' pool" to which selections are made from the scientists who are abroad or are likely to return to India. Salaries are offered in the range of Rs.400 to Rs.700 or above in the case of specially qualified personnel, so that they do not suffer from any uncertainty in regard to their employment after returning to India. During their temporary posting in the pool, they enjoy the status of officers and are attached to one of the scientific, educational, teaching or research institutions, or even to industries. They can during this period apply and look about for suitable employment consistent with their qualifications and training. However, if they do not find suitable employment within a specified period, the Government, through CSIR, permits the creation of supernumerary posts against which these foreign trained scientists can be appointed.

75. Although this programme of the scientists' pool has been successful, it still has not been possible to bring back all the scientists with higher training in the advanced countries. In certain cases, the reason is the better standard of living and higher emoluments offered to them in the countries abroad. In other cases, the scientists concerned do not find on their return the highly sophisticated equipment and instrumentation to which they have become accustomed during their training and work abroad. Although it would be difficult to say that all the conditions which would be necessary in order to attract back every Indian scientist have been achieved in India, no Indian scientist who would like to return and work in India would find either financial or scientific difficulty in doing so.

National register

76. The Council of Scientific and Industrial Research also has a National Register Unit which maintains a roster of all the scientific, technical, engineering and medical personnel in India and abroad. They issue registration cards to scientific personnel and also supply information in respect of vacancies. In a limited way they also carry out manpower studies and collaborate with other organizations engaged in similar studies, e.g. the Institute of Applied Manpower Research and Indian Statistical Institute, in making projections of the requirements of scientific and technical personnel. They also publish a monthly bulletin "Technical Manpower" which gives a classified list of foreign-trained scientists in different fields of specialization who have returned or are about to return to India. They also give a list of vacancies and employment information.

Auxiliary technical personnel

77. The paucity of scientific and technical personnel in certain specialized fields has already been pointed out. However, the position in regard to the auxiliary technical personnel engaged in mechanical jobs, such as turners, fitters, electricians and instrument repairers, is more serious. The emoluments and earnings for this category of staff employed in industry are much higher than in the research laboratories. As a result, service sections of the laboratories are losing this category of staff to the detriment of the organization as a whole. The Third Reviewing Committee has recommended a review of the salaries of the auxiliary technical staff, keeping in view the emoluments available to them in industry.

Recruitment and promotions

78. The recruitment to all categories of scientific and research staff in the CSIR laboratories and in other scientific and technological institutions is through open advertisement in newspapers and scientific and technical journals. Recruitment to the senior posts is made on an all-India basis. Selection is made by the selection committees consisting of scientists and technologists from the universities and industrial research laboratories, and officials from the concerned government departments. The posts of the directors are not advertised in this manner, but wide publicity is given through notifications in the scientific and technical journals. The chief executive officer of the Council, i.e. the Director-General, and members of the selection committee collect names with curriculum vitae and other data of prospective candidates out of which a selection is finally made.

79. For the scientists, promotion to a higher post is through a review every five years when the work of each scientist is judged by a committee of experts. In case his work is above average, he is promoted to the next grade. Promotion is also possible through the scientists applying for a post carrying a higher grade when it is advertised. There is also a system of "merit promotion", where a scientist of exceptional merit can be considered for promotion to any higher category of post depending upon his qualifications and quality of work.

80. The scientists are permitted to apply for posts outside their department and laboratories, but the number of such applications is restricted to two per year. In spite of these restrictions, the movement of certain categories of staff is quite high.

Salaries

81. The scientific personnel with M.Sc. degree or above may be recruited in any of the following grades at the salaries given:

(a) Junior scientific assistant:	Rs. 210-425;
(b) Senior scientific assistant:	Rs. 325-575;
(c) Scientist Grade A:	Rs. 350-900;
(d) Scientist Grade B:	Rs. 400-950;
(e) Scientist Grade C:	Rs. 700-1,250;
(f) Scientist Grade D:	Rs. 1,300-1,600;
(g) Scientist Grade E:	Rs. 1,600-1,900.

82. The laboratories of the Council, as well as universities and industrial companies, provide amenities to a part of their staff by way of housing etc. However, this aspect requires much greater attention. At an average not more than 30 per cent of the scientific research staff in the laboratories have been provided with housing.

83. The salaries of the staff in the scientific grades do not compare yet with those in the administrative services and this is one of the shortcomings of the Indian scientific and educational system. The better students continue to be attracted to the administrative services because the salaries, promotions and privileges available in the administrative cadre are much better than those available to scientists and technologists.

G. Dissemination of information and application of results of industrial research

Industrial liaison and extension services

84. Every industrial research laboratory under CSIR has a division or a unit whose specialized job it is to maintain contact and liaison with industry, to assist in the communication of the results of research from the institute to the industry and to help in the industrial application of the results of research. Most of the laboratories also bring out periodic publications in the form of brochures, bulletins and/or technical digests, aimed at supplying information to their specialized field of industry. Some laboratories also have technical abstracting and documentation services. Besides these, the CSIR headquarters has an industrial liaison and extension services unit which co-ordinates the work of the industrial liaison units of the laboratories and supplements their efforts in maintaining contact with the Federation of the Chambers of Commerce and Industry, central government departments and the departments and ministries responsible for planning and industrial development. The different activities under this head are briefly described below.

Publications and information

85. CSIR headquarters has under it a Publications and Information Directorate which publishes the following scientific journals:

(a) Journal of Scientific and Industrial Research;
(b) Indian Journal of Pure and Applied Physics;
(c) Indian Journal of Chemistry;
(d) Indian Journal of Technology;
(e) Indian Journal of Experimental Biology;
(f) Indian Journal of Biochemistry.

86. The Directorate also brings out a journal, Research and Industry especially designed to communicate the results of research which are ready for industrial utilization. The Industrial Liaison and Extension Services Unit also brings out a quarterly "information news-letter" carrying information on the results of research projects which are already complete or at a stage nearing completion and which are of direct interest to the industry. The Publications Directorate also publishes a monthly journal in Hindi, Vigyan Pragati, giving items of interest to small, cottage and rural industries. The following laboratories also publish their own bulletins which are given below:

Central Glass and Ceramic Research Institute, Calcutta: A technical bulletin and technical abstracts for glass, ceramic and refractories industries;

National Metallurgical Laboratory, Jamshedpur: A technical bulletin for metallurgical industry;

Central Food Technology Research Institute, Mysore: A monthly journal Food Science;

Central Leather Research Institute, Madras: Leather Science;

Central Fuel Research Institute, Jealgora; "FRI News";

Central Building Research Institute, Roorkee: "Building Digest";

Central Public Health Engineering Research Institute, Nagpur: "Environmental Health".

87. Besides these, every laboratory brings out its annual technical report as well as technical reports on several technical projects or subjects of scientific and industrial importance. The laboratories also carry out surveys of industries, sometimes in collaboration with other institutions, such as the National Productivity Council, the Directors of Industries of the States, or the Small-Scale Industry's Service Institutes.

Indian National Scientific and Documentation Centre (INSDOC)

88. The major activity of the INSDOC lies in supplying reprints, photocopies, microfilms and other scientific material to the research workers and institutions for nominal payment. INSDOC also produces a journal containing a list of research papers published in South and South-East Asia.

Central Design and Engineering Unit

89. Since one of the major reasons for non-utilization of results of research from laboratories is the absence of design and consulting engineering services in the country, CSIR has set up a central design and engineering unit which is expected to undertake the task of design, engineering, procurement of equipment and its fabrication in the country, erection and commissioning of industrial plants based upon the studies carried out at the pilot-plant level in the laboratories. The unit would also evaluate the data obtained by the laboratories at the pilot-plant level in regard to its adequacy or otherwise for the purpose of upscaling to industrial level. The unit would supplement the efforts of the chemical engineering and design units in the laboratories and would assist them either on specific projects on which data may be available with them or by taking up complete design engineering of projects which may be considered of national importance. This unit is proposed to be expanded into a design and engineering institute with participation of industry.

National Research Development Corporation of India (NRDC)

90. On the lines of the corresponding organization in the United Kingdom, the results of research carried out in the CSIR laboratories are offered for utilization through NRDC, a body set up under the Companies Act with the following aims and objects:

(a) To develop and exploit in the public interest, for profit or otherwise, inventions, whether patentable or otherwise, including technical and engineering know-how of processes developed by the CSIR laboratories and other governmental and semi-governmental research institutes or industries;

(b) To enter into reciprocal arrangements with similar organizations in other countries, to exploit Indian inventions in these countries and their inventions in India;

(c) To issue exclusive and/or non-exclusive licences on such terms and conditions regarding payment of premiums, royalties, share of profits and/or any other basis as are considered advisable to commercially developed inventions and to ensure commercial production of the products of invention;

(i) To instal and work pilot, prototype or semi-commercial units or full commercial plants to develop a particular invention or inventions and to ensure production from such invention or inventions; and to sell or otherwise dispose of the products of such inventions on payment or otherwise and generally on such terms and conditions as may be deemed fit.

91. The Corporation, which has technical and administrative staff of its own, receives information about the results of research which have reached the stage of industrial utilization from the laboratories of CSIR or other public and private research institutions and government departments. It then publicizes research in all scientific and technical, industrial and trade journals, inviting interested entrepreneurs to make their offers or terms for the licensing of the processes developed by the laboratories. Depending upon the requirements of the market, the processes are licensed to one or more parties on suitable terms. The Corporation also assists the parties by way of training of personnel in the laboratories and helping them in many other ways to achieve successful implementation of the results of research.

92. The Corporation also finances development projects consisting of pilot plants and prototype plants for trying out the results of research at this level before they are offered for commercial utilization.

Industrial consultancy services

93. Under the present rules, the national laboratories can act as consultants to the industries, and the services of the scientific and technical personnel can be used by the industries for advising on their problems. The industry can also indicate the particular scientist with whom they would like to consult. The industries also sponsor specific research projects in the laboratories against payment, where the results are made available to them on exclusive or preferential basis.

94. Although these facilities exist, sufficient use of them has not been made by the industry. This is particularly so because most of the industries are being developed in the country with foreign collaboration, with future development and improvement on the basis of research in their own countries.

Design services

95. The small industry service institutes, which are mostly located near industrial estates also provide design, workshop and engineering facilities to small industries in the area. Usually an industrial estate is established where land, electricity and water and other facilities are provided by the state governments at concessional rates and where a large number of industries are grouped together into an area. The small industry service institute establishes a design and engineering workshop in such an area to provide design and fabrication facilities to the neighbouring industries.

Extension services

96. A number of laboratories under CSIR have their extension centres located in different parts of the country. CSIR laboratories which have field centres

[illegible] those on food, metallurgy, public health, [illegible] and mechanical engineering. Most of these [illegible] the industry. These centres are provided with technical [illegible] constant contact with industry of the area and act [illegible] the results of research and information to the industry. They [illegible] analysis, quality control, varietal trials on fruits and [illegible] the region, studies of raw materials and actively assist the industry [illegible] the specialized knowledge from their parent institutes for application in the industry. They also, to an extent, serve as a feedback of the problems requiring investigations to their parent industries.

97. Some of the extension centres hold demonstrations for an industry by sending specialized teams and inviting the industry to witness these demonstrations. These demonstrations are usually held in the premises of selected industries.

Seminar, symposia

98. Most of the laboratories of the Council hold one or two seminars or symposia every year on technical subjects where scientists and technologists from the industry, universities and international organizations are invited to discuss the results of research presented in the form of papers, lectures or discussions. These seminars serve as a valuable forum for personal contact and for exchange of views on scientific and technical subjects. They also provide means whereby outside scientists and industrialists can visit the research laboratories and see for themselves the facilities available for investigation, as well as the schemes and projects on which active research is in progress in the laboratories.

Open days

99. Most of the laboratories have one or two "open days" every year during which they make every effort to invite the public to visit the laboratories when the scientists explain the significance of their work and its application to the public. One day is specifically reserved for industrialists who are taken round the various research and pilot-plant sections of the laboratory and explained the work of the laboratories.

Inquiry services

100. Every laboratory entertains and receives a large number of inquiries from the public and from the industries. Most of these inquiries are answered on the basis of available technical knowledge in technical literature, books and journals. However, some of these inquiries yield problems which form the basis of further investigations and are put on the regular programme of the laboratories. Some inquiries also result in sponsored research projects. The inquiry service offers a useful means of continuous contact with the industry. The laboratories arrange visits by their specialized personnel to industries either by deputing their staff or against payment by the industry to render technical assistance and offer industrial advice.

H. Technical assistance received

101. CSIR and its laboratories, institutes of technology and other research, training and technical organizations have received a substantial amount of aid from more advanced countries. The Institute of Technology, Bombay, has received equipment and experts, such as professors from the Soviet Union who have also provided for the visits of Indian personnel for higher training in the Union of Soviet Socialist Republics. They will, in due course, take the place of the Soviet experts who would return at the completion of their assignment. Similarly, the Institute of Technology at New Delhi has been set up with the assistance of the Imperial College of Science and Technology in the United Kingdom. The Institutes of Technology at Madras, Kanpur and Kharagpur have received financial aid from the United States of America, the United Kingdom, the Federal Republic of Germany, etc. in the form of equipment, library faciliites and experts. CSIR and its laboratories received aid under various programmes sponsored by the United Nations, United Nations Educational, Scientific and Cultural Organization (UNESCO), United States of America Technical Co-operation Mission (TCM), Colombo Plan, United Nations Technical Assistance Board (UNTAB), etc. Most of this aid comes in the form of equipment and experts for the setting up of newer institutes in the fields of engineering, petroleum research and technology, instrumentation, public health, etc. Details of the aid that has been provided are given in annex VI.

ANNEX I

Table 1

National laboratories, institutes and other units under CSIR

S. No.	Laboratory/Institute/Unit	Year of establishment	Name of Director/ Principal executive officer
I.	Research laboratories/institutes		
1.	National Chemical Laboratory, Poona	1950	Dr. K. Venkataraman
2.	National Physical Laboratory, New Delhi	1950	Dr. G.D. Joglekar (Scientist-in-charge)
3.	Central Fuel Research Institute, Jealgora	1950	Dr. A. Lahiri
4.	Central Glass and Ceramic Research Institute, Calcutta	1950	Dr. Atma Ram
5.	Central Food Technological Research Institute, Mysore	1950	Dr. H.A.B. Parpia
6.	National Metallurgical Laboratory, Jamshedpur	1950	Dr. B.R. Nijhawan
7.	Central Drug Research Institute, Lucknow	1951	Dr. M.L. Dhar
8.	Central Road Research Institute, New Delhi	1952	Prof. S.R. Mehra
9.	Central Electro-Chemical Research Institute, Karaikudi	1953	Dr. K.S.G. Doss
10.	Central Leather Research Institute, Madras	1953	Dr. Y. Nayudamma
11.	Central Building Research Institute, Roorkee	1953	Shri. Dinesh Mohan
12.	National Botanic Gardens, Lucknow	1953	Prof. K.N. Kaul
13.	Central Electronics Engineering Research Institute, Pilani	1953	Dr. Amarjit Singh
14.	Central Salt and Marine Chemicals Research Institute, Bhavnagar	1954	Dr. D.S. Datar (Deputy director-in-charge)
15.	Central Mining Research Station, Dhanbad	1955	Dr. K.N. Sinha
16.	Regional Research Laboratory, Hyderabad	1956	Dr. G.S. Sidhu
17.	Indian Institute for Biochemistry and Experimental Medicine, Calcutta	1956	Dr. S.H. Zaidi

18.	Regional Research Laboratory, Jammu	1957	Dr. K. Ganapatti
19.	Central Mechanical Engineering Research Institute, Durgapur	1958	Shri. M.M. Suri
20.	Central Indian Medicinal Plants Organization, Lucknow	1959	Dr. B.N. Mitra
21.	Central Public Health Engineering Research Institute, Nagpur	1959	Shri. R.S. Mehta
22.	Central Scientific Instruments Organization, Chandigarh	1959	Dr. P.S. Gill
23.	National Aeronautical Laboratory, Bangalore	1959	Shri. K.G. Krishnamurthi (Officer on special duty)
24.	Indian Institute of Petroleum, Dehra Dun	1960	Dr. M.G. Krishna
25.	National Geophysical Research Institute, Hyderabad	1961	Dr. Hari Narain
26.	Regional Research Laboratory, Jorhat	1961	Dr. M.S. Iyengar
27.	Indian Ocean Expedition, New Delhi	1962	Dr. N.K. Panikkar

II. <u>Industrial and technological museums</u>

28.	Birla Industrial and Technological Museum, Calcutta	1959	Shri. S.K. Bagchi (Curator-in-charge)
29.	Visvesvaraya Industrial and Technological Museum, Bangalore	1962	Shri. A. Bose (Officer-in-charge)

III. <u>Scientific and technical services organizations and units</u>

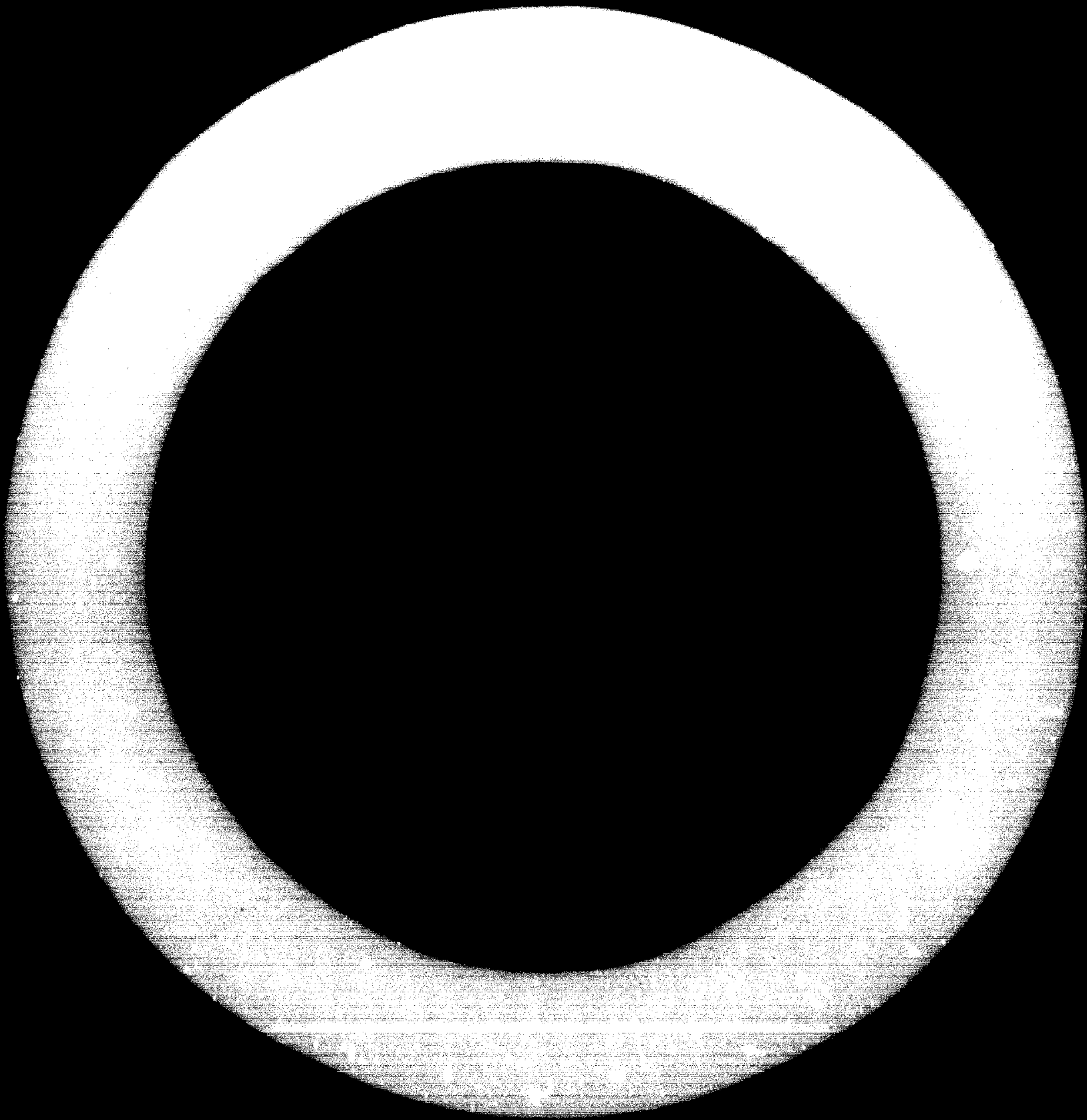
30.	Patents Unit	1942	Shri. R.B. Pai (Patents officer)
31.	National Register for Scientific and Technical Personnel	1948	Shri. K. Ray (Deputy director)
32.	Information and Publications Directorate	1951	Shri. B.S. Kesvan (Director)
33.	Indian National Scientific Documentation Centre	1951	Shri. B.S. Kesvan (Director)
34.	Defence Co-ordination Unit	1962	Shri. A.K. Bose (Defence Co-ordination Officer)
35.	Research Co-ordination, Industrial Liaison and Extension Services Unit	1963	Shri. Baldev Singh (Research Co-ordination, industrial liaison and extension officer)
36.	Central Design and Engineering Unit	1963	Dr. K.S. Chari (Deputy director)
37.	Survey and Planning of Scientific Research Unit	1963	Shri. A. Rahman (Deputy director)

ANNEX II

TABLE 3

Statement of co-operative research associations

Sl. No.	Co-operative research association	Year of estab-lishment	Industry served	CSIR financial support 1961-62	1962-63	1963-64
				(Rs. in millions)		
1.	Ahmedabad Textile Industry's Research Asson., Ahmedabad	1947	Cotton textile	0.6740	0.5217	0.6340
2.	South India Textile Research Association, Coimbatore	1956	Cotton textile	0.2480	0.5140	0.2675
3.	Silk and Art Silk Mills Research Association, Bombay	1957	Art silk	0.2196	0.2178	0.2400
4.	Indian Rubber Manufacturers' Research Asson., Calcutta	1959	Rubber	0.0032	0.0120	0.0071
5.	Bombay Textile Research Association, Bombay	1960	Cotton textile	0.4176	0.4440	0.4208
6.	Indian Plywood Industries Research Association, Bangalore	1960	Plywood	...	0.0200	0.1530
7.	Indian Paint Research Asson., Calcutta	1962	Paint	...	...	...
8.	Tea Research Institute, Toklai (Assam)	1963	Tea	...	...	0.2000
			Total	1.5624	1.7295	1.9224



ANNEX III

Table 4

Number of senior/junior fellowships awarded in the universities/research institutes outside CSIR 1957-1963

Year	Fellowships			Expenditure (lakh rupees)
	Senior	Junior	Total	
1957-58	-	2	2	
1958-59	19	43	62	
1959-60	46	132	178	[illegible]
1960-61	84	209	353	11,516
1961-62	114	376	490	11,717
1962-63	101	364	465	16,855
1963-64	353	1,212	1,565	31,289

ANNEX IV

Scientific policy resolution

New Delhi, 4 March 1958/13th Phalguna, 1879

1. No. 131/CF/57 - The key to national prosperity, apart from the spirit of the people, lies, in the modern age, in the effective combination of the three factors, technology, raw materials and capital, of which the first is perhaps the most important, since the creation and adoption of new scientific techniques can, in fact, make up for a deficiency in natural resources, and reduce the demands on capital. But technology can only grow out of the study of science and its applications.

2. The dominating feature of the contemporary world is the intense cultivation of science on a large scale, and its application to meet a country's requirements. It is this, which, for the first time in man's history, has given to the common man in countries advanced in science, a standard of living and social and cultural amenities, which were once confined to a very small privileged minority of the population. Science has led to the growth and diffusion of culture to an extent never possible before. It has not only radically altered man's material environment, but, what is of still deeper significance, it has provided new tools of thought and has extended man's mental horizon. It has thus influenced even the basic values of life, and given to civilization a new vitality and a new dynamism.

3. It is only through the scientific approach and method and the use of scientific knowledge that reasonable material and cultural amenities and services can be provided for every member of the community, and it is out of a recognition of this possibility that the idea of a welfare state has grown. It is characteristic of the present world that the progress towards the practical realization of a welfare state differs widely from country to country in direct relation to the extent of industrialization and the effort and resources applied in the pursuit of science.

4. The wealth and prosperity of a nation depend on the effective utilization of its human and material resources through industrialization. The use of human material for industrialization demands its education in science and training in technical skills. Industry opens up possibilities of greater fulfilment for the individual. India's enormous resources of manpower can only become an asset in the modern world when trained and educated.

5. Science and technology can make up for deficiencies in raw materials by providing substitutes, or, indeed, by providing skills which can be exported in return for raw materials. In industrializing a country, a heavy price has to be paid in importing science and technology in the form of plant and machinery, highly paid personnel and technical consultants. An early and large-scale development of science and technology in the country could therefore greatly reduce the drain on capital during the early and critical stages of industrialization.

6. Science has developed at an ever-increasing pace since the beginning of the century so that the gap between the advanced and backward countries has widened more and more. It is only by adopting the most vigorous measures and by putting forward our utmost effort into the development of science that we can bridge the gap. It is an inherent obligation of a great country like India, with its

traditions of scholarship and original thinking and its great cultural heritage, to participate fully in the march of science, which is probably mankind's greatest enterprise today.

7. The Government of India has accordingly decided that the aims of its scientific policy will be:

(i) to foster, promote, and sustain, by all appropriate means, the cultivation of science, and scientific research in all its aspects - pure, applied and educational;

(ii) to ensure an adequate supply, within the country, of research scientists of the highest quality, and to recognize their work as an important component of the strength of the nation,

(iii) to encourage and initiate, with all possible speed, programmes for the training of scientific and technical personnel, on a scale adequate to fulfil the country's needs in science and education, agriculture and industry, and defence;

(iv) to ensure that the creative talent of men and women is encouraged and finds full scope in scientific activity;

(v) to encourage individual initiative for the acquisition and dissemination of knowledge, and for the discovery of new knowledge, in an atmosphere of academic freedom;

(vi) and, in general, to secure for the people of the country all the benefits that can accrue from the acquisition and application of scientific knowledge.

The Government of India has decided to pursue and accomplish these aims by offering good condition of service to scientists and according them an honoured position, by associating scientists with the formulation of policies, and by taking such other measures as may be deemed necessary from time to time.

ANNEX V

Table [illegible]

Statement showing growth of expenditure of CSIR (including national laboratories/institutes) 1954-1965

Year	Expenditure (Rupees in lakhs)
1954-55	216,757
1955-56	274,868
1956-57	309,060
1957-58	365,836
1958-59	472,507
1959-60	591,780
1960-61	687,759
1961-62	812,630
1962-63	958,725
1963-64	1,175,000

ANNEX VI

Table 6

Statement showing financial assistance by international organizations (1960 onwards)

S. No.	Laboratory/institute/project	Duration	Amount of grant (rupees)
I.	<u>United Nations Special Fund</u>		
1.	Central Mechanical Engineering Research Institute, Durgapur	1960-63	34,43,750
2.	Central Mining Research Station, Dhanbad	1960-65	33,05,525
3.	Central Public Health Engineering Research Institute, Nagpur	1961-65	24,93,750
4.	National Aeronautical Laboratory, Bangalore	1961-66	68,38,575
5.	Central Scientific Instruments Organization, Chandigarh	1962-65	46,80,650
6.	Institute of Tropical Meteorology, Poona, and International Meteorological Centre (IMC) Bombay (CSIR is contributing towards the setting up of IMC only)	1963-66	41,49,125
II.	<u>Ford Foundation, New York</u>		
1.	Central Drug Research Institute, Lucknow	1962-67	13,77,500
III.	<u>Rockefeller Foundation, United States of America</u>		
1.	National Chemical Laboratory, Poona	1961-63	1,80,000
A.	P.L. 480: <u>United States Department of Agriculture Grants</u>		
1.	Central Leather Research Institute, Madras		
	(i) Studies on the mode of reaction of polyphenolic tanning compounds with hide proteins (collagen) to obtain fundamental information for developing heavy leather with improved properties	1961-66	1,81,000

		Amount of grant (rupees)
(ii) Studies of the interrelation of hide quality with the rate of tanning and the efficiency of tanning to obtain information for use in developing improved processes for making leather	1961-64	1,28,000
(iii) Studies on shrinkage phenomenon in collagen and leather	1961-64	3,70,000
2. Regional Research Laboratory, Hyderabad		
(iv) Exploratory investigations of selected hydroxylated derivatives of linseed, safflower and soya bean to determine feasibility of producing new industrial products from these oils	1963-68	1,10,440
(v) Preparation of polymerizable monomers from castor oil	1963-68	1,51,255
(B) P.L. 480: National Institute of Health, United States of America		
1. Central Food Technological Research Institute, Mysore		
(i) Production of protein rich foods using oilseed meals	1961-65	37,20,000
2. Central Drug Research Institute, Lucknow		
(ii) Development of potential anti-cancer agents	1962-65	2,79,100
(C) P.L. 480: National Bureau of Standards, United States of America		
1. National Physical Laboratory, New Delhi		
(i) Study of F-layer effects with Doppler fading technique	1961-64	1,14,500
(ii) Determination of physical properties of and irradiation effects on ionic crystals and semi-conductors with a view to develop more useful solid state device	1961-65	2,00,000

			[illegible]
[illegible].	National Chemical Laboratory, Poona		
(iii)	Chemical and thermodyamic properties of refractory materials at high temperat[illegible]	[illegible]	[illegible]
(iv)	Investigation of the synthesis and properties of new type glycolmone-alkyl ethers for the control of water evaporation to extend the industrial utilization of cotton-seed oil	1961-66	4,41,800
(v)	Investigation of the effect of heat of tung oil and the characterization and identification of compounds resulting from heat treatment to extend the utilization of tung oil	1961-66	2,31,500
(vi)	Investigation of the isoflavones of petroleum ether-extracted soya bean meal as a basis for improving the feeding value of soya bean oil meal	1962-67	2,70,358
3.	Central Leather Research Institute, Madras		
(vii)	Preparation and physicochemical properties of polypeptidy collagens, plastins and model collagens	1961-64	67,429
(viii)	Basic studies on the physical and chemical properties of tanned collagen fibre to obtain fundamental information on criteria	1963-68	2,50,655
4.	Central Drug Research Institute, Lucknow		
(ix)	Investigation of the distribution of aerobic actinomycetes with particular emphasis on their isolation, characterisation, antibiotic production and production and preservation, for placement in the culture collection of the Agriculture Research Service as potential agents for the conversion of farm-produced raw materials to products useful to industry and the consuming public	1962-67	4,17,500

			Amount of grant (rupees)
(D)	P.L. 480: Bureau of Commercial Fisheries		
1.	Central Food Technological Research Institute, Mysore		
	Investigation on the influence of processing methods and other factors on the edible quality and nutritive value of fish-flour	1962-64	2,50,000
IV.	United Nations Children's Fund		
1.	Central Food Technological Research Institute, Mysore	1961	1,00,000
V.	Swiss Foundation for Technical Assistance, Zurich		
1.	Central Scientific Instruments Organization, Chandigarh	1961-64	35,08,000 for equipment and the services of about eight Swiss experts
VI.	Population Council, New York		
1.	Central Drug Research Institute, Lucknow	1961-64	2,00,118
VII.	French Institute of Petroleum		
1.	Indian Institute of Petroleum, Dehra Dun	1960-65	18,90,000
	Total during 1960-68		4,26,00,550

XXIII. INDUSTRIAL RESEARCH IN IRAN

Prepared by Manouchehr Taslimi*

A. National industrial research policy

1. After the introduction and successful implementation of land reform, one of the six major articles of reconstruction approved by the people in the referendum of 26 January 1963, the acceleration of industrial development, particularly in the fields relating to agriculture, assumed greater significance. And in this new light, the need for industrial research, little heeded until then, became more apparent and was fully recognized by the officials of the Ministry of Economy and the Plan Organization. Industrial research consciousness among the industrialists is yet to be created. However, fundamental and applied research have been carried out, on a small scale, in the seven universities and the three institutes of technology of Iran for the last twenty-five years. But this has only been owing to the personal interest of the individual research-worker, a lonely traveller, whose efforts have not always been appreciated by the industrialists. Consequently, it has had little impact, if any, on the development of industries. The new impetus in the Ministry of Economy has had to go a long way to clear the ground for future development.

B. Background and current arrangements

2. In 1956, according to an agreement contracted between the Governments of Iran and the United States of America, a project was devised to establish a centre for industrial research, consisting of six laboratories, i.e., ceramics, chemistry, textiles, leather, foundry and repair-shop. Construction of buildings started in 1958 at Karaj, forty kilometres west of Teheran, and was completed in 1960. The area of the plot of land in which the buildings are located is eight hectares The total floor surface is about 5,000 square metres.

3. The cost of buildings and equipment to this date amounts to $US900,000, one-third of which was contributed by the Government of the United States of America.

4. Recently, the Ministry of Economy decided to place its industrial research laboratories under the Institute of Standards. The latter organization is attached to the Ministry of Economy and has a governing council whose members are appointed by the Minister for a term of two years. It is run as a commercial concern and does not observe the rules and regulations of the Treasury. It is hoped that this new arrangement will result in:

(a) Attracting better qualified scientists, engineers and technicians by offering more favourable terms of employment;

(b) Putting an end to the chronic shortage of funds for research;

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* Professor of Historical Science and Technology, Teheran University.

(c) Preventing duplication of efforts and expenses;

(d) Providing stronger incentives for producers, industrialists and farmers, as well as those engaged in export, to refer to the industrial research centre and profit by its services.

C. Function and scope

5. The industrial research centre of Iran attempts:

(a) To obtain, classify and publish information and statistics concerning all the different aspects of industry and mining in the country;

(b) To carry out research concerning all the industrial products and mineral resources of the country, either directly or by contracts with the institutes of technology and engineering colleges;

(c) To determine the standards of industrial products and provide laboratory testing service;

(d) To carry out socio-economic research serving the industry;

(e) To provide consultation services;

(f) To provide training courses for skilled workers and technicians in the industry, and arrange seminars to discuss economic and industrial problems;

(g) To exchange information with industrial research centres in other countries.

D. Problems and needs

6. With the gradual expansion of the volume of industrial investment, public as well as private, there is a proportional increase in the demands made on the industrial research centre. To meet this pressing need for more and diverse research, a few obstacles will have to be overcome. They are as follows:

(a) Scarcity of qualified scientists, engineers and technicians to be recruited for research. In this connexion, steps have been taken to entice the prospective candidates into employment by offering them numerous financial remunerations over and above their basic salaries;

(b) Lack of industrial research tradition and discipline. This would call for technical assistance, envisaged to be received from the United Nations. Owing to a decline of programmes in Iran of the Agency for International Development (United States of America), it appears that no assistance will be forthcoming through bilateral agreements;

(c) Lack of equipment, particularly in the field of electricity. The requirements have been listed, but no action has been taken to procure them, awaiting the benefit of expert advice.

XXIV INDUSTRIAL RESEARCH IN CEYLON

Prepared by A. Navaratnarajah*

A. Government's role in developing countries

1. The dynamic and basic role that Governments have to play in promoting industrial development and research in developing countries is now well recognized. Unlike the Governments of developed countries, which can well be content to be referees and umpires, the Governments of developing countries have not only the responsibility of providing the framework for development and research, but also to be active participants in such development. The initial lead will have to be given by the Government for the "take-off". The minimum framework that Governments have to provide for any development are: (a) security and order, (b) a general level of education with special emphasis on technology; (c) adequate health facilities; (d) adequate transport facilities; (e) power; and (f) an efficient and honest public administration.

2. Having provided these basic facilities, the Government of the developing country has the further responsibility, if the country is to achieve development, of:

(a) Making a survey of available resources;

(b) Carrying out research on the utilization of these resources;

(c) Carrying out research on the efficiency of the factors that process these resources;

(d) Training of technical personnel for carrying out the research and for maintaining competently any industry;

(e) Arranging for foreign technical assistance and foreign technical know-how;

(f) Setting up pilot projects as well as investing in important industries where private capital is hardly likely to be forthcoming;

(g) Creating the necessary atmosphere and incentives to draw out private capital from the traditional investments to investments in industry;

(h) Setting up financial organizations to provide credit facilities;

(i) Adopting a fiscal policy which, while it would generate incentives for development and local manufacture, would also ensure that:

- (i) It had adequate financial resources to undertake its vast and manifold responsibilities;
- (ii) There was a fair distribution of wealth;
- (iii) There was protection for local manufacturers, while not unduly increasing consumer costs;

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* Director, Development Division, Ministry of Industries.

(iv) Foreign capital was to be encouraged, not in competition with local capital but in those areas where local capital was shy,

(v) Inflation was not created, but on the other hand the supply of money for developing needs was not restricted,

(j) apportioning the limited foreign exchange that is available will be between essential consumption and much needed development and even within development, on a basis of priorities for the several competing needs of development. Hereto, the Government is charged with the responsibility of apportioning the exchange available between the country's needs of capital investment and raw materials needed to keep the existing industries going.

3. Successive national Governments of Ceylon have accepted these responsibilities

<u>**Background information**</u>

4. Ceylon is a small country of 25,000 square miles, with a population of 12 million. It has a cultural heritage dating back 2,500 years. She lost her independence at the beginning of the sixteenth century to the Portuguese. The Portuguese were succeeded by the Dutch, who in turn were displaced by the British. After 450 years of colonial rule by these three Powers, it emerged again as an independent nation within the British Commonwealth in 1948.

5. Of the imperialist Powers, the only Power which effected any development of significant importance was the United Kingdom. It developed three plantation sectors of economy: the tea, rubber and coconut industries. These three industries even today account for 95 per cent of Ceylon's revenue, as well as foreign exchange earnings.

6. The tea and rubber industries were essentially in foreign hands, while the coconut industry was mostly with indigenous capital. The colonial economy was mainly the export of these primary products after the preliminary processing and the import of the essential consumer goods.

7. These industries permitted Ceylon to be provided with the basic facilities that are required for industrialization. Thus, the United Kingdom Government ensured a united Ceylon, with a well-established tradition for security and order. Ceylon too can claim to be one of the most literate countries among the developing countries. It has had a free education scheme since 1941, from the kindergarten to the university. It has also a well-developed health service. Owing to the plantation industries, the colonial government had to invest in a wide network of transport facilities. Ceylon currently has three major harbours, a railway connecting practically all parts of the island, and a well-planned system of road networks. Its public administration compares very favourably even with that of developed countries. For servicing the three plantation industries, major engineering firms had been established. This provided limited industrial experience, a comparatively small trained labour and the beginnings of technical know-how. The banking and commercial sectors also had been developed.

8. More important to this paper is the fact of recognition given by the colonial government to applied research by the establishment of research institutes in each of these industries. The earliest research institute was the Tea Research Institute, which was founded by Statute No. 1[illegible] of 1925. The law provided for an

[illegible]onomous institute for the purpose of research, [illegible] training. The Institute was placed under the [illegible] representative of all interests connected with [illegible]. [illegible] elected by the board. The financing of the Institute [illegible] which currently is 55 Ceylonese cents [illegible]. [illegible] institutions were established for rubber (1930) and coconut ([illegible]).

9. These three institutes were mainly concerned with the agricultural aspects [illegible] the industry, although they provided some assistance and facilities for the industrial aspects of processing these agricultural products. Thus, they advised on factory layout, equipment and processing. Their importance for these three major industries cannot be over-emphasized. They have proved themselves very valuable assets and their work has gained international recognition. Successive Governments have recognized them and hardly any question on these industries is decided without consulting them. They have gained a reputation for impartial, well-considered scientific advice free of any political or other bias. Until recently, these institutes were manned by foreign personnel, but they have now been mostly replaced by local personnel. It is important to observe, however, that despite the post-independence Government's keen policy of "Ceylonization", the research institutes have been kept clear of such nationalistic considerations.

10. The tradition of applied research and the entrustment of such research to autonomous institutions was therefore well established in Ceylon.

Beginnings of industrial research and development

11. The colonial policy, however, was not to develop manufacturing industries. The idea was fostered that Ceylon, being too small in its market and lacking in such essential resources as capital, technology and raw materials, would do well to develop its agricultural products for export rather than to enter into manufacturing industries. Even indigenous capital sought the export industries and finding adequate returns in these investments, never ventured into industry. With the first signs of independence, however, the outlook began to change.

12. The Donoughmore Constitution in 1930 provided for constitutional reforms and gave the people of Ceylon a certain measure of self-government. The Constitution provided universal franchise, and an elected assembly and a Board of Ministers, who were responsible for the internal government of the country. One of the first acts of the Donoughmore Reforms was to provide a Ministry of Labour, Industries and Commerce.

13. The new Ministry of Labour, Industry and Commerce took over the entire responsibility of making a survey of available resources, carrying out research on the utilization of these resources and carrying out research on the efficiency of the factories that process these resources. The Ministry also arranged for the training of technical personnel for carrying out research. The Ministry created a Department of Industries and within this Department set up an industrial laboratory for:

(a) Ascertaining the properties of raw materials found in Ceylon;

(b) Investigating the industrial uses to which they can be put,

(c) Laying down standards for local raw materials [illegible]

(d) Assisting government factories in their problems,

(e) Assisting local private sector industries.

14. The Department also recruited science graduates from the university and after an initial period of training at the research laboratory, sent them overseas for advanced study of technology in particular fields. Simultaneously, a separate department of geology was established to investigate the availability of raw materials and mineral resources. These investigations revealed the availability of the following natural resources: limestone, graphite, mica, ilmenite, monazite, salt, kaolin, glass-sand and, more recently, iron ore deposits. A quantitive estimation of these resources was made by the Department of Geology and economic exploitation was experimented by the Department of Industries.

15. The advent of the Second World War made it urgent that local industrialization should begin at once. Essential raw materials like acetic acid were uncertain and hindered the war effort. The work that this small industrial research laboratory did with its humble beginnings began to yield immediate fruits. The Industries Department was able to set up the following factories, which were established with State capital and departmentally managed, as pilot projects on the results of the research carried out in the laboratory:

(a) Plywood and saw-mill;

(b) Steel rolling mill;

(c) Leather factory and tannery;

(d) Quinine and drugs factory;

(e) Coir yarn factory;

(f) Ceramic factory;

(g) Acetic acid factory;

(h) Glass factory;

(i) Semi-mechanized paper factory.

16. In setting up these pilot projects, the Department was badly handicapped, as no capital machinery could be obtained during the war. Second-hand machinery had to be adapted and utilized. For instance, the ceramic factory had to use a second-hand desiccated-coconut mill together with second-hand machinery obtained from India. The paper factory used a drier which was usually used for drying desiccated coconut. The boiler for the steel rolling mill was one which had been condemned by the railway, but which was used in the factory after repairs.

17. While all these activities were being undertaken by the State, the private sector showed hardly any interest in industrialization. When the Government decided to open the plywood factory, it offered this industry to the private sector. The tea industry was importing its requirements of tea chests from abroad. Th restrictions on trade consequent to the war imperiled the Ceylon tea industry.

imports of tea chests had virtually ceased and the industry was forced to pay any price for the chests. Here then was an industry with a guaranteed profit. The private sector still did not display any interest and the Government had to step in.

18. In 1948, Ceylon became an independent nation within the framework of the British Commonwealth. The factories that had been put up during the war could not stand up to peace-time conditions. Their products could not compete either in quality or in price with imported goods. Consequently, the Government looked askance on these factories. With a view to reorganizing these factories and setting up the base for industrialization on a sound footing, the Government invited a large number of foreign experts in various fields. The United Nations and other international organizations for aid readily came to the assistance of Ceylon. One of the most significant teams sent to Ceylon was the World Bank Mission. The Mission, after reviewing progress made in industry and industrial research, recommended the immediate creation of an autonomous applied research institute as the first and most essential step for industrial development. Government accepted this recommendation and created the CISIR.

B. The Ceylon Institute of Scientific and Applied Research

19. The CISIR was founded as an autonomous institute by Statute No. 15 of 1955. It has its headquarters in Colombo. The headquarters is in a building of 40,000 square feet and is well equipped with a laboratory, workshop and library. Its objectives are:

(a) Technological research with special emphasis on the utilization of local resources;

(b) Standards testing;

(c) Promotional activities;

(d) Training of research workers;

(e) Dissemination of scientific and technical information.

The Institute is under the charge of the Ministry of Industries.

Board

20. The management of the Institute is vested in a board which, in its original concept, was to be constituted of: (a) Three members elected by successive boards (the first three members were to be appointed by the Minister in charge of Industries); (b) one member appointed by the Prime Minister; (c) one member appointed by the Minister of Finance; (d) two *ex-officio* members, the Permanent Secretary to the Ministry of Industries and the Director of the Institute.

21. The Chairman of the Board was appointed by the Minister annually. The members were appointed for two years. These were honorary appointments.

Administration

22. The director is appointed by the Minister and is a paid employee, whose terms and conditions of employment are fixed by the Minister of Industries in consultation with the Minister of Finance. The Director is ex-officio vice chairman of the board. The board is responsible for all appointments to the Institute, but delegates the power of appointing all officers except the accountant to the director. A non-Ceylonese cannot be appointed except with the specific approval of the board. The director determines the conditions of employment including remuneration of the employees of the Institute, subject to an appeal to the board whose decision is final. Disciplinary control, short of dismissal of the employees of the Institute, is vested in the director, subject to an appeal to the board whose decision is final. The director also could not dismiss an employee without the prior approval of the board. The director is under the disciplinary control of the board.

Personnel

23. The first personnel of the Institute were the research officers and research assistants of the industries department. These numbered twenty-one. The board recruited on its own two research officers and three research assistants besides an accountant and secretarial staff.

24. The World Bank and United Nations Technical Assistance Administration donated the services of Dr. Godwin as the first director of the Institute for five years and Dr. Liefelund as chief engineer of the Institute for three years.

25. The Institute also arranged on an agreement with the International Co-operative Administration for six specialists in management, industrial engineering, tools and die-making. These specialists were provided with local counterparts, who were offered facilities for further training overseas.

Funds

26. The Institute was given a donation of Rs.1 million a year for the first five years by the Government. It was the hope of the promoters of the Institute, particularly the World Bank Mission, that it would be self-financing after the five years. Before, however, the Institute could utilize the Rs.5 million for any specific project, it had to obtain specific approval of the Minister. The Institute was also enjoined to provide sufficient funds from the Rs.5 millions for carrying out research that had already been carried out by the Industries Department and for carrying out any future government research projects.

27. The Government, in addition, transferred to the Institute machinery and equipment of the two industrial laboratories and the entire technical library of the Industries Department comprising of 4,000 volumes. These assets were valued at Rupees 500,000.

28. The Institute also received from the Colombo Plan a fully equipped chemical engineering unit comprising a laboratory and workshop estimated at Rs.1.12 million. The International Co-operative Administration donated a 150 K.V.A. Generator and books valued at Rs.284,000/-.

[illegible]. The Institute, after five years, was to be self-financing [illegible] from such services as it provided to its clientele. Further [illegible] optional.

Work of the Institute

30. The research programme of the Institute is comprised of:

(a) Those projects which had been transferred from industrial development;

(b) Those projects which were suggested to the Institute by various government agencies and approved by the Minister;

(c) Those projects which were initiated by the Institute on its own;

(d) Those projects which were suggested by the Corporation and government departments on their own;

(e) Those projects which were suggested by the private sector industries.

(a), (b) and (c) were financed from the donation of Rs.5 million with the approval of the Minister. (d) and (e) were charged for by the Institute from the authorities responsible for the initiation of the projects.

31. The Institute also undertook a large number of testing services for the private sector industries. The Institute made special efforts in promotional activities. The Institute was mainly responsible for the sponsoring of the Standards Bureau, the Productivity Association of Ceylon and the Small Industries Service Institute. A project report was also submitted for the formation of the Industrial Corporation of Ceylon. The Institute, in addition, undertakes technical and economic feasibility studies of various industrial projects suggested by the private sector. The Government utilizes its services for technical advice and information.

32. It is significant to note that neither the board nor the Government was expected to plan the research programme of the Institute. This programme was to be determined by its clientele.

Relations with other organizations

33. The Institute has no control over the other research institutes or the research being carried out in departments or corporations. These could make use of the services of the Institute as clients for their operations.

Government control

34. Governmental control was limited to the direction that it should not perform any work which, in the opinion of the Minister, was contrary to public interests. The Government and the sponsors felt that with (a) government representation on the board; (b) appointment of the chairman and the director by the Minister; (c) control of the Rs.5 million donation, the disbursements of which had to receive the Minister's approval; and (d) accounts being audited and submitted to Parliament, there would be sufficient safeguards for government interests in the Institute. The Minister was also empowered to call for any information provided such information had not been contracted for as confidential by the Institute.

Incentives for research

35. As further inducements for the Institute, the Act provided for patenting of discoveries and inventions by the Institute, which could be utilized on royalty payments. The Institute was also exempted from income-tax and stamp duty. Customs duty exemption requires the approval of the Ministers of Finance and Industries. Contributions and donations or payments for services rendered by the Institute were exempted from income-tax.

Director's administration report

36. A full and comprehensive review of the work that the Institute had performed since its inception, its organization, staffing, technical assistance received, its budget, prepared by the Director of the Institute is given in the Administration Report.

Present government policy towards the Institute

37. The Government, after the first five years of the Institute, has had to review the policy followed in respect of the Institute and research in general. In the first place, no scientific applied research institute in the industrial field in an undeveloped country could expect to be self-financing. Private entrepreneurship is so scarce and limited. The Government has therefore to subsidize the Institute generously. The Government has always accepted the full responsibility for a survey of the available resources and research in the utilisation of these resources, training of technical personnel and arranging for the technical know-how, and is committed to a programme of public sector industrialization. In the pursuit of this policy, it has invested in strategic and important industries conducive to further development. The Government has, therefore, necessarily to have a larger say over the one and the only institute of this kind. The research has to be planned, programmed and directed to national needs and cannot be left for market conditions. This is particularly so when there is such a scarcity of scientific talent. Also, the research institute cannot be allowed to work in isolation. It has to correlate its research and co-ordinate it with other institutes, like government departments and corporations, which too undertake research in their respective spheres.

38. Bearing these considerations in mind, the present Minister of Industries has radically changed the concept of CISIR. The Minister introduced amendments to the CISIR Act which received Parliamentary and Governor-General's approval on 26 May 1962. These amendments permitted (a) the three members of the board to be elected, instead of being nominated by him; (b) the board was to be subject to and act in accordance with general directions that the Minister might from time to time issue; (c) accounts of the Institute were to be audited and subject to comments by the Auditor-General before presentation to Parliament.

39. The Minister also obtained cabinet approval for an annual grant to the Institute, which would enable it to work on an annual budget of Rs.1 million regardless of the income it received. The Treasury would grant the Institute the deficit between Rs.1 million and its revenue. This has ensured for the Institute continual financial support so that it can engage personnel with security and pursue its research programme unhampered by financial considerations.

40. In pursuance of his powers, the Minister directed the Institute to prepare a national programme of research after a survey of available resources and man-power. This research programme was discussed with all scientific talent in the country, including the University, the National Planning Department and the Central Bank, besides other research institutes and departments interested in scientific research. A committee has now been appointed to draw a priority list of this research programme and, in collaboration with CISIR, apportion the research items to suitable agencies. The Minister has also appealed to all the embassies for help in carrying out the research programme. He has directed CISIR to contact research institutes overseas and other organizations to help in pursuing the research programme.

C. Other institutes

National Research Council

41. Research is not only carried out by CISIR, but in other institutions as well. The Tea Research Institute, Coconut Research Institute and Rubber Research Institute have already been referred to. The planning department has its own research staff, primarily in planning techniques. The Central Bank does research in demography, finance, market surveys, etc. The Medical Research Institute does research on health and pharmaceutical problems. The Government has recently established an Ayurvedic Research Institute. Departments like the Irrigation, Fisheries and Public Works have their own research units. Public sector corporations which are in charge of major industries like cement, textiles, ceramics, paper, etc., have a small research and training staff in their respective industry. The Ministry of Industries has proposed setting up committees which would include both public sector and private sector personnel for detailed study of groups of related industries.

42. With a view to co-ordinating all these small units of research, the Minister of Industries, on the advice and representations of the Ceylon Association for the Advancement of Science, has proposed a National Research Council. The Council is to have as its Chairman the Prime Minister and is to be an advisory body to the Government in framing its scientific and economic policy. It would also advise and co-ordinate all research activity. Special funds are to be provided for research fellowships.

Small Industries Service Institute

43. Ceylon, in collaboration with the United Nations, has established a small industries service institute with the express purpose of promoting small industries and removing the present obstacles standing in the way of their progress. The problems facing small industries are: high cost of production, lack of management talent, lack of technical know-how, inefficient methods of marketing, absence of standardization and quality control, inadequate financial resources, lack of artistic design and diversification, and non-availability of power in rural areas.

44. The Small Industries Institute was inaugurated in August 1962 at Velona. It has a fully equipped office and workshop. Seven United Nations experts have been loaned to this Institute. Local counterparts for these experts have been provided by the Government. The main functions of the Institute are:

(a) The conduct of techno-economic surveys and studies of particular industrial trades and of the industrialization possibilities of particular geographical areas;

(b) The conduct of market surveys of products manufactured, or considered suitable for manufacture;

(c) Initiation of research through CISIR in improved designs of products, alternative materials, improved processes of production, and the development and introduction of tools and equipment particularly suitable for use in small undertakings;

(d) The organization of training courses for government extension personnel;

(e) The organization of an information centre;

(f) The operation of common production facilities services.

45. The Small Industries Service Institute functions as an adjunct to the Department of Rural and Cottage Industries. Proposals are under consideration to float it as an autonomous institute, the management of which is to be vested in a board.

D. Fundamental research

46. The traditional place for fundamental research is the university. Ceylon has only one university with science facilities. The professorial staff are so engaged in tutorial and examination work that they have hardly any time for research. In the present context, it is desirable to impart as much fundamental knowledge as could be gained from developed countries, to as many students as possible, within the limited resources available, than to undertake abstract fundamental research problems. The need in the University is to get scientific personnel interested in research and train them in research methods, rather than the immediate undertaking of scientific research. Ceylon's students specializing in science subjects do a research paper for their final examination. It is unfortunate that there are no post-graduate facilities in the University to further the research prospects of such students. The University's finances, which are by government grant, are so limited that it devotes its entire resources to increasing the input of students. Whatever fundamental research that has been done in other institutes, e.g. government departments, corporations, etc., are those related to applied research problems. The Ceylon Association of Science provides an annual forum for such papers to be discussed.

E. Problems of research in Ceylon

47. The major problem that Ceylon faces is inadequate personnel. There is an acute scarcity of science personnel to man the few industries, to undertake the training schemes and even to teach in secondary schools. Needless to say, research personnel are much scarcer.

48. Research has not yet been successful in economic development of Ceylon's several resources. A qualitative description of the resources and a rough estimate of them are available. But the technological processes for utilization and commercial exploitation still seems to be remote. Ceylon's urgent need is to

[illegible]tain a team of scientific personnel who, [illegible] will [illegible] ensure a concerted and sustained attack on this problem.

49. Ceylon realizes that a large section of her industrial [illegible] equipped with techniques and skills far below those of developed countries, [illegible] that there is consequently an opportunity for a high rate of technological [illegible] through the application of the vast technical knowledge that developed countries have acquired over the centuries. Applied research has therefore to be directed to have as its immediate aim the utilization and adaptation of this knowledge to the country's needs and resources. The Union of Soviet Socialist Republics and Japan have effectively demonstrated that industrialization is possible by such adaptation. But even in the adaptation technique, the problem would be how best the scarce scientific personnel and resources could be utilized, to give maximum results. There has to be maximum productivity in research itself. Results have to be achieved quickly and economically. Ceylon can scarcely afford wasted effort and lost motions. It has therefore to have an operation research technique in the choice of its research problems. This, in itself, is a research project of the highest order and importance. It, however, still remains to be done.

50. An equally important field is development research. In developed countries, it would be sufficient for technological research to be published in order for the results to be utilized. Frequently such research is on order and favourable results are used. In Ceylon, however, entrepreneurship is so limited, so small in size, that it is hardly possible that research results would be utilized unless their economic feasibilities and commercial feasibilities were carefully demonstrated. Development research may not only have to manufacture processes, but encourage entrepreneurs as well. Such research would call for:

(a) Pilot scale studies and designs;

(b) Product evaluation;

(c) Utilization studies;

(d) Economic studies;

(e) Process design;

(f) Market research;

(g) Market development.

It is clear that this is no laboratory affair. It is a direct exploration into the industrial field.

51. Ceylon lacks a suitable organization for undertaking such pilot projects and studies. It is hardly possible for a technological research institute to undertake this function also within its purview without the risk of misusing its valuable and scarce scientific personnel. Development research, while it does require technical skill, is more related to managerial functions.

52. Such a development institute can and should maintain a consulting and advisory service. Even in the adaptation technique, entrepreneurs face several difficulties: repeated breakdowns, wastage or misuse of capital, low percentage of utilization

the high unit costs of production. Similarly, in adapting the machinery for local utilisation, several peripheral operations are required where technical innovations are possible. These should form part of the essential services of the research organisation.

53. It has been Ceylon's experience that frequently the manufacturers of developed countries are more interested in selling the machinery than in seeing whether it is locally adaptable. Frequently, too, the most expensive machinery at the best possible price is sold. On the other hand, Ceylon requires the simplest techniques and sturdily built machinery, so that the comparatively unskilled labour of the country could readily learn the technical processes. India has set up a National Development Research Corporation for such functions. It would be useful to have an assessment of the results achieved.

54. Lastly, it is not enough that research is done. It is far more important that the results of the research should receive wide publicity and attract entrepreneurship. It has been described that there are three stages of research. The first is to begin, the second to end, and the third to publish. In mathematical language, this has been described as 30 per cent for the idea, 30 per cent for the exploratory work and 40 per cent for the writing and publication.

55. It is necessary that research descend to the material level and "sell" the results of research work and help in stimulating and developing industries. This has yet to be achieved in Ceylon.

XXV. PLANNING AND PROGRESS OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH IN PAKISTAN

Prepared by Salimuzzaman Siddiqui*

1. The epoch-making achievements of science and technology in recent times and their impact on every sector of human endeavour have made it imperative for every country to take cognizance of their vital role in its plans of national development. It is in somewhat belated recognition of this fact that the developing countries have increasingly come to realize the need for promoting science and technology to ensure their economic development, together with a steady increase in standards of living, and to achieve a measure of social and political stability. Science and its applications, however, cannot progress in isolation and their planning has to be closely integrated with the whole range of national developments in the fields of education, agricultural productivity and industrial enterprise. In so far, therefore, as the status of development in all these sectors and the background of scientific and social traditions vary widely in the developing countries belonging to the ancient Asian civilizations and to the newly emerging nations, no one cut-and-dried pattern can be laid down for their scientific organization. Even in the more advanced countries, there are wide variations in the character of scientific organizations. For instance, most of the research in Australia, both in the industrial and agricultural fields, is concentrated in the Commonwealth Scientific and Industrial Research Organization (CSIRO). On the other hand, in the United Kingdom, the Department of Scientific and Industrial Research (DSIR) with its extensive network of uni-functional laboratories, the Agricultural Research Council and the Medical Research Council, are separate entities, which have been recently brought under a Ministry of Scientific Research. In India, much the same pattern has been followed, but the Ministry of Scientific Research and Cultural Affairs is mainly concerned with the Centre for Scientific and Industrial Research (CSIR), while the Agricultural Research Council and the Medical Research Council are attached to the respective ministries.

2. In presenting a review of the position of scientific research and its organization in Pakistan, it will be well to note at the outset two important points, in order to facilitate a better understanding of the situation. First, when Pakistan came into existence over a decade-and-a-half ago, it had to face conditions which greatly dislocated the entire educational system of the country and placed a colossal strain on the newly constituted administrative machinery of the State that severely handicapped nation-building activities. Secondly, the areas now constituting Pakistan were greatly neglected in the earlier schemes of higher education, scientific research and development. Thus, except for the Punjab and Dacca Universities and a few subsidiary research stations like the Irrigation and Industrial Research Laboratories in Lahore and the Agricultural College and Research Institute in Lyallpur, all the other universities and governmental research institutions remained

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* Chairman, Pakistan Council of Scientific and Industrial Research, Karachi.

in India after independence. During the brief period of seventeen years since its emergence, Pakistan has, therefore, had to concentrate its efforts on first strengthening and consolidating its educational structure. As a result of these efforts, the new Universities of Karachi, Sind, Peshawar and Rajshahi have been established, and the Agricultural and Engineering Universities in the two wings of the country are now in a formative stage.

3. The main responsibility for scientific research in Pakistan has been placed under six autonomous research organizations, namely:

(a) The Agricultural Research Council;

(b) The Medical Research Council;

(c) The Pakistan Council of Scientific and Industrial Research (PCSIR);

(d) The Atomic Energy Commission;

(e) The Council for Housing and Works;

(f) The Irrigation Research Council.

4. Furthermore, on the recommendations of the Scientific Commission appointed by the President of Pakistan in 1960, a National Science Council has been established for the co-ordination of the activities of its constituent councils and the formulation of broad policies relating to their research programmes. In this whole pattern of the organization of science, the emphasis has been on providing the research councils with an adequate measure of freedom in the management of their affairs, necessary for a massive endeavour in their respective fields of research. To further strengthen this position, the National Science Council, the Pakistan Council of Scientific and Industrial Research and the Atomic Energy Commission have quite recently been brought under a newly constituted Scientific and Technological Research Division, which will be directly responsible to the President of Pakistan. The other four research councils will continue to function in the relevant ministries, which are ultimately responsible for the development and extension work resulting from their researches.

5. The report of the Scientific Commission of Pakistan, on the recommendations of which the National Science Council has been established and the constituent research councils reorganized, may be of some service to those developing countries that are in the process of establishing their national research organizations. One of the more important points, on which a measure of unanimity was eventually reached after prolonged discussions, was the avoidance of a monolithic research structure, because with all the advantages that may at first thought appear to accrue from it, such an organization would tend to cramp and stultify scientific effort, particularly in the field of fundamental research.

A. Basic and applied research

6. There is scarcely a scientific conference on the national or international level in which this perennial problem of the balance that individual countries, with their varying backgrounds and current capabilities, should strike between pure and applied research, is not discussed and deliberated upon at length. It would appear, however, that this distinction between pure and applied research and their relative importance in the development of science, is rather overdone. As a matter of fact, if science is to get a chance to promote effectively the development of a country in its various sectors, both these aspects of research at the laboratory level and in pilot-plant or field investigations, will have to come under the purview of the national research organizations. What is more, no applied research laboratory, if wholly bereft of the atmosphere in which fundamental research can take root and prosper, is likely to develop into an effective centre of research of any kind. As a matter of fact, these two aspects of research are constantly presenting problems to each other, and this process serves to invigorate and vitalize both of them. In respect of the various research councils in Pakistan, it could be said that about 70 per cent of their funds are devoted to applied research, though this cannot be taken as a measure of the respective significance of the two categories of research. There is yet another point to consider in this context. It so happens that just in the developing countries, it is the pure, rather than the applied, research that strikes the imagination of the younger scientists and it may be only in the wake of enthusiasms generated by an entirely non-utilitarian approach to scientific research that they can hope ultimately to make a mark in the advancement of science and technology, and in the economic development of their countries.

7. However, the question at the moment is whether with limited resources in men, materials and funds, one has the capability of playing an effective role in the various fields of scientific research and its applications. In answering this question, two points should be made. First, it is only through a spirit of dedication to science without sidelong glances at more lucrative and seemingly more worth-while careers, that one can make any significant contributions in this field of endeavour. Secondly, the Governments concerned must realize that the neglect of science over the centuries cannot, for all the glorious traditions inherited from the long past, be made good overnight. Scientific achievement and the development of a country are, in the nature of things, a matter of gradual progress by stages, and in the first phase of the effort to build up an effective research potential, there may not be much to show by way of actual returns. Young research organizations will, therefore, be well advised not to hold out rosy promises. At the same time, they would do well to devote a sizable sector of their activities to the investigation of problems that are likely to provide justification for the expenditure on the organization of science. This can be achieved in good measure through what has come to be known as developmental research, which is based essentially on available technical knowledge. By and large, the appropriate manner of advising governments on the selection of areas of research to be pursued vigorously would be through a judicious emphasis on the economic aspect. Once the tasks of science are broadly defined and their priorities presented in a convincing manner, it should not be difficult to rally government support for their implementation.

8. Against this general background of the organization and administration of science, specific reference may be made to the activities of the PCSIR, and to certain problems arising out of an account of these activities. In the interest of brevity, however, this account will have to be limited to a few salient features of

the Council's undertakings 1/ in its central laboratories in Karachi and in the three regional laboratories in Dacca, Lahore and Peshawar, comprising between them over twenty basic and fundamental research divisions.

9. The central laboratories have the following divisions:

(a) Physical research and testing division;

(b) Chemical research division, including research on paints and plastics;

(c) Biochemical research division;

(d) Drugs and pharmaceuticals research division;

(e) Building materials research division;

(f) Fuel research division;

(g) Engineering division with workshop and pilot-plant section.

10. The work of the eastern regional laboratories is done in the following divisions:

(a) Natural products research division (covering work on minor forest products and biological, agricultural and industrial waste);

(b) Fuel research division;

(c) Food and fruit technology division;

(d) Leather research division (principally providing facilities for investigations in the tanning-material resources of the region).

11. The west regional laboratories contain:

(a) Metallurgical research division (including ore dressing and testing of minerals);

(b) Industrial fermentation research division;

(c) Oils, fats and waxes research division;

(d) Glass and ceramics research division;

(e) Food technology research division.

1/ For more detailed information on the scientific work of the Council, reference may be made to the comprehensive accounts presented in its Quinquennial and Biennial Reports, followed by the 1953-1963 Decennial Report; published this year under the title Ten Years of PCSIR.

12. The divisions of the north regional laboratories are as follows:

(a) Indigenous drugs research division;

(b) Fruit technology research division;

(c) Mineralogical research division;

(d) Wool research division.

13. In drawing up this plan, emphasis has been laid on regional development in respect of the raw materials available in the two wings of the country. Because of the widely different character of the raw materials and the problems associated with their industrial utilization, it was considered necessary to duplicate some of the research divisions in the laboratories located in eastern and western Pakistan.

B. Utilization of results of research

14. In the application of science to industry and the promotion of agricultural productivity, the most important factor relates to the resolution of bottle-necks between scientific research and the actual utilization of its results. Successful research on the fundamental side can be a matter of satisfaction quite irrespective of its bearing on practical applications, but applied research is pointless and a source of serious frustration among workers, if it fails to become closely integrated with the relevant sectors of economic development. To effectively cope with this situation, research utilisation boards have been established in some countries, with adequate funds under their control for the promotion of industries based on specific research processes. Such an arrangement may have advantages in more advanced countries with highly developed industrial structures, but they seem to be of doubtful utility in countries with a low level of industrial and technical capabilities. What is needed in such a situation is the closest association of research groups throughout every phase, from the laboratory bench-work and pilot-plant investigations to the actual commercial production.

15. In view of these considerations and on the basis of its experience in this regard over a number of years, the PCSIR has evolved a practical procedure for converting its laboratory processes into industrially feasible propositions. According to this procedure, a process worked out in the laboratory is subjected to pilot-plant investigations for studying and establishing the economics and optimum working conditions. In most cases, this necessitates the designing and fabrication of equipment to suit the operational requirements of the process for commercial production.

16. In the course of pilot-plant investigations, the various resulting products are sold on cost-plus basis, in order to assess the reactions of the consumers in respect of their price and quality, and to make the necessary improvements in the light of that assessment. Such a procedure, though somewhat protracted, ensures the acceptability of the research products in the market and attracts prospective industrialists for their commercial exploitation.

17. In order to expedite the utilization of its processes by industry, the Council has considered it appropriate to set up its own Research Utilization Committee, which deals exclusively with processes evolved by the Council. The offers received from the industrialists, in response to public advertisement through the Press, are scrutinized by the Research Utilization Committee, and the processes are leased to suitable parties on the basis of their trade and industrial experience, against the payment of a nominal premium and royalty. Following the allocation of a process, the Council gives every possible assistance in setting up the factory and in operating it in the initial stages of production, with the help of its own technical personnel, who were associated with the development of the process at the pilot-production stage.

18. Following this procedure, it has been possible to pass on twenty-one new patented processes to industrialists for commercial exploitation, seven of which have already gone into production, while the others will be reaching that stage shortly. Reference may be made in this connexion to the production of: (a) vitamin A concentrates from shark liver oil, which apart from meeting the local demand, are also being exported to some advanced countries, e.g., the United Kingdom, Australia and Japan; (b) a whole range of low-cost building materials, among them the synthetic marble (marbolite) principally based on baryte, which is plentiful in the country; (c) tack-free paints made from semi-drying oils; (d) chlorinated insecticides and fungicides based on indigenously available petroleum fractions; and (e) low-cost protein-rich foods.

19. To give an idea of the present level of these developments, it may be stated that the total investment involved in the initial phase of these industrial enterprises based on research is of the order of two crores of rupees, the premium paid for them to the Council is Rs. 100,000 and the actual declared production to date is Rs. 2 million, the royalty paid to the Council on this production being approximately Rs. 43,000. It is hoped that when the remaining processes of the Council, which have already been taken over by the industrialists, go into production and the demand for their products is built up through commercial enterprise, the production potential will exercise a sizable impact on the industrial development of the country in the course of the next five years. It may be further added that with the production of chlorinated insecticides, which are currently being subjected to field trials with quite encouraging results, there will be a considerable saving in the foreign exchange allocated in the next five-year plan for the importation of pesticides, to the extent of about Rs. 600 million.

20. It may be noted from the foregoing account that many of the functions discharged by CSIR in Pakistan are undertaken by the industrial research associations in countries like the United Kingdom, which has about fifty associations of this type, and these are often cited as an example for the less developed countries to follow. However, in countries like the United Kingdom, there is a long tradition of industrial research which is wholly lacking in the developing countries. For a long time to come, therefore, the national research organizations will have to carry the responsibility for detecting and solving the day-to-day and the long-range problems of industry. It was in realization of this position that, in a recent meeting of the Industrial Advisory Council of the Government, the representatives of various industries unanimously decided to recommend the levy of an industrial cess on production, for the promotion of scientific and industrial research. The formation of industrial research associations is no doubt a healthy trend which deserves to be encouraged, but owing to the present shortage of scientific and technical personnel, it will be only at a later stage that a substantial effort in this direction can be made. The PCSIR is currently striving to

fill this gap by developing a full-fledged industrial extension service and attending to the solution of operational problems referred to its laboratories by the industry.

21. For the utilization of research in the field of agriculture and irrigation, there are fairly well-organized Government departments, but the need is still felt for devising a more effective machinery of liaison, to be maintained at all levels (for example, agricultural institutes, experimental stations and laboratories) with the closest possible association of the Research Council and the field staff of these departments. In order to ensure proper liaison between the research and extension services in agriculture, the Scientific Commission has made the following recommendations:

(a) Every agricultural research institute, research substation and experimental farm should have a research-extension liaison committee consisting of research and extension personnel. These committees should work out research programmes and arrange for utilization of results at each level. The research workers should be given ample facilities for field study of problems. Similarly, extension workers should keep in touch with the progress and trends of research;

(b) Efforts should be made to enlist the active co-operation of leading farmers by persuading them to utilize the results of research in their own fields, so that widespread dissemination of these results by evaluation is assumed;

(c) Extension officers must be as capable and well-trained scientifically as research workers and should have comparable status. The research organization and the research men should maintain an interest in the problem until the colutions they have arrived at are actually adopted by farmers;

(d) A more purposeful, well-directed effort should be made towards the dissemination of information through the establishment of demonstration farms, prompt publication and visual aids;

(e) Efforts should also be made for enlisting the co-operation of village aid organizations and basic democracies in extension work.

C. Scientific and technical personnel

22. By far the most important issue the developing countries have to face is the shortage of scientific and technical personnel, particularly at the higher levels, because the pace of progress in the organization of scientific research and development will be determined by the progressive availability of such personnel. A variety of considerations have a bearing on this issue. First, one must take into account the fact that the emergence of top-level scientific personnel equipped for leadership in research and industrial development is a long process, which does not admit of any short cuts. Moreover, in the implementation of programmes in this connexion, the correct placement of trained men with due reference to their field of specialization is often difficult to arrange. This is indeed a complication, which seems invariably to occur in the formative stage of a newly oriented economy, in which the development of teaching and research institutions, as well as of industries, cannot always be adequately timed with the training of the scientific and technical personnel needed for manning them.

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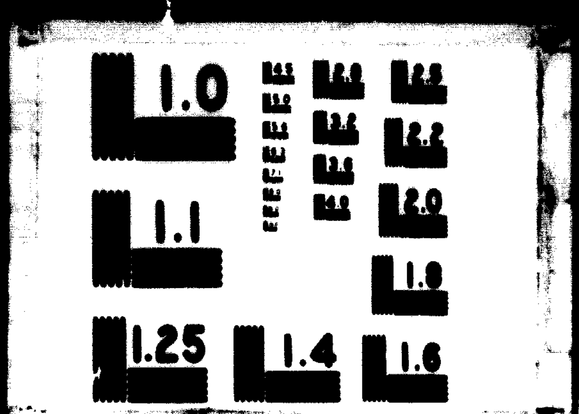

23. Another important point to be considered is that scientific careers do not offer attractive prospects for talented young men, most of whom are at present drawn towards secretarial and administrative services. The disparity is further aggravated by the fact that scientific services have strictly limited cadres with reference to various specialized branches of science, and thus offer few of the opportunities for promotions available to distinguished men in other services.

24. With the passage of time and the phenomenal achievements of science in the service of man, particularly during the current century, the requirements of scientific personnel for dealing with research and development projects have assumed such colossal proportions that scientific pursuit can no longer be treated as a field limited only to certain individuals. Recognizing the implications of this changed situation, the Government of Pakistan has, in principle, accepted the recommendations of the Scientific Commission to bring the status and emoluments of scientific personnel to a level comparable with those of the administrative and executive services.

25. Concerning the current situation in Pakistan in regard to the availability of scientific personnel, it may be mentioned that a sizable middle group of such personnel has been provided through a scheme of overseas training launched shortly before Pakistan's independence. Subsequently, an increasingly larger number of overseas training facilities have been offered under the Colombo Plan and other international assistance programmes. Furthermore, PCSIR has instituted a liberal scheme of study leave for its scientific staff after a period of satisfactory service, so that they may improve their qualifications in the various fields of science and technology. In a number of cases, Pakistani students who run short of funds while studying overseas on their own, are provided with financial assistance by the Council against an undertaking to serve under it over a period of three to five years after the completion of their studies.

D. Association with universities

26. The national research organizations charged with the co-ordination of scientific activities of the country should do everything possible to assist the universities in their teaching and research programmes. This could be done for instance by seconding their own staff for lecturing in their specialized fields to the university classes, making their research facilities available to the university students for their doctoral level work and financing specific research schemes, initiated by active scientists of the universities or allocated to them on a contract basis. It was with this in mind that the various PCSIR laboratories in Pakistan were located in the close vicinity of university campuses, and every effort is being made by it to extend its assistance and co-operation to the universities, without in any way encroaching on their freedom. The National Science Council is laying particular stress on such co-operation between the autonomous research organizations and the universities, and the Atomic Energy Commission and other research councils to which the writer has referred, are striving to follow this directive.

F. Research facilities and resources

27. For any rational planning of science in the developing countries, it is essential at the start to have a proper survey and appraisal of the natural resources of the country because it is only in the light of such an appraisal that policies and priorities in respect of the tasks set for an over-all scientific effort can be adequately determined. In most of the developing countries, the institution of geological and botanical surveys was the first step towards the scientific exploitation of their natural resources. In the survey and prospecting work, however, purposeful co-operation with the relevant research councils can be of great value in arriving at dependable statistical data. In Pakistan, such co-operation is being gradually built up, and has, in particular, led to fruitful results in the development of certain mineral resources of the country.

28. With regard to manpower resources, reference has already been made to the steps taken by the Government for the training of scientific and technical personnel. To meet the growing demands for research and teaching institutions and industry, a carefully formulated plan for training on a more massive scale must be drawn up and vigorously implemented. Taking this into account, the Government is considering a proposal based on the recommendations of the Scientific Commission to annually send out 100 graduates in science, engineering and medicine for overseas training during the next five years. The total period of training of these candidates would be three to four years and their fields of training are to be determined by the requirements of the various research councils. In addition to these measures, increasingly greater emphasis is being laid on raising the standards of teaching and research in the scientific departments of the universities; and it is hoped that with the improved facilities by way of scientific equipment, staff and budgetary allocations, they will, in the course of the next ten years, be in a position to offer opportunities for training at the doctoral level, which are at present quite rare. Furthermore, a plan for the training of laboratory technicians for glass-blowing, precision tool-making, high-vacuum maintenance, and for carrying out routine laboratory operations is under consideration, and it is proposed to establish centres for such training in both wings of the country. Similar measures for training at all levels are being taken in many other developing countries, and they make for a capital investment without which all the plans for national development will be of little consequence.

29. The most important point in the phased establishment of scientific research centres is the close integration of measures for the construction of laboratories, provision of scientific equipment and the placement of trained scientific personnel. However wisely and efficiently this may be planned, one or the other of these provisions nevertheless lags behind for reasons which are somewhat inherent in the under-developed situation of the countries and beyond executive control. A way out of these difficulties is often found in setting up nuclei of research laboratories in temporary buildings and taking up the construction work after a certain stage of expansion of their activities has been reached. This has, in fact, been the general plan followed in the establishment of PCSIR, as well as many other laboratories in Pakistan.

30. In the provision of modern equipment for the laboratories, two important factors must be kept in view. First, it is false economy to be stingy with the provision of newly developed, costly apparatus like infra-red spectrophotometers, mass spectrographs, diagnostic and preparative gas chromatographs and electron

microscopes, because they have become essential for any serious scientific work in many fields of research. Secondly, the provision of none of these items of apparatus is justified unless trained personnel for handling them are available, and they are in actual fact required for projects under investigation. In addition to all this, liberal library and workshop facilities, which often suffer from neglect, have to be provided in fuller measure to ensure the efficient running of the research institutes and laboratories.

F. Funds for scientific research

31. Scientific research, particularly in the applied fields, is an expensive undertaking, and with ever new developments in techniques and appliances, the costs on research have an onward trend. Available figures show that in the United Kingdom, expenditure in the various sectors of scientific and industrial research has increased from £1 million in 1900 to £350 million in 1957. In the United States of America, the figures stood at around $US7 billion. Each of these figures represents 1.6 per cent of the gross national product. In Canada and Australia, the level of expenditure on research is of much the same order. The gross national product of Pakistan is estimated at about Rs. 15,000 million per annum and expenditure on research is currently barely Rs. 50 million. It is hoped, however, that with the reorganization of the universities and the research councils, expenditure on research and development in the country may well be increased to around 1 per cent of the gross national product in the course of the next ten years. A more detailed reference to the statistical material indicates that once a start is made with the organization of research, the figures of expenditure take a steep ascent, which the Governments and industrialists whole-heartedly welcome because of the harvest of rich dividends it brings in.

32. In the preceding review of the scientific situation, the author has tried to deal briefly with certain organizational problems arising out of it. These observations may have touched on some controversial questions, but, in the author's opinion, it is only by tackling them from various points of view in respect of the scientific and economic issues facing the various countries today, that one can meaningfully contribute to their solution and bring countries a good deal closer through a common endeavour.

33. In conclusion, the writer would like to stress the point that scientific achievements and industrial development of a country are, in the nature of things, a matter of gradual, stage-by-stage progress, but that with a brisk implementation of well-considered plans for the organization of scientific effort, the pace of progress can be greatly accelerated. It is only thus that the research organisations of the developing countries can, within measurable time, establish themselves as outstanding national assets, and effect convincing improvements in the economy of the country and the standard of living of the people.

XXVI. [illegible]

Prepared by [illegible]

A. National policy of industrial [illegible]

1. It cannot be asserted that an industrial [illegible] policy [illegible].

2. The teaching of technical curricula in its universities [illegible], soon afterwards the first laboratories made their appearance, [illegible] efforts to the study of local materials, but also in [illegible] natural sciences.

3. Between 1865 and 1875, more definite progress was made with the [illegible] the Department of Exact Sciences of the University of Buenos Aires [illegible]; on the basis of the Mathematical Department, which was created in [illegible] the Academy of Science of Buenos Aires (August 1874); and the Argentine Scientific Society (1872). The Academy of Science of Córdoba (15 December [illegible]) and the Faculty of Physics and Exact and Natural Sciences of this state ([illegible] May 1875) also originated in this period.

4. During the last years of the past century and the first years of the current one, laboratories were established in various study centres and in the main government departments in charge of public works. which expanded rapidly with the development of the country during that time.

5. In these years and those following, up to 1930-1940, professors and specialists, chemists, physicists and engineers worked to improve the teaching of science in Argentina; they carried out some research, or rather, investigated raw materials, minerals and rocks for direct use, woods and the like.

6. These isolated efforts tried to comply, as well as possible, with European standards, as Argentine specialists had frequent contacts with Europe and many of them had been there to study or to attend post-graduate courses, to which should be added the constant stream of European scientists and technicians to Argentina.

7. The development and progress of Argentina's industry was assisted by the framework as described. Many efforts were made to create a feeling of responsibility towards the necessity of industrial research. Among them, the tendency towards standardization, which started more than twenty-five years ago and rapidly acquired acceptance, assuring through the applications of specifications a closer watch and control of the manufacturing processes, thereby contributing to the development of the laboratories mentioned above.

8. A decided effort was made between 1920 and 1930 to establish industrial research institutes, as such, in Argentina. The most successful one was the Laboratory for Testing Materials and Technological Research, of the state of Buenos Aires.

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* President, National Institute for Industrial [illegible] (Instituto [illegible] de Tecnología Industrial).

9. In 1957, the Government created four entities worthy of note: the National Council for Scientific and Technical Research (Consejo Nacional de Investigaciones Científicas y Técnicas); the National Institute of Technology for Agriculture and Livestock (Instituto Nacional de Tecnología Agropecuaria - INTA); the National Institute for Industrial Technology (Instituto Nacional de Tecnología Industrial - INTI); and the National Institute for Productivity (Instituto Nacional de Productividad). Though it cannot be asserted that these entities defined a research policy, they did prepare the way for future decisions in this field, and drew attention to the emphasis given to the impetus and promotion of research applicable to agriculture, livestock and industry, with due attention to the field of pure science.

10. The National Commission for Atomic Energy (Comisión Nacional de Energía Atómica) had been created shortly before, in 1955, and, through necessity, gave impetus to various technological investigations, especially in the metallurgical field. Its metallurgical department is today prominent in Latin America.

11. The universities which, though official, are autonomous in their capacity to make decisions, have enjoyed since 1955 more substantial financial resources, improved their laboratory equipment and started some research, partly dedicated to divulging scientific knowledge and partly to problems or aspects of industrial applications, but without defining a systematic industrial research policy.

Creation of a conscience towards industrial research in Industry and Government

12. One of the institutions created in 1957, INTI, was founded especially to promote, stimulate and support the development of research in industry.

13. This Institute was organized to develop these functions from two different approaches, which were considered basic: (a) to assist and expedite research by creating central laboratories in correspondence with the principal branches of applied science: analytical chemistry laboratories, physical and metrological laboratories and laboratories for testing materials; and (b) the promotion of research in industry, through the formation of investigational centres with industrial groups. These centres are offered facilities in the use of laboratories and equipment, scientific and technical counsel, and financial support. The training and contracting of personnel for these centres, in addition to the promotion and diffusion among industrialists of techniques and methods which contribute to the progress of their industries, complete a picture of practical and efficient promotion.

14. To this end, INTI chose a system of co-operative research, somewhat similar to the way it is organized in the United Kingdom, that is to say, a central organization, being dependent upon the State with administrative autonomy and its own resources, legally authorized to constitute centres of applied research for specific programmes, named "centres of research", which can be formed in partnership with private industrial entities, branches of the national or state governments, or with the universities. In this last case, the universities generally contribute with scientific-technical staff of high standing, whilst the equipment and other necessary elements are supplied by both parties or by the Institute.

Incentives for research

15. The policy INTI has developed [illegible] sustains is to procure the greatest [illegible] engaged, conducive to the formation [illegible].

16. In tax liquidations the investment [illegible] declared as expenses. Furthermore, INTI [illegible] in these centres, which start from cash [illegible] that of the private industries, up to [illegible] offering to the research centres the use of its laboratories, [illegible] its staff, counsel, etc.

17. In INTI, the research centres and their [illegible] laboratories [illegible] adequate for the formation and training of an industrial [illegible]. [illegible] purposes, INTI tries to achieve that selected groups [illegible] students, after training in its laboratories, which can [illegible] years, become the future investigators which industry requires for its [illegible] technical improvement. This training is not carried out in the form of traditional college courses, but merely through laboratory practice [illegible] with the staff of the Institute and the research centres and [illegible]. To attain this end, the Institute admits for the time being up to twelve advanced students or recent graduates of universities or technical schools for a period of six months, which can eventually be prolonged up to one or two years. Some of them are permanently absorbed in the Institute and the others leave to work in industries.

18. No special incentives are offered by the Institute to attract local personnel towards industrial research. They are limited to: (a) the advantages which its surroundings offer to a person with a vocation for study, allowing him the use of equipment and counsel from colleagues of greater experience, all contributing to his formation; (b) the prospects of later obtaining more highly paid employment in industry, and (c) the possibility of fellowships in foreign countries, offered to the Institute by technical assistance services of various nations, as detailed below.

Incentives to promote the application of the results of research in the industrial sector

19. This matter of benefiting from the results of research has not yet been urgent, owing to the short life of the Institute. Nevertheless, the fact that it can become important in the future is kept in mind. Up to now, as generally occurs in all new laboratories, the results mainly correspond to methods, procedures, analysis of errors and how to correct them, which, since they have been obtained by the research centres while solving specific and daily industrial problems, are of immediate application.

20. The various research centres, having been formed at the request of different branches of industry, undertake tasks at different levels of scientific knowledge, from quality control of raw materials and manufactured products, routine [illegible] checks and the solution of daily workshop and plant problems, up to more far-reaching studies; and in some of them, approaching [illegible], as in the Grease and Oils Centre in search of new applications [illegible].

[illegible] illustration, there are already two applications for patent. In [illegible], where [illegible] will have to face the problem of creating new industries for [illegible].

[illegible] are available for this problem and it will be [illegible] the details of the economic and social incentives which would [illegible] utilization of these results in benefit of the country.

<u>Investigation sustained by the Government and private enterprises</u>

[illegible]. The Institute always tries to have studies and research supported by private industry or state departments. This does not imply that the Institute so limits its own initiative and that of its technical staff, but the initiatives generated within the Institute are submitted to an advisory committee, which is formed by highly capable technicians, proposed by the universities, the academies and professional associations. After this body issues an opinion, if the investigation programme or theme chosen is of interest to the country, action is taken to obtain the support of private entities, business groups, professional associations, universities or national, state or municipal departments which could be interested.

B. Establishments for industrial investigation

23. In Argentina, institutes for industrial investigation can be classified in two groups:

(a) Those formed by the large state departments since the beginning of this century, especially for quality control of the public works under their charge;

(b) The university laboratories, which were developed at the same time and contributed to form the necessary staff.

24. It is impossible to mention all the institutes in detail as requested, for lack of complete information. A brief description of the most important, classified in the two groups mentioned, is submitted in annex I. In annex II, information on INTI is added.

C. Financial aspects

25. Nearly all the industrial research establishments in Argentina are financed through the national or a state budget, or the university fund, with the characteristics current in these cases. Only the National Institute of Technology for Agriculture and Livestock, and the National Institute for Industrial Technology differ.

26. The first is financed through a tax of 1.5 per cent on exports of agricultural and livestock products, and INTI's main source is a percentage of the loans which the official banks (Bank of the Argentine Nation and Industrial Bank of the Argentine Republic) allocate to industrial enterprises. This percentage comes to 0.25 per cent of the amount of the credit and is used by the Institute in promoting industrial research along the lines explained previously.

[illegible]. The Institute spends these funds in [illegible] depending on circumstances:

(a) One part, for the construction [illegible]

(b) Another, for adequate payment [illegible]

(c) The third part comprises the funds [illegible] research centres.

[illegible]. The use of this last fund implies [illegible] participation of the respective industries, increased eventually with contributions from INTI for the purchase of instruments and equipment to form their own laboratories.

29. The research centres are in a position to assist or sign contracts for studies or research with different private or public industries, thereby receiving the resulting fees, which are reinvested in their own development. In this manner, a mechanism is created which contributes to canalize the funds of each branch of industry into the type of research most interesting to it, and even to create an organization which offers them services for which they themselves help to pay, with the additional advantage that the resources are not diluted in a large institution, but go to intensify the action of the centre most useful to them.

30. Totally independent of the national treasury, the resources of INTI are credited in its account by both official banks mentioned.

31. This income varies with the normal oscillations of the credit requirements of industry, but as, between them, the official banks control a very substantial part of the total volume of the country's credit operations, the Institute is assured of a continuous income.

32. The Institute's authorities assign part of its resources to a reserve for eventualities, with the object of not having to refer to the national budget.

33. INTI deposits the reserve funds and any transitory surplus in a special account in the Industrial Bank, thus assuring the Institute an additional and regular income. Finally, these funds are increased by the contributions of the industries forming research centres.

Research by contract

34. INTI's statutes allow the undertaking of research by contract, but the policy of the Institute is that they be canalized through the research centres, tending thereby to more liberal promotion and utilization of its resources. On the other hand, as explained before, these research centres have the vitality and flexibility of a 100 per cent private enterprise.

35. In such cases, the Institute has always preferred to give these contracts the character of a transitory research centre.

D. Personnel

[illegible]. All personnel matters, particularly with reference to the scientific staff, have been given special attention. It has not been easy to complete this staff, especially as in some cases, notwithstanding its financial independence and its freedom to contract, some general dispositions applicable to all state agencies, originated by the current difficulty in balancing the national budget, also affect the Institute in principle. It is true that INTI was granted exemption from these difficulties once its status was recognized, but meanwhile some inconveniences were caused.

37. The first problem, related to its personnel, is that in Argentina technicians moulded to the requirements of industrial research are not currently available, as unfortunately has been proved during the short experience of the Institute.

38. Qualified Argentine technical-scientific personnel are of a high professional standard - they are frequently contracted abroad - but usually unprepared for industrial research, which requires solid scientific knowledge, an above-average imagination and a special ability to interest industrialists, especially the smaller ones, in research programmes.

39. However, extremely interesting developments can be observed in technicians who were incorporated in the Institute while still young and trained in permanent contact with the men and problems of industry.

40. Every effort is made to perfect INTI's personnel in foreign countries. The greatest problem here is not the lack of opportunities to place them abroad, but the enormous pressure of work under which the Institute labours and which it must attend in its function of promoting industrial technology, thereby absorbing all of the staff it has had available up to now. At the moment, this matter is being seriously considered, that is, how to establish a better balance so that a percentage of the personnel can attend specialized courses in foreign countries.

41. But the industrial problems cannot wait. The research centres are aware of these problems and duly appreciate them. They constitute an excellent means of study and promotion as an advanced post to explore the possibilities of specialized courses which, once established, can be transferred to the universities or extant technical schools on a permanent basis.

42. In this manner, the following courses and seminars have been developed:

(a) Management and productivity techniques;

(b) Operational research;

(c) Training of industrial personnel;

(d) Productivity in the construction industry;

(e) Profitability and organization of small industries;

(f) Design of electrical household articles;

(g) Basic course of industrial design;

(h) Industrial design: its [illegible] methods in professional practice;

(i) Design [illegible];

(j) Methods [illegible] for [illegible] analysis;

(k) International course on [illegible];

(l) Specialized metallurgy;

(m) Use of thermal energy in industry, for engineers and specialized technicians;

(n) Course on acoustic research;

(o) Matrix analysis of orthogonal frames loaded in its own plane;

(p) Modern microbiological considerations related to the production of [illegible];

(q) Organization of production in the building industry;

(r) Documentary techniques, for librarians;

(s) Methodology and techniques of documentation;

(t) Method of programming by critical path (Programme evaluation and review technique).

43. Regarding the payment of salaries, in effect, the Ministry of Finance, as with nearly all nations, establishes scales of seniority and uniform salaries at equal levels for all the public administration. This policy is a hindrance to active research, makes it difficult to retain INTI's personnel and lacks incentive for development at an adequate scientific level.

44. While the Institute is a decentralized entity with limited dependence upon state control and free disposal of its own funds, its budget has to be presented by the executive branch to the legislative (Congress) for approval.

45. Nevertheless, some facilities have been obtained which will become more effective with time. The salaries of the Institute's seniority scale are somewhat higher than those of public administration at an equal level. Besides, extra salaries up to double the basic scale may be paid at the exclusive discretion of the Institute's authorities. Furthermore, the Institute has a permanent policy towards better working conditions, recognizing that the scientific and applied research staff at high level should be adequately compensated.

E. The application of the results of industrial research

46. As per INTI's method of operation the results of industrial research should be applied immediately. As has been explained, the results at INTI are mainly related to manufacturing methods, design of dies, determination of [illegible] materials and processing and their effects, etc., [illegible]

presented by industry in the [illegible] application has been immediate. It cannot be [illegible] that similar, immediate possibilities would derive from more involved [illegible] research.

47. The Institute, as has already been mentioned, is negotiating the registration of its two first patents obtained by one of its groups, that dealing with greases and oils, which is working, precisely, on research of a more fundamental nature. Once these patents are registered, they will serve as test cases.

48. In this respect, the characteristics of the Argentine industry have considerable influence, as the large enterprises are frequently connected with European and North American interests through technical, commercial and financial ties. The medium and small national firms, which are the natural clients of the Institute, generally do not find themselves in this situation.

49. INTI has a legal department, which studies patent problems and a promotion management department, which provides the necessary connexion with industry. The industrial service rendered, though still incipient, will be perfected with time. Its main objectives are to bring industry closer to INTI and to spread its action to the interior of the country, where groups are already working in five states.

50. The Institute offers a service by means of the Centre of Documentary Research, which is in close contact with the promotion management and in charge of technical information and supply of bibliography. Surveys as to technical programmes and research are carried out by the research centres in co-operation with the industries which contributed to form them and which are its promoters. In the event a research centre has not yet been formed for a specific programme, INTI undertakes the survey or investigation, from which may arise the possibility of forming a new research centre for the purpose.

F. <u>Technical assistance offered to industry</u>

51. In this matter, the Institute, in its desire to assist Argentine industry to improve itself, has not spared efforts to establish contact with all the organizations of technical assistance which might be in a position to co-operate. INTI is aware that, apart from being an important centre of reception of information on the advance of techniques from the most developed countries and of studies for their possible application in Argentina, it is at the same time a centre for the spreading of technical assistance to the provinces and less developed areas of the country. It should be remembered that, in Argentina, maximum development has thus far been concentrated in the city of Buenos Aires and its surroundings, in the states of Buenos Aires, Santa Fe and Córdoba, along the rivers with access to the ocean, where the industrial level is higher than inland. Córdoba, particularly, has had a very marked industrial development and could make an interesting promotion centre for the surrounding states. The Institute bears this in mind and tries to extend its influence to the states in the interior; this is the reason why it has formed research centres in various cities and will continue this policy of forming centres in the interior whenever possible.

52. A list of foreign entities which supply technical assistance via INTI is indicated below:

(a) United Nations technical assistance [illegible] Research Centre for the Efficient Use [illegible] of projects for the practical use of [illegible] Centre for Industrial Design;

(b) United Nations Educational, Scientific and Cultural [illegible] annual courses on marine biology for Latin American university [illegible];

(c) Bouwcentrum of Rotterdam, Netherlands; their director [illegible] on two occasions and was instrumental in the founding of the [illegible];

(d) The National Industrial Fuel Efficiency Service (NIFES) of the United Kingdom, which co-operated in beginning CIPUEC;

(e) Armour Research Foundation of Chicago, United States of America, with which an agreement is in operation for technical information;

(f) Physikalisch-Technische Bundesanstalt of Braunschweig, the Federal Republic of Germany, which is studying an important programme for technical assistance on metrology;

(g) The Réunion Internationale de Laboratoires D'Essais de Matériaux (RILEM), which entrusted to the Research Centre of Applied Technology for Construction (CITAC) the organization of its Latin American Secretariat integrated by eight countries;

(h) The Pan-American Health Office, which acts as counsel to the Research Centre of Ambiental Engineering, with a representative in its executive committee.

53. In these matters, for INTI's purposes, technical assistance must be spread as rapidly as possible to industry and stimulated by establishing a close relationship between INTI and international organizations of high standing in the technological field, allowing thereby an intensive interchange of experts, counsellors and technicians.

54. The mission of the United Nations which contributed to the formation of CIPUEC serves as a good illustration, owing to the permanent ties which were established between this Centre and NIFES of the United Kingdom. This example ought to be repeated with other entities and countries.

[illegible]

INSTITUTIONS DEVOTED TO INDUSTRIAL RESEARCH

A. Government agencies

1. Among the most important, mention may be made of:

(a) Laboratories of the National Waterworks and Drainage Services (Obras Sanitarias de la Nación), Buenos Aires, 1904:

(i) Supervision of water-supply and drainage services throughout the country. Oversees and controls building materials (cements, etc.);

(ii) Edits specifications both for its services and for the materials used in their accomplishment;

(iii) Under supervision of administration of the National Waterworks and Drainage Services;

(iv) Has laboratories for chemistry and microbiology of waters, over-all chemistry and testing materials;

(b) Laboratories of the General Belgrano Railway (Ferrocarriles General Belgrano), Buenos Aires, 1915:

(i) Currently attends to the requirements of Argentine State Railways (EFEA);

(ii) Controls its services, especially fuels and lubricants. Carries out different tests (mechanical, electrotechnical, metallographical, chemical, etc.);

(c) Building Experimental Institute of Buenos Aires (Instituto Experimental de la Construcción de la Ciudad de Buenos Aires), 1938. This Institute has chemical laboratories, tests materials, etc.;

(d) Laboratories of the National Direction of Public Roads (Dirección Nacional de Vialidad), Buenos Aires, 1932. These laboratories deal with chemistry, soils, asphalts and pavements;

(e) Laboratory for Testing Materials and Technical Research (Laboratorio de Ensayo de Materiales e Investigaciónes Técnicas - LEMIT), La Plata, Province of Buenos Aires, 1942:

(i) Carries out service tests for the Department of Public Works (Ministerio de Obras Públicas) of the Province of Buenos Aires. Develops industrial research projects. Their experimental plant is located at Gonnet, Province of Buenos Aires;

(ii) Carries out studies [illegible] of the [illegible] Buenos Aires. [illegible] Aires set up under [illegible] Dr. Pedro Cerriquiri [illegible];

(f) Laboratories of Yacimientos [illegible] (YPF), [illegible], Province of Buenos Aires, 1942:

(i) Set up to attend to service matters and to investigations [illegible] of the state organization in charge of Argentine oil industry;

(ii) Is the major laboratory of the laboratories [illegible] in different deposits;

(iii) A branch of YPF, a governmental enterprise under the [illegible] of the Secretary of State of Energy and Fuels (Secretaría de Estado de Energía y Combustibles);

(g) Metallurgical Department of the National Commission for Atomic Energy, Buenos Aires, 1955:

(i) Physics and technology of metals;

(ii) Over-all metallurgical research;

(h) National Institute of Agricultural Technology, Buenos Aires, 1956:

(i) Has experimental plants and stations throughout the country. Is a decentralized agency of the Secretary of State of Agriculture and Cattle Raising (Secretaría de Estado de Agricultura y Ganadería). Has its own resources, derived from a tax on the expert of agricultural products;

(ii) Has fully equipped laboratories in Castelar, Province of Buenos Aires, and in experimental plants located in other provinces;

(iii) Is engaged in agricultural research and some related industrial matters;

(i) National Institute of Industrial Technology. See annex II;

(j) Laboratory of the Aerotechnical Institute (Instituto Aerotécnico - DINFIA), Córdoba, Province of Córdoba:

(i) Under aegis of Secretary of State of Aeronautics (Secretaría de Estado de Aeronáutica);

(ii) Is equipped for control and research service on manufacturing of airplanes, and automotives, and for the institution of which it is a part.

B. Universities

2. These institutions comprise:

(a) Laboratory of the School of Engineering of the University of Buenos Aires;

(b) Laboratory of the School of Physical and Mathematical Sciences of the National University of La Plata;

(c) Laboratory of the National University of Córdoba:

(i) Metallurgical research group, in connexion with INTI;

(ii) Acoustics research group, in connexion with INTI;

(d) Laboratory of the National University of the Littoral:

(i) Structure research group;

(ii) Institute of Industrial and Agricultural Chemistry (Santa Fe);

(e) Laboratory of the National University of Tucumán:

(i) Industrial chemistry group;

(ii) Structure analysis group;

(f) Laboratory of the National University of Cuyó:

(i) Institute of Agricultural Industries, Mendoza;

(ii) Mining research group, San Juan, in connexion with INTI.

3. There are also laboratories owned by private enterprises and industrial organizations, among which the most important is the Argentine Institute of Portland Cement (Instituto del Cemento Portland Argentino), San Martín 1137, Buenos Aires, which serves the building industry and is financed by the manufacturers of that material.

NATIONAL INSTITUTE OF INDUSTRIAL TECHNOLOGY [illegible]

1. The Institute was founded in December 19[illegible]. It is under the direction of a Board of Directors consisting of four representatives of private industry, one representative of the Industrial Bank of the Argentine Republic (Banco Industrial de la República Argentina) and three representatives nominated by the Secretary of State of Industry and Mining (Secretaría de Estado de Industria y Minería). It is located at Libertad 1235, Buenos Aires.

A. General comments

2. The Institute's main source of income is the contribution of [illegible] per cent of loans granted to industrial enterprises by the Industrial Bank of the Argentine Republic and by the Argentine Nation's Bank (Banco de la Nación Argentina). This contribution amounts to an annual income of about 150 million Argentine pesos, or 76 per cent of the entire resources of the Institute; the balance is obtained from fees, services rendered and other sources, for a total of P. 190 million ($US1.3 million).

3. Its operational policy is aimed at helping to solve industrial problems and is based on the work of a group of laboratories, tending specifically to set up: a chemical laboratory emphasizing analytical chemistry; a physical laboratory emphasizing metrology and a testing laboratory for building materials and metals. Furthermore, in fulfilling its major function, which is to promote interest in and development of applied research within the industry, it helps in setting up research centres on the basis of an association between INTI and enterprises or industrial groups interested in the development of programmes related specifically with their industry.

4. Besides the services and the use of INTI's laboratories previously mentioned, the contribution to the research centres amounts to an equal cash contribution from industry and from INTI to a special fund earmarked for that purpose. The proportion of INTI's contribution can be increased in very special cases, with the authorization of an advisory committee, and of the Secretaría de Estado de Industria y Minería.

5. In addition to the above-mentioned funds, private industry is currently contributing annually to INTI an amount of about P. 30 million to fund research centres.

6. Of the Institute's resources, 26.4 per cent is invested in personnel, which consists of 468 persons, 275 of them working at INTI and 189 at the research centres, distributed as follows:

	INTI	Research centres
Technical staff	124	126
Administrative staff	[illegible]	49
Service and cleaning personnel	72	14

Most of the technical staff, in changeable proportion, is under contract.

7. INTI has twenty-two research centres in operation; three of them have already finished their commission. The name "research centre" is a consequence of the Law which created INTI, and which granted them, in administrative matters, the disposition of private enterprises.

8. INTI itself does not organize teaching and training courses, but research centres have done it, according to the needs of the industry associated with them and not overlapping the activities of other institutions devoted specifically to teaching.

9. INTI's headquarters is located in Buenos Aires, as mentioned above. In the same building are the library and the Documentary Research Centre, as well as the hall where the Board meetings of INTI take place and other halls allotted for the meetings of the research centres' committees, lecture rooms, classrooms, and INTI's administrative departments, including promotion and financial management. Some of the centres that need a central location because of the nature of their work, operate in an annexed building in Cerrito 1139, 200 metres from the headquarters.

10. Most of the Institute's laboratories and the ones needed by the research centres are located in the "Miguelete" establishment, which has an area of thirty hectares, located on Avenida General Paz between Avenida de los Constituyentes and Albarellos. There, buildings previously applied to military uses have been adapted for laboratories. At the end of 1963, 5,700 square metres were in use for physics, chemistry, testing material, etc. Offices and libraries occupied 600 square metres; services and workships, 1,000; and stores, 2,700.

11. INTI also supports Marine Biological Stations in Puerto Deseado (Province of Santa Cruz), and Ushuaia (National Territory of Tierra del Fuego and South Atlantic Islands), for whose technical guidance and management INTI, together with the Facultad de Ciencias Exactas y Naturales of the University of Buenos Aires, the Servicio de Hidrografía Naval del Ministerio de Marina (Naval Hydrographical Service of the Navy Department) and the Government of Tierra del Fuego, has founded the Research Centre of Marine Biology (CIBM).

12. In addition, two more research centres have been founded in the Province of Córdoba, jointly with the National University, for metallurgy and acoustics, and another one in the Province of San Juan for studies on minerals.

13. The purpose is that, as the research centres develop and some of them become private entities belonging exclusively to the respective industry, their location close to the laboratories of the Institute and to the other research centres will help to create a favourable climate that will permit them to develop in a more economical way and in closer relation with the other centres.

14. As new staff is incorporated, INTI gives particular attention to their having the opportunity to improve their training and to acquire experience outside the

country, according to each individual [illegible] facilities for trips to foreign countries [illegible] its research centres providing [illegible] contact to be maintained with [illegible].

15. INTI has also helped to facilitate [illegible] experts affiliated with international [illegible] institutions. Following that plan, a number of experts [illegible], in addition to the group from the International [illegible] connected with the Centre of Productivity of Argentina, and the participants in the conventions that INTI has organized to help its research centres - the deliberations on fuels for industry, which took place in September 19[illegible], and the [illegible] on air pollution, in October 1962.

16. INTI is in contact with and receives technical assistance from the following institutions:

(a) The Technical Assistance Board of the United Nations, which assisted in organizing the Fuel Utilization Research Centre (CIPUEC); planning programmes for the practical use of sea-weed; and making it possible for Prof. Maldonado from the Hochschule für Gestaltung, Ulm, Federal Republic of Germany, to give his advice to the Research Centre for Industrial Design;

(b) The United Nations Educational, Scientific and Cultural Organization, which supports the annual courses on marine biology for Latin American university students;

(c) Bouwcentrum of Rotterdam, Holland, whose Director, Eng. Jan van Ettinger, has twice visited Argentina and helped in founding the Bouwcentrum Argentina;

(d) The National Industrial Fuel Efficiency Service of the United Kingdom, which collaborated in launching CIPUEC;

(e) Armour Research Foundation, Chicago, United States of America, with whom an agreement is in operation for technical information;

(f) Physikalisch-Technische Bundesanstalt of Braunschweig, Federal Republic of Germany, which is studying an important programme for technical aid in metrology;

(g) The Réunion Internationale de Laboratoires D'Essais de Matériaux (RILEM) which entrusted to CITAC (a research centre of INTI) the organization of its Latin American Secretariat, formed by eight countries;

(h) The Panamerican Health Organization which acts as advisor to the Centro de Investigación de Ingeniería Ambiental, and is a member of its Committee.

17. The Institute also gives facilities to students of this or other countries who have finished their university studies and wish to do their theses.

18. INTI, through its centres, is entailed in the development of specific works with about 300 industrial enterprises; programmes with the Laboratory for Testing Materials and Technical Research; the Industrial Bank of the Argentine Republic; the Argentine Nation's Bank; the Schools of Exact and Natural Sciences, Engineering,

Architecture and City Planning, of the University of Buenos Aires; the School of Chemistry and Pharmacy of the National University of La Plata; the Institute of Mathematics, Astronomy and Physics of Córdoba; the School of Exact, Physical and Natural Sciences of the National University of Córdoba; the Mining Department of the School of Engineering of San Juan, of the National University of Cuyo; industrial chambers and associations; the Argentine Association of Productivity, with about 500 members; and the Argentine Institute of Materials Standardization (Instituto Argentino de Racionalización de Materiales), adapted to INTI's policy about research centres and has 700 members. This last Institute is devoted to standardization in the Argentine Republic, in which it has been active for twenty-five years; and it is associated with the International Standardization Organization (ISO) and with the Pan-American Committee of Technical Standards.

B. Research centres

19. The research centres currently existing are listed below with a brief mention of their activities.

Research Centre for the Efficient Use of Fuels

20. This Centre was founded on 28 April 1958. Its activities include:

(a) Giving advice to heads of enterprises about the ways of improving the use of fuels;

(b) Offering its members a free service of study and maintenance of factory's thermic installations;

(c) Co-operating with manufacturers of equipment, burners and machines related to the use of fuels;

(d) Encouraging the raising of the level of knowledge of the matter, among the staff connected with this problem;

(e) Organizing short training courses, lectures, etc.;

(f) Organizing industrial laboratories;

(g) Carrying out working and efficiency controls;

(h) Studies on maintenance of factory's thermic installations;

(i) Studies on saving of fuel (5 to 25 per cent), easy to carry out by means of short-term pay-off investments.

(j) Studies of problems of conversion to natural gas;

(k) Thermic balances.

Research Centre of Fats and Oils

21. This Centre, which was founded on [illegible] April [illegible], [illegible] activities:

(a) Renewal and standardization of industries and [illegible];

(b) Setting up extreme limits standards for each type of oil;

(c) Search for new sources of fatty products and improve techniques that are now being applied in the country;

(d) Study of contents of fatty material in seeds;

(e) Study of a cheap and simple method to reduce sampling time;

(f) Study of fats and determination of their tendency to acidity;

(g) Study of new uses of tung oil. Interest in certain forms (monoglycerides, and nitriles) of oleostearic acid;

(h) Procedure for discovering adulteration of vegetable oils with animal fats;

(i) Method to determine the "foods" in linseed oil;

(j) Classification and characteristics of different types of tallow;

(k) Use of vegetable oils as lubricants in metallurgy;

(l) Preparation of plastifiers originated on vegetable oils;

(m) Utilisation of remaining residues at botton of tanks of linseed oil, sunflower seed oil, peanut oil, etc.;

(n) Research on new natural sources of fatty products (turnip, curcuma, thistle, white seed of palo borracho and others).

Research Centre of Metallurgical Manufacturers (CIME)

22. This Centre was founded on 17 April 1959. It co-operates in solving technical and technological problems of small and medium-sized industrial enterprises. CIME aims to reach its objective through three groups of independent but related activities:

(a) Courses on every matter concerning the organization of such enterprises;

(b) Complementary and correlative to the foregoing undertaking, providing advice on industrial organization in those firms;

(c) Promotion of quality tests of raw materials and manufactured products of these firms. For that purpose, INTI facilitates its laboratories.

The Ford Foundation co-operates with CIML, by granting a substantial contribution for the attainment of the above-mentioned objectives.

Research Centre of Applied Technology in Building (CITAC)

23. CITAC was founded on 18 December 1958. Its activities include:

(a) Analysis of problems related to structural concrete in Buenos Aires;

(b) Recommendation of approximate proportions for concrete, according to materials available;

(c) Devising the right experimental techniques for non-destructive tests on concrete and reinforced concrete structures.

Research Centre of Structural Standards for Concrete

24. This research centre was founded on 27 October 1961 to study and edit a "Project of Argentine Regulations on Concrete Structures". So far, the manuscript of the project has been finished and is being printed.

Research Centre of Marine Biology

25. This Centre, which was founded on 4 May 1960, pursues its activities in Buenos Aires and in its marine biology stations in Puerto Deseado and Ushuaia. Among its projects are:

(a) Systematic research on the so-called "giant sea-weeds" of the Patagonian coast;

(b) Learning about the zooplancton and phytoplancton which surround sea-weeds;

(c) Study of conditions under which the sea-weed develops (salinity and temperature of sea-water);

(d) Summer courses in INTI's Marine Biology Station in Puerto Deseado, Province of Santa Cruz, for Latin American professors and fellowship members, under the auspices of UNESCO;

(e) Physical-chemical study of sea-water;

(f) Marine biology (specially Phyto, Zooplancton and giant sea-weeds);

(g) Chemistry of sea-weeds;

(h) Plan to use the sea-weeds in industry and for animal feeding (INTA and INTI agreement).

Research Centre of Leather Technology

26. This Institution, which was [illegible] of study and research on subjects related [illegible], subjects leading to the improvement [illegible] present programme consists of two parts:

(a) Tanning with a combination of [illegible];

(b) Tanning in solvent system.

Productivity Centre of Argentina

27. This Centre was founded on 20 March 1961. Its purpose is to carry out the Operation Plan agreed on in October 1960 by the Secretaría de Estado de Industria y Minería, the United Nations Special Fund and the International Labour Organisation, to incorporate productivity techniques and principles into the country's professional and business structure. The Centre explores techniques used in Argentina, and the introduction of new ones, conducts pilot projects, advises entrepreneurs, co-operates with INTI in the creation of a technical information service and encourages the creation of productivity units within enterprises, devoted to uninterrupted research on possible co-operative improvements.

Documentary Research Centre

28. The activities of this Centre, founded 22 July 1960, are as follows:

(a) Providing, in a wide and rational way, technical information appropriated for the nation's industrial development;

(b) Contributing to the spreading of technological publications. Placing within reach of Argentine technicians all the technological publications of the world;

(c) Bibliographical information;

(d) Photocopies of documents for members;

(e) Inter-library linkage (with centralized index);

(f) Information from national and foreign enterprises;

(g) Informative bulletin with bibliographical news classified by subjects;

(h) Outfitting for reproduction of bibliographical documentation;

(i) Translations;

(j) Plan to furnish the necessary means to bring up to date the technical library;

(k) Subscription to magazines;

(l) Commencement of a bibliography of bibliographies in order to localize and identify technical documentation;

(m) Libraries on consignment from scientific and technical institutions.

Research Centre of the Rubber Industry

29. This Centre, which was founded on 31 July 1961, contributes to the technical development of the rubber industry by means of analysis and testing of raw materials and finished or semi-manufactured products. It can be extended by incorporating subjects for study, research, publishing, training of specialized technicians, etc.

Research Centre of Mineral Industries

30. The activities of this Centre, founded 2 August 1962, include:

(a) The washing and cleansing of fatty clays and kaolin for special uses;

(b) Extraction of sulphur from low-yield pebble and aluminias, starting from non-bauxitic ores;

(c) Tests on peletyzing and syntherizing of manganiferous ores;

(d) Chemical analysis and metallurgical studies to serve the mining, metallurgical and pottery industries.

Research Centre of Industrial Design

31. This Centre was founded on 12 December 1962. Its activities are spreading and promoting the knowledge of systematic training concerning industrial design, particularly through the following ways:

(a) Contests of industrial design;

(b) Exhibition of industrial design;

(c) Museum of industrial design;

(d) Teaching of industrial design;

(e) Meetings for the diffusion of industrial design;

(f) Permanent exhibition of samples of industrial design.

Structural Research and Analysis Centre

32. This Centre was founded on 10 December 1962 with the co-operation of the School of Engineering of the University of Buenos Aires, aiming to solve the problems posed in the calculation of tower structures. Their working programme consists of the following studies:

(a) Standards for measuring draft [illegible] the structures and to serve as a basis for it [illegible]

(b) Criterion for the resolution of the [illegible] methods;

(c) Possible use of electronic computer [illegible];

(d) Comparison of different answers of the strength of structures.

Research and Information Centre for Building Industry - Bouwcentrum Argentina

33. The purpose of this Centre, founded on 2 January 1963, is to:

(a) Promote and carry out technical, economic and social studies and research in the field of building and housing;

(b) Co-ordinate and disseminate the information resulting from those studies;

(c) Give courses, directed to managers, executives and foremen, about the organization of production within said industry.

This Centre was founded on the basis of the Bouwcentrum of Rotterdam, which achieved a renowned work of rebuilding in the Netherlands.

Research Centre of Mathematical Techniques applied to Business Management

34. The major objective of the Centre, which was founded on 1 March 1963, is the diffusion of the practical use of statistics and operation research, which applies the most advanced techniques to solve managerial problems. The new Centre applies these techniques on behalf of different enterprises and has nominated a committee to raise a census of the industrial potential of the country.

Welding Research Centre

35. This Centre, founded on 20 March 1963, offers a service of control by means of non-destructive tests and gives advice on welding, feasibility of welding splitted materials and techniques to be used.

Cuyó Research Centre of Minerals

36. The Cuyó Centre was founded on 16 April 1963. Its immediate plan of works includes:

(a) Contact with consumers of different types of talcum, to learn the problems related with its utilization;

(b) Visits to mine fields in production, and extraction of representative samples of their products;

(c) Washing essays on each representative type of talcum, steatite or soap-stone, in order to obtain products of higher quality.

Metallurgical Research Centre

37. The new Centre was founded on 1 July 1963; its programme consists of:

(a) Setting up a formula that should permit the forecast of mechanical strength and hardness of grey cast-iron, based on its chemical composition and thickness of the parts;

(b) Formulae for the calculation of powers and stresses in mechanical treatment of plastic deformation;

(c) Formulae for computing the strength to "fragile breakage" which could permit forecasting the results of tests accomplished with different types of concentration factors and at different temperatures.

Acoustics Research Centre

38. This Centre was founded on 21 October 1963. It lends services to the manufacturing industry of acoustical apparatus and building materials, carrying out, among others, the following tests:

(a) Measurement, in echo chamber, of the absorption coefficients of materials;

(b) Measurement, in transmission and reception chambers, of aerial isolation of partition walls;

(c) Measurement, in tubes of stationary waves, of normal absorption and acoustical impedance.

In addition, the Centre will acquire portable equipment which will permit it to make the following determinations: isolation between dwellings, time of room reverberation, frequency response of loudspeakers and microphones, and polar curves of transductors.

Argentine Institute of Materials Standardization (IRAM)

39. Incorporated in INTI's policy of research centres on 23 July 1961, this Institution has been carrying out important tasks in the field of standardization, studying and remarking new standards and reviewing the existing.

40. IRAM occupies the position of temporary General Secretary of the Pan American Committee of Technical Standards, whose major objective is to put standards at a Pan American level and, in last instance, aid commercial and industrial interchange in Latin America. The Centre has published a new Catalogue of Standards corresponding to 1963, which includes the standards in force, under study or under revision.

Research Centre of Ambiental Engineering

41. This Centre was founded on 15 November 1963. Its activities include:

(a) Evaluation of atmospheric pollution;

(b) Organization of a laboratory specialized in the study [illegible] pollution;

(c) Training of technicians at university and non-university [illegible];

(d) Plans for checking on atmospheric pollution.

<u>Research Centre for the Study of Problems in the Celullose and Paper Industry</u>

42. The activities of this Centre, which was founded on 30 December [illegible], include:

(a) Development of a laboratory for physical-chemical tests of paper and celullose;

(b) Chemical studies of national woods, paper loads, gluing, etc.

APPENDIX I

PERIODICAL PUBLICATIONS ISSUED BY INTI AND THE CENTRES UNDER ITS SPONSORSHIP, UP TO SEPTEMBER 1964

<u>Published by INTI</u>:

Review (published by the Documentary Research Centre)
Monthly bulletin
Scientific and technical publications

<u>Published by research centres</u>:

<u>Documentary Research Centre</u>:

Bibliographical bulletin

<u>Research Centre of Marine Biology</u>:

Informative bulletin
Scientific contributions

<u>Research Centre for the Efficient Use of Fuels</u>:

Proceedings of the conferences

<u>Research Centre of Applied Technology in Building</u>:

Technical publications

<u>Research Centre of Industrial Design</u>:

CIDI's news bulletin (monthly)

<u>Research Centre Bouwcentrum Argentina</u>:

Proceedings of the conferences
Technical publications

<u>Productivity Centre of Argentina</u>:

"Productividad" (monthly bulletin)
Productivity documents
Technical memoranda books
Technical-informative publications

<u>Argentine Institute of Materials Standardization</u>:

IRAM Review
Informative bulletin (bi-monthly)

APPENDIX II

PAPERS PUBLISHED, BY AUTHOR, TITLE AND PUBLISHER, UP TO SEPTEMBER 19[illegible]

Author	Title	Publisher
INTI		
Uribe, B.	"Productivity and technological research"	"Mirador", No. 11, 19[illegible]
Diaz Blasco, H. and T. Rique	"Recovery of an industrial by-product: sunflower wax"	VIII° Latin American Congress of Chemistry, Buenos Aires, September 19[illegible]
Figueiro, L., T. Rique and H. Diaz Blasco	"Development of new activities in the arid and semi-arid regions of the country: industrialization of the pine nut: (*Jatropha macrocarpa*)"	Idem
Rique, T.	"Problems and solutions in the industrial process of manufacturing rubber from the *Espina Corona* seed (*Gleditsia amorphoides*)"	Idem
Fiaño, E.N., A. Zanetta and T. Rique	"Argentine woods: native Coniferae"	Idem
Diaz Blasco, H., N. Moundiroff and J.G. Gomez Artero	"Radiation of rice bran with Gamma rays"	Idem
Fiaño, E.N.	"Chemical and technological study of coniferae aiming at using them in paper manufacturing"	INTI, 1963
Diaz Blasco, H.	"Quick method to determine the air content in margarine, shortenings and mayonnaise, etc."	Revista Arg. de Grasas y Aceites 5, 84 (1963)
Research Centre of Fats and Oils		
Crespo, F.	"Study of a new method to detect pollution agents in castor oil"	Revista Arg. de Grasas y Aceites: 2, [illegible], [illegible]
Crespo, F.	"The constitution of Linoleic acid derived from olive oil"	Idem: 2, 57, [illegible]

Author	Title	Publisher
Research Centre of Fats and Oils (continued)		
Crespo, F. and R.A. Macchi	"Study on halogenization of fatty substances in the presence of mercuric acetate"	Idem: 2, 97, 1960
Crespo, F. and R.A. Macchi	"Method to detect the addition of margarines in cotton seed oils"	Idem: 3, 60, 1961
Macchi, R.A.	"The Vizern assay applied to Argentine olive oils and mixtures with different seeds oils"	Idem: 3, 60, 1961
Crespo, F., R.A. Macchi and I. Gallardo	"Preparation and analysis of glyceride monoeleostearate"	Idem: 3, 76, 1961
Gallardo, I. and I. Sameh	"Method to detect the existence of animal fat in vegetable oils"	Idem: 3, 105, 1961
Gallardo de Kuck, I., R.A. Macchi and F. Crespo	"Studies on thermic polymerization of derivatives from eleostearic acid, I-polymerization of the I-monoglyceride"	Idem: 4, 3, 1962
Research Centre for the Efficient Use of Fuels		
Porta, L.	"Río Turbio and Argentine railways"	Revista "Energía Industrial" Nov./Dec. 1960: pages 43/49
Fernandez, F.J. and M. Lehmann	"Formation of steam from condensate"	Idem: Nov./Dec. 1961 pages 50/52
Salvador, L. and D. Lombardi	"Utilization steam produced and recovery of the condensate"	Idem: March/April 1961, page 53
Lombardi, D.	"Recovery of heat in an electrolitic zinc plant"	Idem: May/June 1961 page 58
Salvador, L. and M. Lehmann	"Thermic study of a factory of foods"	Idem: July/August 1961, page 53
Salvador, L.	"Recovery of lost heat"	Conference of Industrial Fuels, Buenos Aires, IX, 1961
Lehmann, M. and F.J. Fernandez	"Use of natural gas burners"	Idem
Porta, L.D.	"Gazogenes applied to boilers"	Idem

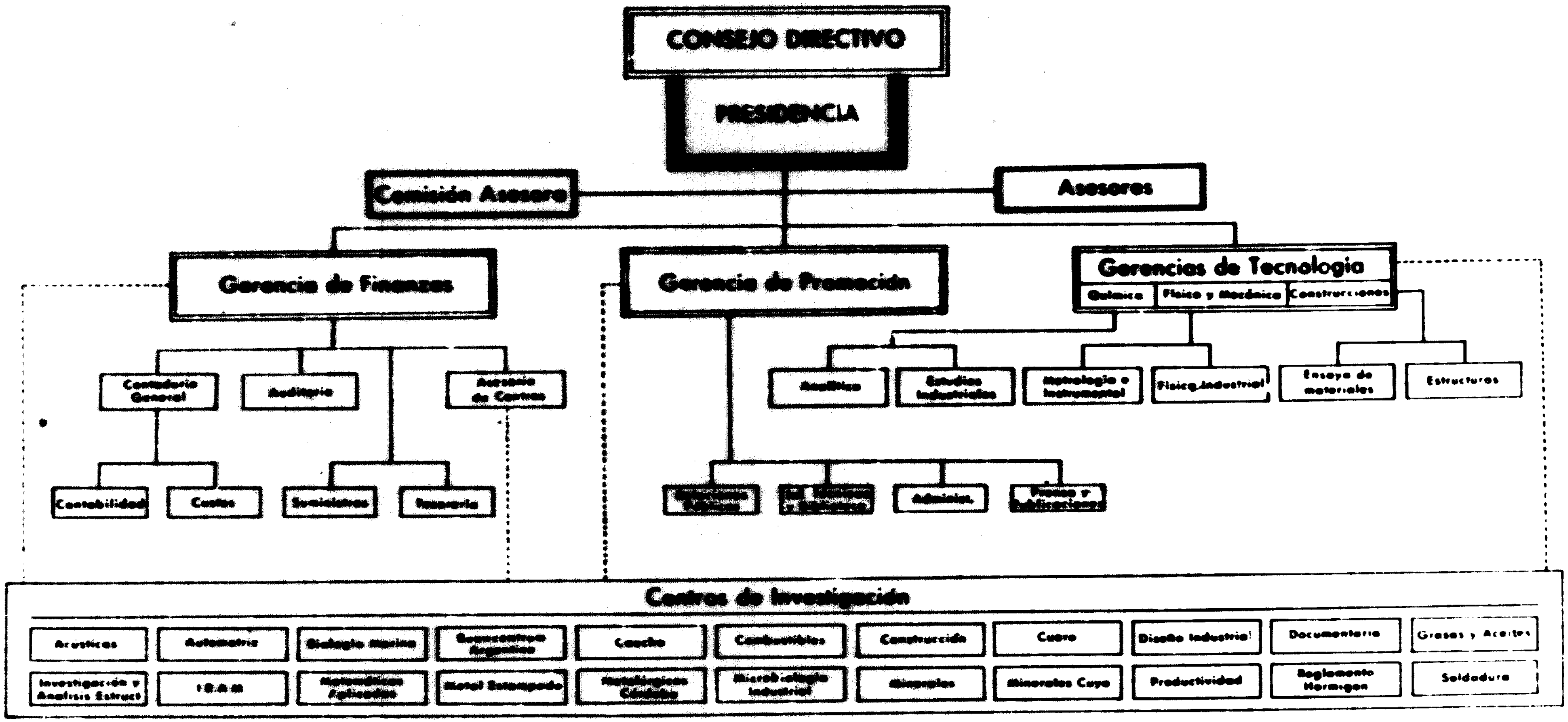
Author	Title	Publication
Research Centre for the Efficient Use of Fuels (continued)		
Salvador, L.	"Evaluation of the atmospheric pollution problem in Buenos Aires"	I Latin American Conference on Atmospheric Pollution, Buenos Aires, October [illegible]
Leikis, E.	"Formation and elimination of polluters in the combustion process"	Idem
Porta, L.D.	"Air pollution by steam locomotives"	Idem
Lombardi, D.	"Domestic boilers and atmospheric pollution"	Idem
Research Centre of Marine Biology		
Ringuelet, R.A., A. Amor, N. Magaldi and R. Pallares	"Ecological study of the intertidal fauna of Puerto Deseado"	"Physis" (Review) 64 35/53, 1962
Jensen, Arne	"Industrial use of marine sea-weed in Argentina"	CIBM (February 1964)
Ringuelet, R.A., W. Dioni and F. Buckle	"Preliminary examination of iliofaune distribution in the intertidal mud of Puerto Deseado"	Physis XXIV, 67, 103-106
Ringuelet, R.A.	"Ecological study in the Patagonian coastline. The supralittoral floor in the estuary of the Deseado River"	Physis XXIV, 67, 95-101
Pujals, C.	"Catalogue of Rhodophyta quoted for Argentina"	Rev. Arg. Museum of Natural Sciences. Cs. Bot. 3 (1)
Kuhnemann, O.	"Macrocystis Pyrifera's penetration in the estuary of the Deseado River"	Bull. of the Arg. Botanical Society 10 (2-3): 105/112
Bernasconi, I	"Perknaster Densus Patagonicus, New Argentine subspecies"	Idem: 65, 257/258, 1962
Boltovskoy, E.	"The littoral foraminiferal Biocoenoses of Puerto Deseado"	Contributions from the Cushman Foundation for Foraminiferal Research: 2, 58/70, 1963
Halperin, D.R.	"Marine Cianoficeas of Puerto Deseado"	Revista "Darwiniana" 4, 566/72, 1963

Author	Title	Publisher
Research Centre of Marine Biology (continued)		
Neushul, M.	"Reproductive morphology of antarctic kelps"	"Botánica Marina" (Review), 1, 21/24, 1963
Research Centre of Technology Applied to Construction		
Burgoa, G.	"Aggregates available and nature of works for concrete in Buenos Aires"	CITAC, 1961
Burgoa, G.	"Adequate dosage for structural concretes"	CITAC, 1962
Research and Investigation Centre for Building Industry - Bouwcentrum Argentina		
Van Ettinger, J.	"Decision in building" - Lecture	Bouwcentrum Argentina, 1962
Van Ettinger, J.	"Towards a habitable world" - Lecture	Bouwcentrum Argentina, 1962
Van Ettinger, J.	"Building rationalization" - Lecture	Bouwcentrum Argentina, 1962
ARGENTINE BOUWCENTRUM	"Directory of Planning, Building and Housing Institutions"	Bouwcentrum Argentina, 1963
Garcia Olano, E., L.M. Gasparotti, R. Humar, M. Litwinczuk and G.J. Notenson	"Demographical data in relation with housing"	Bouwcentrum Argentina, 1964
Vapñarsky, C.A. and G.J. Notenson	"Research methodology of housing needs"	Bouwcentrum Argentina, 1964
Productivity Centre of Argentina (CPA)		
Lasalle, G.M.	"Productivity problems" - Lecture	CPA, 1962
Lasalle, G.M.	"Safety, a Development factor" - Lecture	Idem
Jasminoy, H.E.	"Active methods of industrial training"	Idem
Jasminoy, H.E.	"Enterprises and development of the human factor" - Lecture	Idem

Author	Title	[illegible]
Productivity Centre of Argentina (CPA) (continued)		
Meier, J.H. and E.G. Bendinger	"Productivity measurement in cotton-spinning mills"	[illegible]
Heller, F.A.	"Mutual aid, source of enterprise development"	[illegible]
Research Centre of Leather Technology (CITEC)		
Giovambattista, H. and A. Sofia	"Process of chrome tanning. Study of the cinetics of the mechanism based on the external fase exhaustion"	Argentine Association of leather chemists and technicians Review, 5, No.111, 19[illegible]
Research Centre of Industrial Design (CIDI)		
Tedeschi, P.	"What is industrial design"	Catalogue of the first International Exhibition of Industrial Design (May 1963)
Uribe, B.	"Culture and industry: manufacturers' responsibility"	Idem

ORGANIZACION FUNCIONAL

INSTITUTO NACIONAL DE TECNOLOGIA INDUSTRIAL



———— : Relación de dependencia
- - - - : Supervisión tecnica administ ación y fiscalización

ORGANIGRAMA GENERAL	ORGANIZATION CHART
INSTITUTO NACIONAL DE TECNOLOGIA INDUSTRIAL	NATIONAL INSTITUTE OF INDUSTRIAL TECHNOLOGY
CONSEJO DIRECTIVO	BOARD OF DIRECTORS
PRESIDENCIA	PRESIDENCY
Comisión Asesora	Advisory Committee
Asesores	Advisors
GERENCIA DE FINANZAS	FINANCIAL MANAGEMENT
Contaduría General	General Accountant
Contabilidad	Accounting
Costos	Costs
Auditoría	Auditing
Suministros	Supplies
Tesorería	Treasury
Asesoría de Contratos	Research Contract Advisory
GERENCIA DE PROMOCION	PROMOTION MANAGEMENT
Relaciones Públicas	Public Relations
Inf. Técnicas y Bibliotecas	Technical Information and Library
Administ.	Administration
Prensa y Publicaciones	Press and Publications
GERENCIA DE TECNOLOGIA	TECHNOLOGICAL MANAGEMENTS
Química	Chemistry
Analítica	Analytical
Estudios Industriales	Industrial Studies
Física y Mecánica	Physics and Mechanics
Metrología e Instrumental	Metrology and Instrumental
Física Industrial	Industrial Physics
Construcciones	Constructions
Ensayo de Materiales	Material Testing
Estructuras	Structures

CENTROS DE INVESTIGACION	RESEARCH CENTERS
Acústicas	Acoustics
Automotriz	Automotive
Biología Marina	Marine Biology
[illegible] Argentina	[illegible] Argentina
Caucho	Rubber
Combustibles	Fuels
Construcción	Constructions
Cuero	Leather
Diseño Industrial	Industrial Design
Documentaria	Documentary
Grasas y Aceites	Fats and Oils
Investigación y Análisis Estructural	Structural Research and Analysis
I.R.A.M.	IRAM
Matemáticas Aplicadas	Applied Mathematics
Metal Estampado	Stamped Metal
Metalúrgicas Córdoba	Córdoba Metallurgical
Microbiología Industrial	Industrial Microbiology
Minerales	Minerals
Minerales Cuyo	Cuyo Mineral
Productividad	Productivity
Reglamento Hormigón	Concrete Regulation
Soldadura	Welding

——— = Relación de dependencia

- - - - - - - = Supervisión técnica, administración y fiscalización

——— = Dependency Relations

- - - - - - - - = Technical supervision, management and control

APPENDIX IV

BREAKDOWN OF TECHNICIANS EMPLOYED AT INTI AND
RESEARCH CENTRES

Institutes		Number of Technicians
Major laboratories		[illegible]
Research centres		[illegible]
1. Research Centre for the Efficient Use of Fuels	8	
2. Research Centre of Fats and Oils	7	
3. Research Centre of Stamped Metal	3	
4. Research Centre of Technology Applied to Construction	3	
5. Research Centre of Structural Standards for Concrete	-	
6. Research Centre of Marine Biology	14	
7. Research Centre of Leather Technology	9	
8. Productivity Centre of Argentina	18	
9. Documentary Research Centre	- a/	
10. Research Centre of the Rubber Industry	3	
11. Research Centre of Mineral Inductries	15	
12. Cuyo Research Centre of Minerals	3	
13. Research Centre of Mathematical Techniques Applied to Enterprise Management	12	
14. Structural Analysis Research Centre	3	
15. Research and Information Centre for Building-Bouwcentrum Argentina	13	
16. Research Centre of Industrial Design	5	
17. Research Centre of Ambiental Engineering . . .	4	
18. Acoustics Research Centre	2	
19. Welding Research Centre	1	
20. Metallurgic Research Centre of Córdoba	3	
		250

a/ INTI personnel (Library: 8 technicians).

APPENDIX V

RESEARCH PROJECTS CARRIED OUT BY INTI AND RESEARCH CENTRES

Major laboratories

(a) Investigation of problems on industrial processing of rubber from espina corona seeds;

(b) Galactomananaes rubbers in food processing. Need of bromatological regulations;

(c) Investigation tending to obtain alginas and recovery of their salts;

(d) Investigation about use of straw in paper manufacturing;

(e) Test for the thrifty obtainment of a charcoal and fuel-oil mixture: "carboil";

(f) Obtainment of waxes as by-product of sunflower oil manufacturing and investigation of its technological possibilities;

(g) Investigation of oil from the sacha higuera fruitage and its technological possibilities;

(h) Investigation on native coniferae cultivated in the country, in order to obtain pulps and paper;

(i) Investigation of the chemical composition of sea-weeds from Argentine southern coastline, concerning their ecology, site and harvesting time;

(j) Investigation of by-products from food industry, with a view of obtaining animal foods (dried blood and fish);

(k) Chemical composition of leguminous seeds (by request of the Chemists' School of Puerto Rico);

(l) Investigation of the colour of yolk from poultry fed with a sea-weed compound;

Research Centre of Fats and Oils

(a) Investigation of a new method to detect polluter agents in castor-oils;

(b) Natural structure of linoleic acid in olive oils;

(c) Investigation on halogenation of fatty matters in the presence of mercury acetate;

(d) Method to investigate the addition of margarine in cotton-seed oils;

(e) Quick method to determine oil in [illegible];

(f) Vizern's assay applied to Argentine olive [illegible] different seed oils;

(g) Preparation and analysis of glyceril [illegible];

(h) Spectrophotometric determination of animal fats in vegetable [illegible];

(i) Investigations on thermal polimerization of eleostearic [illegible]. I-Polimerization of 1-monoglyceride;

(j) Comparative colorimetric study of bovine tallows, using Lovibond and Fac. colorimeters;

(k) Critical examination of the recommendations outlined by the Pan American Committee of Technical Standards;

(l) Determination of soaps in refined oils. Work carried out by CIGA in co-operation with the respective Committee of IRAM;

(m) Investigation on hydrolisis of tallows during their storage;

(n) Investigation of tung oil derivatives: glycerol-acetone, glycerol-acetone eleostearate, polymers from glycerol-acetone eleostearate and produce from the interesterification of tung oil with glycerol-acetone;

(o) Study of methods to determine small quantities of methylic esters in oils (requested by the International Union of Pure and Applied Chemistry);

(p) Study of foaming agents suitable for the production of multicellular plaster (requested by the Research Centre for Mineral Industries).

Productivity Research Centre

(a) Productivity measurement in cotton-spinning mills.

Research Centre of Marine Biology

(a) Ecological study of the intercotidal fauna of Puerto Deseado;

(b) Foraminiferae of Puerto Deseado;

(c) Catalogue of Argentine Rodopycaeas;

(d) Vegetal communities of the Deseado River estuary;

(e) Algae distribution in the Patagonian coastline, down from parallel 47 to close by Comodoro Rivadavia.

Research Centre of Leather Technology

(a) Kinetic study of chrome tanning process;

(b) Method to hasten the vegetal tanning process;

(c) Tanning by combination of formaldehyde-sulphated quebracho extract;

(d) Tanning in solvent system.

Research Centre of Technology applied to Construction

(a) Study on "Aggregates available and ways of working concrete in Buenos Aires City";

(b) Adequate dosages for structural concrete, with aggregates available in Buenos Aires;

(c) Study of the characteristics inhering in arids available in different areas of the country;

(d) Technological study of limes and plasters;

(e) Investigation of concrete additives.

Research Centre for Mineral Industries

(a) Investigation of portable plants for concentration of minerals: a highly useful tool for the development and technification of small and medium-sized level mining enterprises.

(b) Investigation of quality and treatment of bentonites.

Research Centre of Ambiental Engineering

(a) Evaluation of atmospheric polluter agents in Buenos Aires City.

Research Centre of Structural Standards for Concrete

(a) Writing of a project of "Argentine Regulations for Designing, Calculation and Building of Concrete Structures".

Research and Information Centre for Building - Bouwcentrum Argentina.

(a) Methodology of the research on needed supply of dwellings;

(b) Over-all demographic data related to dwellings.

Structural Research and Analysis Centre

(a) Simplification of the calculation methods for tower structures.

Acoustics Research Centre

(a) Research on the effects of jet [illegible] the army.

APPENDIX VI

OUTLINE OF ACTIVITIES OF INTI AND RESEARCH CENTRES

Research Centres	Research	Assistance	Control
Major Laboratories	(a) (b)	(a) (b)	(b)
Fuels Research Centre	(b) (c)	(b)	(c)
Fats and Oils Research Centre	(a) (b)	-	(c)
Stamped Metal Research Centre	-	-	-
Construction Research Centre	(b)	(b)	(a) (c)
Concrete Structures Research Centre	-	-	(a) (c)
Marine Biology Research Centre	(a) (b)	(a)	-
Leather Research Centre	(a) (b) (c)	(b)	(b) (c)
Productivity Research Centre	(b)	(b)	-
Documentary Research Centre	-	-	-
Rubber Research Centre	(a) (b) (c)	(b)	(b) (c)
Minerals Research Centre	(a) (b) (c)	(a) (b)	-
Industrial Design Research Centre	(a) (c)	(b)	-
Structural Research and Analysis Centre	(b)	-	(c)
Research and Information Centre for Building (Bouwcentrum Argentina)	(a) (c)	(b)	(c)
Mathematical techniques applied to Enterprise Management Research Centre	-	(a) (b)	-
Welding Research Centre	(b)	(b)	(c)
Cuyo Minerals Research Centre	(b)	(a) (b)	- (c)
Metallurgical Research Centre	(a) (b)	(b)	(c)
Acoustics Research Centre	(a) (c)	(a) (b)	(b) (c)
ILAM Research Centre	-	-	(a) (b) (c)
Ambiental Engineering Research Centre	(a) (c)	(a) (b)	(c)
Cellulose and Paper Research Centre	(a) (b) (c)	(a) (b)	(c)

Explanation of the outline:

<u>Research activities</u>

(a) Research applied to specific products;

(b) Research applied to specific processes;

(c) Research applied to special equipment.

<u>Activities in assistance</u>

(a) Research and technical aid for setting up and development of new industries;

(b) For settled industries.

<u>Control activities</u>

(a) Fulfilment of governmental regulations;

(b) Fulfilment of settled technical standards;

(c) Quality standards for private enterprises.

XXVII. THE ROLE OF THE MEXICAN INSTITUTE OF TECHNOLOGICAL RESEARCH WITHIN THE SCOPE OF THE ORGANIZATION OF INDUSTRIAL RESEARCH IN MEXICO

Prepared by I. Deschamps*

1. In the present report, an attempt is made to follow as closely as possible the pattern suggested by the Centre for Industrial Development of the United Nations Department of Economic and Social Affairs.

A. National industrial research policy

2. Throughout the last twenty years an ever-increasing interest in research and development has become evident in Mexico. It will be found that fundamental research activities in practically all traditional fields of endeavour are being strengthened and expanded in major universities. It will also be found that at least some initial steps in the direction of more activities in the field of fundamental research appear to be taking place to varying degrees throughout the state colleges and universities. It is hoped that as full-time professorships are established and more laboratory facilities are made available at universities in Mexico City, 1/ Guadalajara 2/ and Monterrey, 3/ most other universities in the various states of the Republic will follow this trend of introducing research programmes together with their current teaching activities.

3. The major programmes of fundamental research in the technical fields of chemistry, biochemistry and allied subjects are being conducted at the National University of Mexico and at the National Polytechnic Institute, either directly or through such special bodies as the Institute of Chemistry (NUM) and the Institute of Advanced Studies (NPI). The former, for instance, has contributed important work in the field of esteroid and hormone chemistry. Industrial ventures with some unique features have taken place in Mexico and abroad; these have undoubtedly benefited from the systematic research programmes carried out at the University. A number of professionals trained at the Institute of Chemistry are now participating in advanced development programmes at specialized pharmaceutical firms. 4/

4. The Institute of Advanced Studies is a newly created branch of the Polytechnic Institute. Its well-selected staff, through the use of its outstanding laboratory facilities, is expected to render invaluable services to the country. Although a major part of its research programmes is undoubtedly of a fundamental nature, it has been announced that some development work will also be encouraged at this Institute.

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* Technical Director, Instituto Mexicano de Investigaciones Technológicas.

1/ Mexico City, Federal District Zone and surrounding State of Mexico area hold the major industrial centre of the country.

2/ Second largest city, capital of the western State of Jalisco.

3/ Second ranking industrial area, capital of the northern State of Nuevo León.

4/ Syntex, S.A., Productos Esteroides, S.A., Protex, S.A. and others in the Mexican Republic.

5. In connexion with agriculture and forestry, both fundamental and applied research are being carried out on a comparatively large scale by special organizations sponsored by the Ministry of Agriculture. Under a co-operative project between this Ministry and the Rockefeller Foundation, important research ventures have taken place. Among these, the universally known breeding programmes on corn, wheat and barley are the most outstanding. The organization of the International Centre for the Development of Maize and Wheat is bound to have far-reaching benefits for all countries where these grains play a significant economic role. Perhaps the key achievement derived from the various research programme begun a number of years ago in connexion with agricultural crops has been the establishment of the National Institute of Agricultural Research. 5/ Today this Institute displays a truly outstanding professional structure and has recently availed itself of new facilities to implement its present programmes.

6. Similarly, the National Institute of Forest Resources is undertaking a broad programme in connexion with the inventories of Mexican woods, including both temperate and tropical forest areas. Also, this Institute is concerned with studies on the utilization of forest resources, mostly in terms of timber and plywood.

7. With regard to the all-important subject of water, it is worth while mentioning the outstanding services rendered by the Hydraulic Resources Institute, which has been operating for a number of years under the auspices of the corresponding Ministry. This Institute has been instrumental in the development of pilot models, which in turn have given rise to the numerous dams and other types of reservoirs and hydraulic projects systematically encouraged by the several Mexican Governments that have been in office since the early 1930's.

8. As for the specific subject of applied research institutes, directly connected with the industrial development of the country, it is pertinent to say that this type of activity is in every way a modern phenomenon in Mexico. It has followed the prior ventures of institutional research in the United States of America, Canada and Europe, which in many instances appeared also after the Second World War. A number of the existing research and development organizations came into being, to a large degree, through the efforts of the Department of Industrial Investigations of Mexico's Central Bank. 6/ In the background of these developments there are the efforts of the Bank of Mexico in regard to the important training programme of scientists and engineers at numerous universities and research laboratories abroad. This programme was launched during the latter part of the Second World War. To date, several hundred young men and women who first received their basic training in Mexican universities and technical schools have been privileged with invaluable opportunities for post-graduate work in selected centres abroad. The large majority were chosen within the fields of agriculture, chemical sciences and engineering; food, fermentation, cellulose and fibre technology; and petroleum, mineral and metallurgical chemistry. The full support or a substantial part of their financial needs has been undertaken through this unique programme. Upon their return to Mexico, these post-graduates have become engaged in important supervisory level activities, both in government positions and in numerous industries.

5/ These programmes were originally carried out directly by the Ministry of Agriculture, through its special studies section.

6/ Banco de México, S.A.

9. This training programme has also made it possible to staff, to a varying degree, the newly created research and development organizations. Among these, there are the Institute of Mineral Resources, later redesigned into the Council for Non-Renewable Resources, 7/ as a part of the Ministry of the National Patrimony; the National Laboratories for Industrial Development, 8/ currently operating under the Ministry of Industry and Commerce; the Mexican Institute of Technological Research (IMIT) and the Institute of Industrial Research of Monterrey, 9/ the latter linked in its operation to the Southwest Research Institute, located in Texas, United States of America, with the joint sponsorship of the Technological Institute of Advanced Studies, 10/ which is mainly supported by the local industry of the State of Nuevo León, Mexico.

10. The latter three institutes carry out sponsored work for the Government and for industry, following relatively different approaches.

11. In terms of volume of operations and of degree of diversification, IMIT may be regarded as the largest in the country. Most of its work falls within the applied concept of research in the following areas:

(a) products and waste materials derived from agricultural and forest operations. These include research and development on food products, specialized feeds, fermentation products, fibres, cellulose and paper and on numerous organic materials, such as vegetable oils, waxes, tannin materials and derivatives;

(b) research and development on mineral resources, mainly in connexion with extraction, beneficiation and upgrading of metallic and non-metallic products, through adaptation of known techniques and development of non-orthodox processes.

12. Founded in 1950, under the auspices of the Mexico's Central Bank, IMIT is currently a civil association, sponsored and conducted by the three major national credit institutions of the country; namely, the Bank of Mexico, the National Finance Company 11/ and the National Bank of Foreign Commerce. 12/ Its budget is formed by the yearly contributions of these three institutions and by resources derived from contract work with industry. These contracts are selected by its Board of Directors in terms of their relative value to the national economy.

13. During its first five years the Institute was operated under a contract with the Armour Research Foundation (ARF), United States of America, currently the Illinois Institute of Technology Research Institute. Its operational pattern resembled in a number of ways the one adopted in those days by ARF. In time, this pattern has been the subject of numerous modifications in an effort to adapt the Institute to local conditions. Among the current special features of the Institute, it is worth mentioning the following.

7/ Consejo de Recursos Naturales No Renovables.

8/ Laboratorios Nacionales de Fomento Industrial.

9/ Instituto de Investigaciones Industriales, Monterrey, Mexico.

10/ Instituto Tecnológico y de Estudios Superiores de Monterrey, Mexico.

11/ Nacional Financiela, S.A.

12/ Banco Nacional de Comercio Exterior, S.A.

Built-in research training programme

14. In 1955, IMIT began a training programme for young [illegible] from various universities and technical schools of the country. This programme was aimed at solving the permanent problem derived from the scarcity of specialized professionals, a condition that [illegible] research and development activities, not only in Mexico but in most developing countries throughout the world. These countries are solving, at least to a varying degree, the all-important problem of supplying industry with university-trained people. In all fairness and in spite of the outstanding efforts of distinguished universities and technical schools, the matter of supplying the highly specialized type of professionals who can readily participate in applied research programmes has not been properly satisfied as yet. In contrast with the most advanced nations, where this type of man may be either located in specialized university laboratories or, most certainly, in the research departments of numerous industries, from which they may be drawn to further engage in institutional research programmes, the situation in developing countries is far too different. Most local industries in developing countries are not generally engaged in research and development programmes of their own nor can research men be brought from abroad for other than short periods of time in connexion with specific research projects at research and development organizations.

15. The severity of this problem is such, and the means of solving it so restricted throughout most developing countries, that the matter of setting up special research training programmes at research and development organizations will be found a mandatory decision to adopt. This kind of decision was taken at Mexico's IMIT, soon after its initial staffing with foreign trained scientists and engineers had been accomplished.

16. The training programme was organized in terms of annually engaging approximately thirty-five to forty-five selected young scientists and engineers. These included candidates just out of school, immediately prior to taking their final university examination and recently graduated, or those having a few years' experience in industry or in other research laboratories. Those who do well during a first year of thesis work at IMIT 13/ are then granted fellowships to continue with their research training at the Institute. This second-stage training may last two to three years, after which the best members in the group are encouraged and sponsored to carry out post-graduate work in carefully selected universities and research centres of the United States of America, Canada and European countries. 14/ Upon their return, they are free either to engage in formal research and development projects at the Institute or to take a position in the Government or in industry. This freedom of decision has proved most effective as a means of ensuring that only those truly prepared for and deeply interested in applied research remain at the Institute.

13/ These theses are a requirement of universities for the granting of the final degree.

14/ Through fellowships granted by international agencies, foreign Governments and universities, and frequently supplemented by the Bank of Mexico.

17. Approximately [illegible]0 per cent of the trainees' time is devoted to lectures and seminar work within the Institute, and the balance is used exclusively in participating in main research projects, within collateral lines where both the project and the trainees can profit the most. As a result of these efforts, new candidates with sound training and, above all, with the right research attitude, are annually available to fill in the lower staff brackets. From there on they are currently promoted into leading positions. No substitute has been found for this procedure and in the light of its benefits its expansion is being consistently encouraged, not only in terms of trainees from local sources, but most willingly in behalf of scientists and engineers from other countries. Representatives from Colombia and from the various Central American countries have already benefited through their participation in these built-in training programmes. In the future it is expected that these facilities will be broadened so as to make possible the inclusion of a wider group of Spanish-speaking trainees from sister countries throughout Latin America and, in turn, this will offer a true opportunity for a broader exchange of talent and experiences with other research and development institutes in the area.

18. If one were to be asked about the relative importance of the various types of contributions that IMIT has made to the Mexican economy, the reply would not be a simple one to formulate. However, no single effort of IMIT will bear as far-reaching consequences as this training programme is currently producing. Because of the multiplying effects that are expected to derive from the systematic supply to industry of scientists and engineers with newly acquired points of view on industrial matters, the writer is confident that effective motivations and practical means for technological change are being introduced into industry. This programme is thus regarded as an essential operation which is intended to be maintained and encouraged continuously in view of its proved merits. At any rate, it is regarded as an indispensable programme, at least until such a time when the highly diversified type of professional skills required by research and development organizations become available.

IMIT attitude concerning fundamental and applied research and their relative encouragement in relation to one another

19. After having described the general patterns of Mexico in regard to institutions devoted mainly to fundamental research and/or to applied research, it is of interest to refer to the extent to which an applied research organization may be expected to apply its efforts along the two main types of research. In this connexion, the IMIT programme structure may be considered for the sake of this analysis.

20. First, it would be relevant to state that the two types of research can scarcely be disjointed or considered as entirely separate or distinct concepts. Except for the presence or absence of specific economic goals, the basic disciplines involved cannot be anything but identical. With the possible exception of certain specialized tools used in connexion with advanced stages of a research and development programme, such as those involving unit operation and pilot-plant equipment, the research techniques remain basically the same, whether one is dealing with a purely fundamental matter or with an applied research case. Largely, the characteristic of the latter is the presence of relatively narrow parameters which tend to limit technical decisions in the light of a number of economic considerations and of operational limits expected to show up at the industrial scale.

21. If proper technical and economic parameters are [illegible] revised in the light of results obtained at the various stages of the research programme, it will then be possible to improve the probabilities of success of the project. This, however, will not exclude certain cases whereby a certain amount of fundamental research is required. Such parameters are devised, generally, not only in terms of possible market considerations, such as price boundaries, availability of raw materials and many other practical considerations, but, above all, they will be a reflection of hypothetical assumptions, based in part on previous observations and experiences gained by those bearing the responsibilities for the implementation of the project. It follows, then, that if some of these parameters cannot be substantially modified in instances when the best hypotheses and experimental confirmations show that they can hardly be met, the only possible way out will be to release, to the extent that it may be necessary, the restrictions imposed upon the research leaders. They will proceed in this way with a high degree of freedom in the search for new approaches for the solution of the problem. When this happens, the activities will then take the form, at least temporarily, of what may be regarded as fundamental research efforts. Thus, no strict boundary may be defined that could separate the two apparently different trends.

22. In practice, most applied projects are permitted greater freedom in their initial stage. This stage should be carefully evaluated as far as time and allowable expenditures are concerned, as it really means a phase in which research men are being given opportunities for developing valuable approaches to the solution of the problem. Then, it may also happen that hroughout the research programme one or several intervals must be allowed for more fundamental research along specific lines of the project, so as to properly implement a satisfactory resolution at the end of the research venture.

23. An intermediate type of research in which both applied and fundamental studies are used is the exploratory type of programme being encouraged at IMIT. These programmes are launched either prior to the setting up of formal research projects or in connexion with collateral lines intimately connected with the technical contents of main projects in operation.

24. At least 25 per cent of the entire volume of research operations at IMIT falls into this category of exploratory research. In carrying out these projects, a few guiding principles are being observed:

(a) The allocation of funds is limited to a comparatively small amount of man-hours, mostly representing funds in the neighbourhood of 50-70 thousand pesos per exploratory project ($US4,000 to 5,600);

(b) There is the understanding that once these amounts are used no further research will be authorized until a number of internal and external conditions can be met, and, above all, that the right kind of sponsorship should first be available;

(c) The work to be conducted should constitute a good training ground for the learning of new techniques or for the evaluation of advocated approaches;

(d) If at all possible, these projects should constitute a means for contributing to previous knowledge in the field, by means of pertinent scientific publications;

(e) They should preferably be carried out by incorporating as many trainees as deemed convenient, so as to render, in this way, the best possible assistance to local universities to which a group of the trainees are still attached at the time of their participation;

(f) This type of exploratory project should be regarded from the very beginning as a possible source for future formal projects of a developmental nature or at least as the means to implement and reinforce research ventures expected to take plate at a later date.

Incentives at IMIT to encourage research and development programmes

25. In 1955, special measures were adopted at IMIT to encourage the use of research by industry and the Government. Since then, these initial measures have developed into more elaborate policies for expanding sponsored work with the co-operation of outside local sources.

26. Initially, a direct reduction of one-third of the cost of the work was absorbed by the Institute, as a kind of subsidy in the light of: (a) the very low level of demand observed in those days for research services and even for analytical and testing work; and (b) the comparatively high costs of operation which are bound to result from several internal conditions typical of small institutes, above all, the initially high overhead expenses adversely affecting over-all charges to sponsors.

27. It was later deemed pertinent to modify this policy to the extent of considering the participation of the Institute in the research costs as a share which should justify a compensation to be received by IMIT in the event of a successful venture.

28. In most instances, current contracts with sponsoring parties include clauses to the effect that the Institute is entitled to specific royalty payments based on volume of product sales for a period of ten years or more, as a compensation for its share in the research costs and very often, as well, for the previous work carried out by the Institute on closely related subjects or on the same matter, through its self-sponsored research programmes. 15/

29. In spite of some initial concern as to the applicability of this system in Mexico, it has proved entirely feasible and satisfactory for a number of reasons:

(a) It allows for a substantial cost reduction which tends to encourage a positive decision by the sponsoring party. This is altogether essential in view of the scarcity of resources that can be devoted to pre-investment programmes and of the high interests that industry must pay when borrowing money from financial sources. Coupled with this, there is the insufficient awareness on the part of most local industrial groups of the benefits of research and the fact that research investments are, in principle, regarded as operations involving, *per se*, a certain amount of risk;

(b) It provides the sponsor with a greater confidence as to the performance of the Institute in the implementation of the project, since the success or the failure of the venture will not only affect the sponsor but the Institute as well;

15/ These are supported by internal funds derived from permanent sponsorship provided by the three banks indicated in para. 12.

(c) It constitutes a strong [illegible] by the research personnel, who appreciate more fully the [illegible] consequences the Institute will have to bear in the event of [illegible] potential benefits to all if the project is carried [illegible].

30. In instances when the Institute has carried out a considerable amount of [illegible] in a given subject, to the extent of feeling well prepared to [illegible] sponsored project, the contract stipulations may include a comparatively higher royalty and a certain degree of splitting of industrial property rights between the sponsor and the Institute, always in terms of satisfying the requirements and needs of the sponsoring group, and providing the Institute, to the extent that is feasible, with adequate rights with respect to the application of findings in other areas or for purposes other than those set forth by the sponsor. 16/ In this way, it may be possible not only to satisfy the interests of the sponsoring party, but to utilize the know-how obtained in connexion with projects of national interest without entering into the possibility of conflicting situations. How far these contracts can go in the covering of the different purposes outlined is always a matter of negotiation, whereby, at any rate, the national interest will be set at a first priority level. The experiences gained from numerous research service agreements reached with local and foreign institutions have placed the Institute in the position of being able to determine the best ways and means to approach forthcoming commitments.

31. Above all, the conclusion has now been reached that joint sponsorship, whereby the Institute participates in the research ventures by absorbing up to 50 per cent of the costs under royalty or similar agreements, constitutes a solid mechanism for availing the Institute with additional sources of income on a rather permanent basis. This additional income can then be used in connexion with projects bearing the highest interest from the standpoint of the national economy.

32. Obviously, true accomplishments resulting from sponsored work with industry are in turn strong incentives for a greater co-operation and support by governmental institutions, be these in the form of Government-sponsored projects, or of grants, endowments or other means of financial assistance.

<u>Means of financing of research and development operations at IMIT</u>

33. The Institute has been most fortunate, since its first day of operation, in the manner in which it has been able to satisfy its annual budgetary needs. During its first years, the entire financial burden was carried by the three national credit institutions indicated in para. 12, who were also responsible for the initial planning and setting up of the organization. Even today these three institutions absorb a high percentage of the over-all budget, even though increasing amounts of income have been derived, especially in the last six years, from private sources. The reason for this is that the annual budget of the Institute has grown in a rather impressive manner, as a result of a continued expansion of activities in different directions.

34. Growing industry in developing countries is being based mainly on transfers of well-established processes from advanced nations. In many instances, these transfers assume the form of clearly defined schemes of operation and involve equipment and machinery which have been tried out successfully in other parts of

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16/ Royalties are usually set forth in the range of 1 to [illegible] per cent of sales volume.

the world. Adaptation requirements are mostly taken care of by parties supplying the specific know-how and often this assistance goes as far as providing expert advice and engineering services from abroad.

35. In the last ten years, the number of local engineering firms has multiplied many times and the use of these firms, rather than foreign consultants, is becoming more and more frequent. Because of the fact that many new industries are set up under the joint partnership of foreign and local investors, the trend will be found to be that the former groups are likely to specify the procedures to be observed at the time of launching the new industrial ventures. More often than not, these specifications will be in line with operational conditions abroad and product characteristics in general will follow foreign market trends. However, this situation is changing, primarily as a result of government restrictions concerning the imports of raw materials and of equipment and through many local policies which tend to encourage the use of native resources and available facilities.

36. Although industry has developed under a considerable number of special privileges, the time has come when industry is starting to revise many of its initial production policies, including the modification of processes to make possible the use of locally available resources. Alternate solutions are being developed to accomplish adequate substitutions and many new examples of projects connected with the development of typical products of specific interest to the Mexican markets are now being detected throughout industrial circles. A number of these projects will be found in the field of the development of food products, along the lines of the utilization of locally available raw materials for cellulose and paper and in the field of the beneficiation of minerals.

37. Even though these new trends can be clearly observed, a strong inclination towards local research and development programmes is not likely to take place in the very near future, most probably because of the financial limitations of local industries. Pressing needs in basic areas of investments, with particular reference to essential equipment and its maintenance, do not seem to allow for expenditures in research and development, regardless of how important the latter activities may be considered by potential sponsoring sources.

38. This may be a very strong reason for encouraging self-sponsored research programmes in those institutes which may be privileged to have sound backing from governmental or decentralized institutions. The most important consequence of this possibility is that projects may then be developed to a point whereby inherent risks can be brought to a minimum and, in this way, local sponsors could be in a better position to participate in advanced stages of such projects and to invest further in the final industrial ventures.

39. If, in addition to such self-sponsored research programmes as those carried out at IMIT, low-interest-rate funds could be placed at the disposal of governmental agencies and industry for use within research and development programmes, duly regulated through adequate trust organizations, one might expect a clear-cut change of attitudes with respect to research activities, in the direction of intensifying developmental work by institutional research organizations. Moreover, this monetary policy could be coupled with adequate tax exemption measures to implement further the technological activities in the industrial sector. 17/

17/ The Government is granting tax exemptions on imports of scientific equipment purchased by research and development organizations, under special regulations.

B. Industrial research establishments of Mexico

40. There are numerous organizations and specialized departments of governmental and private institutions where applied research of various types is being conducted.

41. In view of limitations in space and for the sake of keeping this text within a reasonable length, the three major research organizations which are rendering sponsored services to the Government and to industry are described in terms of their major characteristics in the table annexed to this paper. Much information on these institutions and on a number of many others in the country may be found in specialized monographs, e.g. Report of Scientific Institutions and Research Scientists in Mexico (Office of the Foreign Secretary, National Academy of Sciences - National Research Council) and Training Opportunities in Latin America (United States of America, Agency for International Development, Mexico).

42. In addition to the three major research and development institutes listed in this table, a list of a number of special bodies, attached to either governmental or private institutions, is also presented.

43. In conclusion, the author wishes to state that the views included in this report are his own. However, it is felt that they will often fall within the present thinking of people in positions of responsibility in other research and development institutions of Mexico.

44. As for the attitude of IMIT with regard to national and international programmes of research, the author feels prepared to reiterate that IMIT is currently encouraging a broad exchange with other similar institutes in Mexico and abroad, not only along the lines of scientific information, but of research and development personnel as well.

ANNEX I

MAIN FEATURES OF THE THREE MORE FULLY INTEGRATED RESEARCH AND DEVELOPMENT ORGANIZATIONS IN MEXICO

Institution name	Instituto Mexicano de Investigaciones Tecnológicas, A.C.	Laboratorios Nacionales de Fomento Industrial	Instituto de Investigaciones Industriales
Personnel with executive responsibilities	I. [illegible]. - Tech. Director[a]	R. Rojas - Director[b]	A. Guerra García - Director[c]
Institution address	Legaria 694. México 10, D.F.	Av. Industria Militar No. 261. México, D.F.	Monterrey, N.L.
Founded (date)	1950	1948	1951
Main working areas	Applied biochemistry, organic chemistry, Mineral and metallurgical chemistry, Cellulose, paper and fibre technologies, Techno-economic research Bibliographic and patent searches, Analytical and testing services, Research consulting and training.	Applied chemistry, Food technology, Cellulose and paper technology, Automotive technology Steel, concrete and construction technology, Standards, Techno-economic research, Industrial development.	Technologic and economic research, Agricultural products technology, Bibliographic and patent searches, Metal and other materials testing, Metallurgic and mineral technology, Waste and by-products utilization, Analytical and testing services, Research consulting and training.
Raw materials, products and industrial waste or by-products being investigated.	Highly diversified agricultural products, including cereals, legumes, and other crops of industrial interest, Tropical and temperate woods and sugar-cane bagasse, Foods and animal feeds, fermentation products, Metallic and non-metallic minerals, Fuels and construction materials	Food and fermentation products, Medical products, Hardwoods and softwoods, Automotive products, Steel and other metallic products, Concrete materials.	Agricultural products, Mineral and metallurgical products, Food and fermentation products, Printing, painting and dyeing products, Waste cellulose products, Plastics and synthetic products, Lubricant products.
Type of institution	Not for profit (civil association)	Not for profit (Decentralized organization)	Not for profit (under a civil association)
Sources of income	Major sources are: Banco de México, S.A., Nacional Financiera, S.A. and Banco Nal. de Comercio Exterior, S.A. - Sponsored projects from Industry Especial funds for training (Banco de México, S.A.) Royalties derived from licensed processes, locally and abroad.	Major sources are Government funds. Sponsored projects from industry, to a limited extent.	Sponsored by Enseñanza e Investigación Superior, a civil association Sponsored projects from Industry.
Annual budget	$US650,000-800,000, including yearly investment in equipment and library.	About $US[illegible],000.	Estimated about $US200,000.
Staff structure	Actually 170 persons. - 35 research leaders and associate personnel, 20 research assistants, 30 trainees - 85 employees in Administrative and General Services.	20 research leaders and associate personnel.	25 research leaders and associate personnel.
Technical assistance sources	Armour Research Foundation of Illinois Institute of Technology, under yearly contracts for specialized consultations. Frequent temporary contracts with a number of local and foreign research specialists and consultants.	Several local and foreign research organizations.	Instituto Tecnológico y de Estudios Superiores de Monterrey. Associated with the Southwest Research Institute.
	a/ Technical Direction and Administrative Supervision, under J.J. Castellanos, operate under Board of Directors appointed by three national credit institutions with C. [illegible], Board Delegate. A board of trustees constituted by General Directors of Credit Institutions has the final responsibility.	b/ Institute Directors Office operates under a Board of Directors constituted by representatives from several government ministries, the Chamber of Commerce, and other private institutions.	c/ Director is appointed by a Directory Committee.

ANNEX II

LIST OF INSTITUTIONS AND SPECIAL BODIES CONTRIBUTING TO
RESEARCH AND DEVELOPMENT PROGRAMMES IN MEXICO

Instituto de Química
Dr. A. Sandoval, Director
Universidad Nacional Autónoma de México
Ciudad Universitaria, D.F.

Instituto de Ingeniería
E. Rosenblueth, Director
Universidad Nacional Autónoma de México
Ciudad Universitaria, D.F.

Centro Electrónico de Cálculo
Ing. S.F. Beltrán, Director
Universidad Nacional Autónoma de México
Ciudad Universitaria, D.F.

Centro Nacional de Cálculo
Ing. M.A. Barberena, Director
Instituto Politécnico Nacional
Zacatenco, D.F.

Comisión de Fomento Minero
O. Urria Urgel, Director
Tecamachalco, D.F.

Instituto Nacional de Investigaciones Agrícolas
Dr. R. Peregrina, Director
Sría. de Agricultura y Ganadería
Londres 40, México, D.F.

Departamento de Química, Instituto Tecnológico de
Monterrey; J.A. Domínguez, Director
Monterrey, N.L. México.

Departamento de Ingeniería Experimental
J. Guerrero Torres, Director
Sría. de Recursos Hidráulicos
Sierra 23, Tecamachalco, D.F.

Facultad de Agronomía
A. Guerrero Gárate, Director
Universidad de Nuevo León
Monterrey, Nuevo León, México.

Escuela de Agricultura y Ganadería
R. Gutiérrez Leonel, Director
Instituto Tecnológico de Monterrey
Monterrey, N.L. México.

Departamento de Investigación Científica
L. Garibay Gutiérrez, Director
Universidad Autónoma de Guadalajara
Guadalajara, Jal. México.

Instituto Nacional de la Investigación Científica
R. Monges López, President
Enrico Martínez 24, México, D.F.

Instituto de Investigaciones Tecnológicas
W. López, Director
Universidad de Guanajuato
Guanajuato, Gto. México.

Comisión Nacional de Energía Atómica
A. López, Director
México, D.F.

Instituto de Estudios Avanzados
A. Rosenblueth, Director
Instituto Politécnico Nacional
Zacatenco, México.

Consejo de Recursos Naturales no Renovables
S. Cortés Obregón, Manager
Héroes y Dr. Barragán, México, D.F.

Instituto de Investigaciones Científicas
Dr. Menchaca, Director
Universidad de Nuevo León
Monterrey, N.L. México.

Instituto de Biología
R. Llamas Flores, Director
Universidad Nacional Autónoma de México
Ciudad Universitaria, D.F.

Instituto Nacional de Investigaciones Forestales
R. Villaseñor, Director
Secretaría de Agricultura y Ganadería
México, D.F.

Escuela Nacional de Ciencias Biológicas
G. Massieu, Director
Instituto Politécnico Nacional
Zacatenco, México.

Escuela Superior de Ingeniería Mecánica y Eléctrica
C. Aznar, Director
Instituto Politécnico Nacional
Zacatenco, México.

Instituto Mexicano de Recursos Naturales Renovables
E. Beltrán, Director
Insurgentes 429, México, D.F.

Escuela Nacional de Agricultura
G. Palacios de la Rosa, Director
Secretaría de Agricultura y Ganadería
Chapingo, Edo. de México.

Laboratorios Syntex, S.A.
J. Rosenkranz, Manager
Carretera Toluca, Km. 13.5
Edo. de México, México.

Instituto de Ciencias
Universidad Veracruzana
Lomas del Estadio
Jalapa, Veracruz, México.

Universidad Michoacana de San Nicolás de Hidalgo
R. de Buen, Research Coordinator
Morelia, Michoacán.

Laboratorios de Investigación de la
Facultad de Ciencias Químicas
G. Velasco Fernández, Director
Universidad Veracruzana
Jalapa, Veracruz, México.

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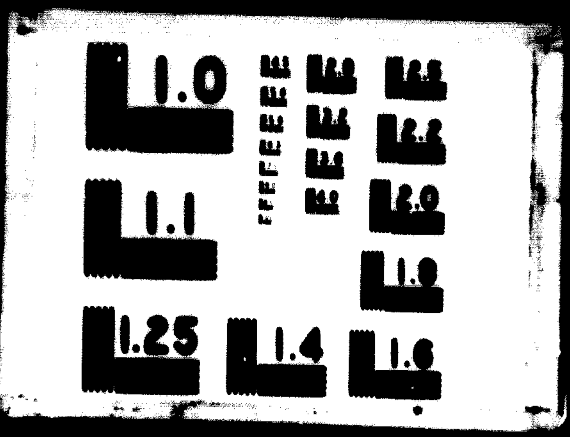

XXVIII. INDUSTRIAL RESEARCH SPECIALIZED INSTITUTIONS IN COLOMBIA

Prepared by H. Franco Bravo*

A. Over-all industrial policies

1. The economic development plan as drawn up by planning entities is intended to give special emphasis to the manufacturing sector. Owing to its intensity and to some of its qualitative characteristics, this objective requires the promotion, vigilance and assistance of an official agency. Within the institutional frame of the Colombian Government, none could be better qualified than the Institute of Industrial Development (IFI - Instituto de Fomento Industrial).

2. Some of the important characteristics of the above-mentioned industrial development programme are listed below in order to give a clearer picture of the kind of activities upon which the Institute should concentrate. These characteristics are the following:

(a) The planned annual rate of increase in industrial production for the decade 1961-1970 is that of 8.6 per cent per annum in comparison with the 5.3 per cent which prevailed during the period 1955-1960. This will give a rough idea of the greater effort now needed;

(b) The accelerated rhythm of industrialization will be particularly stressed in manufacturing sectors, e.g. lumber, food, paper and pulp industries, chemical products, basic metallurgy and the metal-processing industry. The flourishing of many of these industries will be achieved only through careful technical and economic planning of industrial units which are better prepared to meet the greater difficulties in financing, productivity and marketing that are inherent in these industries. These problems have not been traditional in most of the consumer goods industries which have constituted the basis of Colombia's initial development;

(c) The feasibility of such a noteworthy acceleration in the rhythm of our manufacturing development is not an exclusive function of the availability of an extensive repertory of individual projects. It does not seem possible to obtain the co-operation of the private sector in carrying out the substantial investments contemplated in the plan, unless there are also available satisfactory financial incentives, such as adequate industrial credit, tax exemptions, capitalization instruments and schemes for an accelerated depreciation;

d) The first stage of the plan which prevailed from 1961-1964 was prepared with the help of an inventory of industrial projects which permitted an approximate measurement of the number and size of initiatives being carried out in the different manufacturing sectors. An up-dating of the inventory shows that such sectors as petroleum by-products and coal, paper, pulp, food and metal-processing will remain with their respective investment quotas programmed for the period 1961 to 1964, unaccomplished in their greater part, if the present schedules continue to be maintained. These discrepancies indicate bottlenecks in Colombian industrial development, which should receive immediate attention if the goals of the ten-year plan are to be carried out in a balanced way;

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* Director, Institute of Industrial Development.

(e) The [illegible] This phenomenon is easily [illegible] detailed planning [illegible] difficult, and in some cases [illegible] industry, the participation of the [illegible] decisive in the preparation [illegible] mentioned sectors.

F. Industrial studies

Types of studies

3. In Colombia, experience has shown that there are two types of studies needed for the manufacturing industry. The first group includes those studies of a general nature, which deal with the analysis of development of that sector and whose primary end is to supply basic information and conclusions as to government policy regarding industrial matters. The second type refers to the more specific and detailed aspects of the ways and criteria of programmes for the orientation and/or acceleration of industrial development. Naturally, both fields have many elements which bind them together, so that it can be stated fairly that specific studies with the above-mentioned objectives would not lead to the best results without first following a global diagnosis of the sector.

Global studies

4. Development of production in the manufacturing industry. These studies imply mainly the analysis of quantum indices of production and employment. Their object is to contribute a diagnosis regarding the way in which a particular sector will develop and detect those industries showing dynamic deficiencies. On the basis of such a study, the problems which affect development can be properly identified. Such a study requires, at the same time, adequate background and the elaboration of statistics which will give the best possible judgement on the nature of these problems.

5. Changes in supply and demand of manufactured products. Studies relating to structure and changes of supply, are of special interest when they refer to the origin of goods; that is, whether they are national or imported goods and whether they are consumer goods, capital goods or intermediate. In this connexion, it is, for example, of the utmost importance to establish and exercise controls which will permit an accurate appraisal of whether industry is becoming more or less dependent on foreign raw materials and intermediate imported goods. At the same time, the studies of supply facilitate an approximate observation of those lines of production whose volume and other characteristics might justify their substitution by national manufacture. Furthermore, the exact knowledge of the supply of manufactured goods permits more effective appreciation of the results of control or limitation on imports, and justifiable changes in import policy.

6. Competitive status of industry. One of the great problems which the authorities have to meet constantly is the degree to which it is advisable to protect national industry against foreign competition. These studies imply knowledge of costs and prices, exact knowledge of tariff incidence on imports of manufactured products and evaluation of the greatest number of import substitution possibilities.

7. Financing. No doubt one of the other problems about which it is always convenient to inform the authorities in charge of directing industrial policies is that of financing the development of manufacturing. In this connexion, it is convenient to make a quantitative study of the importance and tendencies of the various financing sources and the destination given to resources provided by them. Among these sources are the internal resources of the enterprises themselves (undistributed profits and depreciation reserves) and external sources (banking loans, foreign loans, etc., and capital contributions from individuals, the Government or foreign sources).

8. Inventory of projects. A task of great importance is to keep an up-to-date inventory of important public, private and foreign projects. The main purposes of such an inventory are: (a) to evaluate immediate development possibilities; and (b) to appreciate which are the future development trends and where lie the more notorious deficiencies. Whenever possible, a task of this type must be done simultaneously with the accumulation of background data about every project, since this is the only way to evaluate its various possibilities quantitatively.

9. Projections. Among the general problems of primary and permanent interest are those related to outlining short-run or intermediate prospects for global industrial development and its main sectors. This should include fundamental aspects of production, employment, investment, supply of raw materials, intermediate goods and services, power and fuel, etc.

10. Other studies. There are other studies which must be conducted within a wider working scheme, i.e., productivity analysis of capital and manpower, institutional aspects, taxation, etc.

Specific studies

11. Specific studies must be made to complete the knowledge of industrial problems and their prospects in order to summarize recommendations. Such studies have as a permanent goal the formulation of a programme of industrial development. Among them are those related to certain industrial groups which, owing to their inadequate development or particular problems, their potential demand, or their possibilities of export or import substitution, deserve closer and more detailed studies.

12. Substitution of imports and promotion of exports. In Colombia, import substitution studies are considered of the utmost interest by the State, as shown by Law 29/1959. Studies of this kind are in themselves fundamental in any industrial development programme, since it is known that the greater industrial increment occurs in the import substitution sectors. But it is also true that owing to the need not only of saving, but of increasing foreign currency reserves, other studies, whose importance is as great, refer to industrial exports. Thus, studying the possibilities of increasing traditional exports of manufactured goods and of starting exports of new products is a field that cannot be underestimated.

13. Specific projects. The main justification for studies of this nature by the Government is that very often certain industries do not develop adequately, owing to lack of know-how in that particular field on the part of private entrepreneurs. Often there are financial resources available for industry, but the different alternatives are not always sufficiently studied so as to allow the proper selection, both from the State's standpoint, and from that of private entrepreneurs.

7. Industri[illegible]

14. In Colombia there are several [illegible] way or another, perform functions connected with [illegible] most important are the National Planning Department [illegible] Planeación y Servicios Técnicos), the Ministry of Development, [illegible] Industrial Development, the Bank of the Republic, the [illegible] superintendency of Foreign Trade (which replaced the [illegible] of Imports), the Institute of Technological Research (IIT - Instituto [illegible] Investigaciones Technológicas), the National Training Service [illegible] Agricultural Credit Bank (Casa de Credito Agrario).

15. Currently, however, these institutions carry [illegible] the National Planning and Technical Services Department has [illegible] of the industrial position of the country to explain and [illegible] government industrial policy indicating the obstacles which arise [illegible] sectors and the adequate means to solve the various problems that arise.

16. A brief explanation regarding the institutions which in one way or another carry out industrial research follows.

National Planning Department

17. Even though the basic function of economic planning of public works and services has been foreseen in the Constitution since 1945, in fact, activities in this field only began in 1948 after a study of the Colombian economy by the International Bank of Reconstruction and Development (IBRD).

18. The law of 1958 created the Planning Department. Under this legislation it was ordered that specialized technicians should prepare the necessary studies in the planning field. Furthermore, the Planning Department was charged with fostering the creation of these technical services in government departments where they did not exist.

19. The Planning Department, according to present legislation, is responsible for informing the Government on all matters related to the economy and on the means to accelerate its development.

20. The Department is an official entity directly under the Presidency of the Republic whose operational funds come from the National Treasury.

21. In order to properly respond to the organizational needs in connection with development programming, the Department has a group of economists and engineers at its disposal who are well aware of the studies which are currently being carried out by the specialized entities of the State. In this way they are able to maintain the needed harmony required by the industrial development plans and the [illegible] economic programmes of the country.

The Ministry of Development

22. This Ministry has the following branches: [illegible] administrative, the national superintendency [illegible] superintendency of public companies.

[illegible] industry. However, its functions [illegible] specific in the [illegible]: [illegible] other studies for price control when [illegible] with the National Superintendency of [illegible], which is a branch [illegible] the Ministry; it intervenes in the field of [illegible] regarding authorization to import goods which are under special licence regulations, including some raw materials. The actual permits are issued by the Foreign Trade Superintendency (Superintendencia de Comercio Exterior). This office also keeps some statistics registering the production and capacity of some important industries while at the same time endeavouring to keep statistics on the over-all industrial establishment. In addition, it carries out some special studies, such as those connected with industries that wish to work under the conditions of the national re-export scheme or "Vallejo Export Plan".

24. However, the necessary mechanism for the general study of industrial problems does not exist in the Ministry. None the less, this Ministry has an important instrument of action within the industrial sector: the Institute of Industrial Development, whose Board of Directors is presided over by the Minister of Development and whose statutes give it great elasticity for working to complement development plans of the manufacturing industry.

The Institute of Industrial Development

25. The Institute currently has an executive staff of ten people, including the general manager and assistant managers distributed into four departments: legal, administrative, economic research and engineering. IFI has carried out some specific industrial studies in the fields of food, metal, basic metals and chemicals. It must be noted that the organic statutes of IFI, as well as those laws and decrees pertaining to it, make clear dispositions as to the functions of IFI concerning industrial development. Currently, as a finance corporation, it has established an order of priorities for loans and investments in the industrial sectors that require funds for a better utilization of installed equipment. This order of priorities is focused mainly on those industries which have projects for exports, import substitution and national production increment. The institute is a legal entity, created by Law 1157/1940, whose funds and patrimony are drawn from its own treasury, from rediscounts made by the Bank of the Republic (Central Bank), from private savings and from the Government. Its administration is the responsibility of a board of directors, and a general manager and an assistant manager are in charge of operations.

Bank of the Republic

26. It was organized by the Kemmerer Mission in 1923. The Bank has within its functions and its administrative structure some specific aspects connected with industry. Its research department includes studies on national income and product estimates, and other economic concepts in the industrial sector. The Bank handles the Private Investment Fund (FIP - Fondo de Inversiones Privadas) which canalizes financial resources towards industry after gathering knowledge of the corresponding needs.

Superintendency of Foreign Trade

27. It was created in [illegible]. This Agency replaced the National Superintendency of Imports and absorbed the functions of the former Foreign Exchange Registry. It [illegible] important role connected with industry, but limited to the affairs

[illegible] import [illegible] requirements. The [illegible] committee. In this [illegible] the administrative [illegible] of Finance and the Ministry of [illegible], [illegible] industry and its new [illegible] superintendency [illegible] Superintendency is not the entity [illegible] programming, since its basic aims [illegible] use of national materials. Nevertheless, it [illegible] complete information available, on [illegible] on the global development policy of the Government. The [illegible] furnished by the central planning agency, the Planning Department. [illegible] this Superintendency has received advice from the IFI [illegible] of new industrial installations in the country.

Institute of Technological Research

28. The Institute of Technological Research is an autonomous entity [illegible] for the application in Colombia of the scientific principles developed both in the country and abroad, and for adapting techniques already developed abroad to domestic circumstances. Thus, the Institute provides for the research requirements [illegible] from the industrial, agricultural and government sectors. It is, to a certain extent, evident that IIT will always be an advisory agency on those technical and engineering problems of industrial economics to all agencies concerned with them. In accordance with this, Law 29/59 in its article 11 states literally: "The Government, through the Institute of Industrial Development and together with the co-operation of the Institute of Technological Investigations, shall carry through the studies necessary to determine which articles must be preferably produced in the country to substitute imports not only of finished products, but also of raw materials and intermediate articles".

29. To organize IIT, the Agricultural Credit Bank obtained advice from the Armour Research Foundation of the Illinois Institute of Technology. IIT was established in 1955. Currently, 50 per cent of its budget is made up of contributions from its sponsors, which are listed in their order of precedence: the Bank of the Republic, the National Federation of Coffee Growers, the National Petroleum Enterprise, the Agricultural Credit Bank and the Institute of Industrial Development. The remaining 50 per cent comes from the United Nations Special Fund for Technical Assistance [illegible] Programme for Intermediate and Small Industry, amounting to $US558,[illegible]; from the United States of America Agency for International Development contribution of $US139,000, and from agreements with national and foreign agencies and with private industrial concerns for the study of special products.

30. This Institute has very good laboratory facilities, acquired over several years, and modern equipment for instrumental analysis.

31. In 1958 it was reorganized as an autonomous agency with its own legal status. It continues to play an important role in connexion with the manufacturing industry. However, this role is limited to technical studies and reports, since these are the main objects of the Institute. These studies are made, [illegible] and are financed by the entities benefiting from such studies [illegible] contribute funds towards its operation, such as IIT.

[illegible] IIT carried out studies relating to the plastics [illegible] studies that were made by [illegible].

National Training Service

53. The National Training Service was created by Decree 118/1957 and is financed by employers' contributions. Employers are requested to devote 5 per cent of their monthly payroll to be distributed between family allowances (4 per cent) and SENA funds (1 per cent). The National Training Service is a decentralized agency with its own legal status and patrimony, whose purpose is to provide young and adult workers with a professional training in the fields of industry, commerce, agriculture, husbandry and mining. The objective is to give the worker a technical training and to shape socially useful and responsible citizens.

54. SENA has organized branches in most provinces of the country. This agency is in a position of primary importance among modern state innovations intended to solve the socio-economic conflicts which arise from management-labour relations. It also accomplishes a very important function in the educational field, for it enables the workers to contribute more rationally and technically their human efforts to the production of wealth. Thus they will tend to improve deficient national production and contribute to obtain better wages themselves, lower costs of production for their employers and a rise in living standards for the country as a whole.

Colombian Institute of Technical Specialization Abroad (ICETEX)

55. The Colombian Institute of Technical Specialization Abroad (ICETEX) is an agency whose purpose is to lend money to students and professionals who wish to follow a career or a specialization in certain scientific and artistic fields. There is no doubt that this service provides great benefits to the Government and private enterprises which profit from the know-how of numerous Colombians who attend educational centres abroad.

Other agencies

56. There are other agencies, public and semi-public, connected with certain industrial aspects. Among these are the Agricultural Credit Bank and the Cotton Development Institute (Instituto de Fomento Algodonero). The provincial governments also have some interests in the industrial field.

57. Finally, the universities, i.e., the National University and the University of los Andes, perform different types of economic, industrial and social research. There are, besides, many consulting firms specialized in the various fields of national industrial and economic life. These services, performed by firms and individuals, both domestic and foreign, are constantly available. Furthermore, every agency has easy access to the information which others gather through their own research.

XXIX. INDUSTRIAL RESEARCH AND DEVELOPMENT INSTITUTES IN THE UNITED REPUBLIC OF TANZANIA

Prepared by James E. Mkonya*

A. National industrial research policy

1. The development of the industrial sector of the economy has received much emphasis in the current Five-Year Plan recently launched in Tanganyika. Out of a total plan outlay of £246 million, about £60 million are earmarked for industry alone - the highest proportion among all sectors of the economy. At the end of the present Five-Year Plan industry is expected to contribute 10 per cent of Gross Domestic Product instead of the current 6 per cent. An ambitious Three-Year Plan is in the course of preparation in Zanzibar. The actual work of industrial development is, however, already in progress. The Plan will provide a very valuable guide to a prosperous future.

2. The country is aware that it cannot accept the anomaly which existed in the country as a result of colonial rule - exporting raw materials only to reimport them in manufactured form at highly enhanced prices, thus unnecessarily draining the country's reserves. It is not merely a question of import substitution, but of creating new techniques, more employment opportunities and doing away with the vagaries of a totally agricultural economy which is at the mercy of fluctuations in world demands and supplies. Although agriculture is still the mainstay and is bound to remain so for a considerable period, it is accepted that industry forms an important area of development. With this fact as a resolve which is being implemented, the country is witnessing the dawn of an industrial revolution.

3. In his policy speech to the Budget Session of the National Assembly on 30 June of this year, the Minister for Industries, Mineral Resources and Power, Mr. Hanga, said: "The fundamental task of our Ministry in the five-year plan is to transfer our United Republic with its backward technique to the lines of new modern technique ... the long-term task of my Ministry is to convert the United Republic from an agrarian and weak country, dependent upon the caprices of other countries, into an industrial and powerful country, fully self-reliant and independent... "

4. With the goal of expanding and establishing industries goes the need, and this is a very urgent need, to carry out industrial research of various kinds to encourage the process of industrialization.

5. Although the United Republic of Tanzania has a population of 10 million, it has access to the East African Common Market with a total population of 25 million. Tanzania has recently developed in the light industrial field. New factories producing shoes, razor-blades, food products, tobacco products, ready-made clothing, blankets, enamel hollow ware, galvanized sheets, plastic

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* Ministry of Industrial Mineral Resources and Power.

[illegible], sisal baler twine, cement bagging, extraction of vegetable oils, etc., have come into operation. Well-established industries include the manufacture of metal containers, paints and varnishes, insecticides, coir matting, furniture, rubber products, wire nails, beer, aerated water, leather goods, oxygen and acetylene, as well as several textile mills. The £5 million Hale Hydroelectric scheme has come into operation.

6. As of July 1964, the following new investments were under development in the United Republic of Tanzania: aluminium-rolling and fabrication, sugar-mill and refinery, oil refinery, tyre manufacturing plant, cement plant, plastics factories, large-scale shirt manufacture, production of rayon and cotton piece-goods, sisal ropes and twine manufacture, enamelled hollow ware, several new breweries, mechanized decortication of cashew nuts and galvanized corrugated iron sheeting.

7. Consideration is being given to: manufacture of pharmaceutical products, several new dairies, radio-electrical appliance and component assembly, fishing-net manufacture, glass factory, large-scale textile mill, motor vehicle assembly, manufacture of asbestos cement products and larger-scale production of soap and soap products.

8. Under the recent "Kampala Agreement" between countries in the East African Common Market, Tanganyika will have exclusive right to assemble and manufacture Land Rovers, and limited assembly and manufacture of a type of lorry and truck which Tanganyika will define. Tanganyika will also have exclusive rights in radio assembly and manufacture, and in the manufacture of motor vehicle tires and tubes. The object of this Agreement was to reduce the imbalance of trade among East African countries.

B. Current Research Activities

9. Most of the research activities can, at the current time, be grouped under applied industrial research. Fundamental research, which is really concerned with the expansion of the periphery of knowledge, has not made significant progress as the University College has only been recently opened. The future, however, looks bright. The obvious fact is that fundamental research does not pay in immediate dividends, and the incentive is therefore less. Various successful attempts in the field of applied industrial research relating to Tanzania have been made by the East African Industrial Research Organization (EAIRO), Nairobi, Kenya.

10. Applied research has been mainly in the fields of economic studies to determine the feasibility of industrial proposals. There are four such main bodies in the United Republic: the Market Research Ltd., the Economist Intelligence Unit Ltd., the Statistical Bureau of the Directorate of Development Planning, and the Ministry of Industries, Mineral Resources and Power. Development corporations also carry out studies in projects which interest them or require their participation. The Ministry of Industries, Mineral Resources and Power is in fact setting up an Industrial Studies and Development Centre, and has applied to the United Nations for funds and the following experts to undertake training of local personnel and make feasibility studies: projects director, industrial engineer, industrial economist and industrial chemist.

11. In 1961 the Government [illegible]
and make a survey of Industrial [illegible]
Development in Tanganyika". [illegible]

12. One of the new factories [illegible]
Tanita factory for cashew-nut [illegible]

13. A new government body [illegible]
in order to avoid making mistakes [illegible]
because of unawareness of government [illegible]
Committee. This Committee consists [illegible]
ministries and serves as a medium of information [illegible]
industrial opportunities. It also helps to [illegible]
far as the over-all industrial picture is [illegible]
East African matters.

14. The Government is encouraging research in [illegible] work complete exemption from taxes.

15. The Government does not give subsidies or grants to private organizations for research purposes. Public bodies, however, are partly or wholly financed by the Government and, as such, government funds can be diverted into research work.

16. Government bursaries for training in various aspects of research and other areas of knowledge both within East Africa or abroad are advertised every year. These bursaries are available to those completing school certificates or persons already in employment. There is a proviso that candidates for such bursaries have to sign a declaration that they would work in government service for a certain period depending on the duration of the course.

17. Many other scholarships are offered under special Commonwealth aid to African Programmes, and scholarship schemes of the Union of Soviet Socialist Republics, the United States of America, the Federal Republic of Germany, and many other countries. All these are canalized through the Government's Ministry of Education, but anyone is welcome to apply for them. These are general scholarships and are not only for research training. The United Nations Special Fund has provided assistance through seminars.

18. The Government's expertise and knowledge are available to the [illegible] industrial sector. Publications of surveys on industrial development, and the Government's welcoming attitude to the injection of investment into the country are definite measures to encourage manufacturers to apply the results of industrial research. Comprehensive investment guarantee legislation has been enacted, and the Government is prepared to negotiate with individual Governments with a view to entering into double taxation agreements.

19. There is no restriction imposed on the repatriation to the [illegible] of capital, profits and dividends. The Tanganyika Development [illegible] the Tanganyika Development Finance Company [illegible] actively as positive instruments of development.

20. A number of incentives are available [illegible]
the range of raw materials admitted [illegible]
has been increased. [illegible]

Tools are currently exempt from duty. The Customs Tariff provides protection for a wide number of industries. A system of initial investment and annual depreciation allowances has been established to facilitate the writing-off of expenditure incurred on industrial building and new plants installed in factories. Tax relief is also available for expenditure incurred in research. A programme is in operation whereby industrial sites are available in a number of areas to facilitate the establishment of new industries.

21. In the ultimate analysis, policies of all governmental and semi-governmental bodies rest with the Cabinet.

22. When the Industrial Development and Studies Centre is firmly established, there will be a greater flow of information to the public and private industrial sector than ever before, and this will give a fillip to the use of results of research in Tanzanian industries.

23. The large amount of money earmarked for the development of industry in the Five-Year Plan is bound to stimulate industrial research activities in the country. Iron-ore mining is allotted £5 million, and coal mining and the chemical complex, £5 million. According to the Minister's policy speech: "... the establishment of heavy industry is the over-all basic policy of the Ministry.... The idea behind this policy of industrialization is to achieve our economic independence that will enable the people of the United Republic to look forward to freedom from the daily struggle for necessities... to the full flowering of the human personality and the human spirit which our society will make possible".

24. There are a number of organizations which are not located in the United Republic of Tanzania, but which are partly financed by it since they are run by the East African Common Services Organization. Certain private firms also work on an East African basis. The following deserve to be mentioned: East African Institute of Social Research, Kampala, Uganda; Department of Economics, Makerere University College, Kampala, Uganda; East African Statistical Department, Nairobi, Kenya; Mechanical and Agricultural Engineering Department, University College of Nairobi, Kenya; Departments of Agricultural Engineering and Agricultural Economics, Makerere University College, Kampala, Uganda; East African Industrial Research Organization, Nairobi, Kenya; East African Extract Corporation Ltd., Nairobi, Kenya, Cooper McLougall and Robertson, Nairobi, Kenya; Fisons (E.A.) Ltd., Nairobi, Kenya; Twiga Chemical Industries Ltd., Nairobi, Kenya; and Shell Chemical Co. of East Africa, Nairobi, Kenya.

25. The East African Industrial Research Organization has been doing a considerable amount of work. It can also play a much larger role in the field of industrial research in East Africa. The following are excerpts from the Arthur D. Little report on industrial development in Tanganyika:

> The technical feasibility of recovering the enzyme bromelin from the pineapple plant has been demonstrated by the East African Industrial Research Organization.
>
> High-quality sand can be separated from the kaoline deposits at Pugu. Such sand is also of high purity and of excellent quality for glass making, according to tests made by the East African Industrial Research Organization.

The use of kenaf and doum fibre [illegible] textile manufacture presents a possible opportunity, [illegible] realization will depend on process and product development. [illegible] development work should be carried out by the [illegible] Research Organization.

26. Brief descriptions of some development institutes in the United Republic of Tanzania are contained in the annex to this paper.

ANNEX

DESCRIPTION OF DEVELOPMENT INSTITUTES IN UNITED REPUBLIC OF TANZANIA

A. National Housing Corporation - Self-help housing programme at Magomeni, Dar es Salaam

1. The National Housing Corporation was established in March 1962 to meet the need for low-cost housing for families in urban areas; "half of whom live in totally inadequate dwellings".

2. There is the twin problem of meeting the present deficit and the annual increase of urban population. The present deficit is about 9,000 houses. Growth of population ranges from 10 per cent to 50 per cent. It is anticipated that the gap will be filled over a period of ten years.

3. Houses being built are grouped into three categories: Standard A (£350 per house), Standard B (£700 per house) and Standard C (£1,400 per house).

4. The National Housing Corporation will have to build 27,795 houses during the current Five-Year Plan (1964-1969) at a cost of £14,392,000. According to the Five-Year Plan, central government contribution will amount to £5 million. Tentatively, £3.5 million has been earmarked for house construction purposes. "It will rest with the National Housing Corporation to find the balance by borrowing on its own account from official organizations or from private institutions and individuals".

5. Staff is comprised of an architect from Argentina and a technical expert. The architect came in 1963 under the auspices of the United Nations Low Cost Housing Programme in an advisory capacity.

6. The scope for research covers the following project: "a sample survey of the participants in the self-help Housing Scheme Programme at Magomeni, which involves examination of composition of household, income, housing types (past and present) and attitudes towards self-help schemes".

7. It is envisaged that future developments will include conducting three sample surveys in Dar es Salaam for comparative purposes.

8. As this is a semi-governmental project aimed at improving housing standards of the people, it can be definitely expected that the research will benefit the users all over the country.

9. On completion of building, houses are either sold (repayment is over a period of about ten years at the rate of roughly Shs.200/- per month) or rented by people at about Shs.[illegible]0/- per month, depending on the grade of the house.

10. Mr. Edward D. Hollander has the following to say in an article in Development Research Digest (1 July 1963):

Miserable inadequate housing [illegible]
countries, and the betterment of [illegible]
complex process of development... [illegible]
is itself an expression of social [illegible]...
achievement of better housing, in turn, [illegible]
organization and political attitudes which [illegible]
development.

B. Economist Intelligence Unit, Dar [illegible]

11. The company is located in Dar es Salaam. [illegible]
Group with its head office in London. The Economist newspaper [illegible]
company. The Economist Intelligence Unit was established in [illegible]
and its office in Dar es Salaam was opened in [illegible].

12. The staff of the company in Dar es Salaam is comprised of the [illegible]
his secretary. There are six correspondents in East Africa. When [illegible]
is undertaken, however, additional staff are available from the head office in
the United Kingdom. There is no problem of obtaining staff.

13. As this is a profit-making body, its finance is derived from fees obtained
from research on contract. It does not receive grants.

14. The company undertakes various types of research work as follows: economic
analysis, conducting market research, feasibility studies and international
research as related to economic problems.

15. The policy is formulated by the board of directors in London, two of whom
have executive responsibility.

16. It consists of the following sections: industrial and financial commodities,
statistics, international, marketing and publications. This, of course, is
in the United Kingdom.

17. The budget varies from time to time, depending on receipts from clients.

18. The company has no direct relationship with public bodies, individuals
and other firms except that its publications are available to them and the
company is ready to undertake research on their behalf. Information on various
aspects of research is available. The company can also prepare papers free of
charge for Governments for submission to the Department of Technical Assistance
in the United Kingdom from whom payment would be obtained for a research project.

19. So far, the company has undertaken a retail market survey in Tanganyika
and is currently engaged in preparing an Investment Handbook for the United
Republic of Tanzania. The Economist Intelligence Unit has the following
publications to its credit in East Africa:

(a) Quarterly Report on East Africa;
(b) Economy of East Africa;
(c) A study of Trends; Power in Uganda;
(d) Uganda - the background to Investment;
(e) Survey of Wholesale and Retail Trade in Tanganyika.

7. Government Chemist, Ministry of Health, Dar es Salaam

20. The Government Chemical Laboratories in Dar es Salaam were established in 1931 as a part of the Ministry of Health. The head of the establishment is the Government Chemist.

21. There are three distinct sections in the organization: forensic; food, water and industrial; and vitamin and specialized nutrition. Its scope of research is as follows: foods, toxicology and analytical methods.

22. Industrial research is not normally a part of its work, but it does carry out ad hoc investigations on various industries. A firm can ask for help in solving certain problems, e.g. large-scale air-conditioning plants with regard to corrosion problems. It does charge fees for such laboratory work if done for non-governmental bodies.

23. On occasion, the organization does engage in formulating standards. It is concerned with the technical aspects. There is a proviso here: the organization merely acts in an advisory capacity rather than doing the actual drawing up of such legislation.

24. As far as minor matters are concerned, the Government Chemist makes the policy. On major issues, however, the Permanent Secretary of the Ministry of Health is responsible for the policy. The executive responsibility rests with the Government Chemist.

25. Public and private bodies occasionally consult the Government Chemist on individual matters. There is no direct working relationship though Chambers of Commerce and industry and more frequently individual members ask the Government Chemist for views on particular topics. The University's faculty of science in Dar es Salaam has not yet been opened and as such there has been very little contact. In future, however, there is bound to be a considerable amount of consultation between them.

26. The establishment is a part of a Government Ministry and as such receives approximately £20,000 every year from government funds. Its earnings from fees amount to about £1,500 to £2,000 a year. The only grant received in the past four years was one from the United Nations Children's Fund, a supply of equipment for the nutrition section, which is in the course of being established.

27. It is virtually impossible to recruit graduate staff for the chemist level posts. At the moment there is no suitably qualified Tanganyikan; two are on course overseas. Minimum qualification is an honours degree in chemistry or full professional qualification.

28. It is difficult to get expatriates with the necessary experience because no career can be offered. It would be a luxury to employ fresh graduates on short-term contracts. What the country needs now are people who can pass on knowledge to local staff. The Government is trying to obtain officers from other Governments on secondment.

29. There is currently one expatriate Government Chemist, one expatriate chemist, three national assistant chemists, three expatriate assistant chemists, three national senior laboratory assistants, one national laboratory assistant and one expatriate laboratory assistant.

30. An expatriate chemist [illegible] chemist gets £7[illegible] and in the [illegible] are in the scale of £76[illegible] £444-684. Laboratory [illegible]

31. There is no problem in [illegible] general science degrees. An additional [illegible] qualify them for chemist posts, and [illegible] them overseas for such training. No honours [illegible] currently available in East Africa.

32. The establishment does have a consultation service, a technical [illegible] service, and a general information service. The results of its [illegible] various aspects of industry, e.g. fixing standards of products, [illegible] benefit the people in such forms as better products, standards of [illegible] prices commensurate to quality.

33. The organization publishes an annual report, and its staff occasionally contribute articles to other journals.

D. Chemical Laboratory, Department of Agriculture, Zanzibar

34. The chemical laboratory in Zanzibar is a part of the Department of Agriculture. It was established in 1932.

35. Its annual budget is £2,317, which is paid from government funds. The staff consists of one scientist and three others.

36. The organization conducts the following research: routine analysis of food-stuffs, dangerous drugs, alcohol tests, coconut, copra and clove stem oil, etc.; forensic work; and chemical analysis connected with agriculture, dairy milk and mineral deficiency. Analysis is also undertaken for such government departments as agriculture, health, policy, veterinary and customs.

37. The following facilities are available: one weighing room, one main laboratory, one preparatory room for soil sampling, etc., and a small library covering organic and inorganic chemical analysis, soil chemical analysis, water analysis, toxicological literature, etc.

38. Departmental annual reports are published.

E. Mines Division (Statistical Section) of the Ministry of Industries, Mineral Resources and Power

39. The statistical section of the Mines Division is situated in Dar es Salaam. It was established in 1929. In 1952 it was separated from the Ministry of Lands and Mines and became a separate section under the Mines Division.

40. The section is currently run by a mines statistical assistant. The policy and executive responsibility of the section lies with the Commissioner for Mines. No research on contract is undertaken.

[illegible] routine statistical compilation of data, [illegible] employed, output of minerals, cost of production, taxation [illegible] output.

[illegible] supplies the Treasury and other Ministries with monthly statistics, and is in contact with banks regarding account sales of minerals, and with [illegible] agents in connexion with queries sent to them for verification. General inquiries from the public both within the country and abroad are dealt with. General information is provided but not consultative service as such.

43. The current mines statistical assistant is not a national of this country. There appear to be problems as far as getting other local staff 's concerned.

44. The annual estimate for running the section is £2,000 from government funds, as this is a part of the government Ministry. No direct grants from other organizations are available.

45. Publications by the division are as follows: Annual Report of Mines Division; Annual Review of Mining Industry; and Monthly Summary of Mineral Exports.

F. Central Statistical Bureau, Directorate of Development Planning

46. The Central Statistical Bureau is a division of the Directorate of Development Planning which comes under the President's office. The Directorate of Development Planning is responsible for the over-all government policies and their implementation in all sectors of the economy. Statistical data are a necessary prerequisite and guide to the formulation and execution of governmental courses of action, especially in the economic sphere, and the Central Statistical Bureau has therefore a vital part to play in the development of the country.

47. The Bureau was established in 1950 in Dar es Salaam as the Tanganyika Unit of East African Statistical Department and remained so until 1961, when it became a Tanganyika Government Unit.

48. Its main role is to collect statistical data for economic and statistical analysis. The policy is laid down by the Directorate of Development Planning, which is under three Ministers of State and the Director of Planning. The executive responsibility for the Bureau is with the Government Statistician.

49. The Bureau can supply both public and private bodies with data, including data not published for the general public. The Development corporations' main source of information is the economic division of the Treasury. A government director from the Treasury sits through their meetings and writes papers for the various projects. Collaboration between the Bureau and the corporations is expected to increase to a large extent.

50. One of the regular features of the Statistical Bureau is to conduct every two years a census of industrial enterprises for basic information.

51. The Bureau has such facilities as electric and hand-operated calculating machines. For major analysis, the Hollerith Division of the Treasury is available.

52. There is a lack of skilled trained local personnel and thus the Bureau is dependent on expatriates. There is no prospect of an African statistician coming

back from overseas study within the next two years. [illegible]
and other subjects are available for study [illegible].

53. The establishment consists of [illegible]
five statistical officers, and the rest, [illegible]

54. All the funds for economic and statistical [illegible]
Government and the yearly estimate is [illegible]
£3,000 a year, but this, however, is [illegible]
attract expatriate officers their salaries are about [illegible]
local officers.

55. Publications of the Bureau are as follows:

(a) Ad hoc publications:

(i) Public Finance in Tanganyika 1960-1961;

(ii) Village Economic Surveys;

(iii) National Accounts of Tanganyika;

(iv) Industry census reports

(v) Employment and Earning in Tanganyika.

(b) Regular publications:

(i) Monthly Statistical Bulletin;

(ii) Annual Statistical Abstract;

(iii) Economic and Statistical Review (Quarterly).

G. Market Research (Tanganyika) Ltd., Dar es Salaam
Marco Surveys Limited, Nairobi

56. Market Research (Tanganyika) Ltd. is situated in Dar es Salaam. It is a part of the Marco Surveys Group with headquarters in Nairobi. This is a private commercial company, established in 1959.

57. The scope for research of the company is as follows:

(a) Basic economic, political and social research;

(b) Feasibility studies for industrial and commercial expansion;

(c) Research aimed at solving specific problems in the fields of distribution, marketing, advertising, public relations, brand and company images;

(d) Industrial psychology, personnel selection and aptitude testing;

(e) Public opinion polling.

58. The company has so far conducted thirteen public opinion polls on current affairs of East Africa, financed by the Marco Surveys Group.

59. The policy of the company is in the hands of the board of directors, among whom is the managing director of the Dar es Salaam Company. The executive responsibility of the Dar es Salaam Company is with the chairman of the Marco Surveys Group and the managing director.

60. The company does work on contract and this is the way it runs its business. Public opinion polls are, however, financed entirely by the Marco Surveys Group. It does not receive grants from other bodies. Feasibility studies and consumer surveys done for private firms are not published and information regarding its funds is not available at the time of writing. There is a consultation service and a general industrial information service available to the university and other individuals or bodies. Since the research for various firms, etc., is for the benefit of these organizations' efficiency and production, it does reach the users of the various products and services. As the work is mainly economic research there is no technical inquiry service available with respect to machinery. Public opinion polls have so far not been profitable to the company.

61. The Dar es Salaam Company consists of the following personnel: one African manager, two research executives, one of whom is a sociologist from the United Arab Republic, four research assistants (Tanzanians) and three clerical staff (Asians). There is no particular problem in getting staff. Salaries of local and expatriate executives are on the same scale.

62. The company has the following publications: Regular public opinion polls and reports on research projects. The reports on projects are restricted to the firms or bodies concerned.

H. East African Industrial Research Organization, Nairobi, Kenya

63. The East African Industrial Research Organization (EAIRO), located in Nairobi, Kenya, is a part of the East African Common Services Organization (EACSO).

64. It carries on applied technological research for industries in East Africa by means of laboratory investigations. Facilities include laboratories and a technical library.

65. EAIRO was established in 1942. It currently has eight scientists (two vacancies) and five technicians on its staff. The head of the organization is Dr. M.G. Edwards, a chemist. Other members of the staff include: five chemists, one agricultural engineer and one microbiologist.

66. The annual budget is about £60,000. These funds are available from the following sources:

(a) East African Common Services Organization, £27,000;

(b) Governments of the United Kingdom, £27,000;

(c) Nominal fees for research into specific commercial projects, £6,000.

67. The policy of EAIRO rests with the East African [illegible]. The Industrial Research Board which is a function of East [illegible] capacity to EAIRO. The executive responsibility lies with the director [illegible].

68. A wide variety of research is done, as may be seen in the following [illegible]: "vegetable dehydration under local conditions; improvements [illegible] pyrethrum drying; diatomite - producing a filter and low soluble [illegible] reconstitution of waste meerschaum for manufacture of smoking pipes [illegible] coffee processing".

69. In the Annual Report (1962-1963), the director reports:

> In the year under review shortage of senior staff (vacancies for [illegible] research officers have persisted through the greater part of the year out of a total of nine, including one trainee) has led to some restriction of research, particularly as regards the initiation of new projects and this has been counterbalanced to some extent by a greater emphasis on advisory and analytical services.

70. The shortage of senior staff reduced the gross expenditure for the financial years from an estimated £52,964 to £43,588. The actual expenditure was as follows:

(a) Chemical analysis £970 (£837);

(b) Fuel advisory services £91 (£669); research £2,735 (£2,20[illegible]).

71. The report adds: "... attempts were being made to recruit a Food Processing Technologist, a field in which there appears to be an urgent need for research."

72. The pace of Africanization has been slow and disappointing. No candidates have applied for the newly created posts of research officer trainees (two) and laboratory technician trainees (two). It was thought that the reason was that the demand from all sides for both university graduates and those with a higher school certificate greatly exceeded the supply.

73. EAIRO publishes the Annual Report of the East African Industrial Research Organization, which gives an account of the investigation carried out during the year. It has also published an illustrated brochure describing its work.

I. Geological Survey Division, Ministry of Industries Mineral Resources and Power

74. The Geological Survey Division is a branch of the Ministry of Industries, Mineral Resources and Power. It was founded in 1926, is located at Dodoma and is under the supervision of the Commissioner for Geological Survey.

75. The annual report published by the Division introduces it as follows: The functions of the Division are to survey geologically the country and to publish the results in a series of maps and reports, to carry out preliminary investigations of known mineral occurrences and to provide advice both to the Government and to prospectors and other individuals and concerns interested in developing the mineral resources of the country. The geological survey is a long-term systematic [illegible] which is essentially scientific research, but which provides a [illegible]

assessment of mineral potential and for various aspects of economic planning. Before a mineral rock is proved to be of economic value, a considerable amount of preliminary investigation usually has to be undertaken to estimate its amount, grade, costs of extraction and accessibility, and to assess these matters in relation to market demands. This applies equally to deposits of metallic or non-metallic ores and to industrial minerals and rocks. The Division endeavours to carry out the early stages of this work in its economic geology sections and laboratory services and, in collaboration with the Mines Division, assists current operators and encourages new enterprises.

76. In brief, its scope for research is as follows: regional mapping, assessment of mineral deposits, search for new mineral occurrences, laboratory work, chemical and spectographic analysis, petrological examinations, mineral dressing and X-ray determinations.

77. The policy of the Division is laid down by the Commissioner for Geological Survey, who is responsible to the Permanent Secretary of the Ministry of Industries, Mineral Resources and Power. The Commissioner has executive responsibilities, especially in so far as the technical aspects of the Division's work is concerned. The over-all policy of the Division and its implementation is, of course, ultimately in the hands of the Permanent Secretary of the Ministry.

78. There are four main sections: regional mapping, economic geology section, laboratory services, and finance and establishments.

79. The Division can provide information to the public and various concerns on any subject regarding the work of the Division. The publications of the Division are available to the general public, universities and other bodies.

80. Since the Division is a part of the Ministry, it is financed by the Government. Its annual budget is approximately £200,000. The Division does not receive direct grants, subsidies, or fees from any bodies except the Government.

81. The staff of the establishment consists of the following officers: one Commissioner, one principal geologist, one Chief mining geologist, one chief research officer, seventeen geologists, two chemists, six assistant chemists, one mineral dresser, one mineralogist, one chief cartographer and five geological cartographers.

82. All the above-mentioned officers are expatriates except for one chemist, two assistant chemists, one chief cartographer and two geological cartographers. There are not enough local people available to take up these posts, but a few students abroad are expected to fill in the posts on their return.

83. Local geologists and chemists start with £702 plus £60 pay addition, per annum. Expatriate officers receive £537 per annum as overseas addition or inducement allowance. Assistant geologists and assistant chemists receive £684 per annum initially plus £18 pay addition per annum. Geological cartographers are in three grades. Those in grades one, two and three receive basic initial salaries of £684, £792 and £960 per annum, respectively; pay additions are £18, £102 and £120, per annum, respectively; and overseas additions are £372, £537 and £567 per annum, respectively.

84. The annual [illegible]
Republic of [illegible]
Division for [illegible]
aid to supplement salaries [illegible]
the Federal Republic [illegible].

85. The Division has extensive [illegible]
flame photometers and an extensive [illegible].

86. The Division publishes [illegible]
and maps, which are available to the [illegible].

J. Department of Economics, University College, [illegible]

87. The Department of Economics is a part of the University College [illegible], which is in turn a component of the University of East Africa. [illegible] was that of June 1964.

88. Under the University Development Plan (1964-19[illegible]), development [illegible] £2,040,000 is planned to take place at the University College, [illegible]. The Faculty of Arts and Social Science was opened in July 1964, in addition to the existing Faculty of Law. A Science Faculty [illegible]. In the 1967-1968 session, it is estimated that there will be [illegible] at the college in Dar es Salaam.

89. According to the country's Five-Year Plan, £4,90[illegible],000 is earmarked for the University's Development. Of this, £2,040,000 will be spent on the University's expansion plan in the next three years. There is also a provision for [illegible] in the sphere of extramural studies for setting up centres in many of the major towns.

90. There is no particular grant for the Department of Economics. There is, however, a general grant of $50,000 from the Ford Foundation.

91. In the year 1964/65, £3,000 has been earmarked for general [illegible] and £[illegible] for social research. In 1965/66, £4,000 will be spent on general [illegible] and £9,000 on social research. In 1966/[illegible], [illegible]5,000 will be spent for general [illegible] and £9,000 for social research.

92. There are currently three expatriate members of staff and no local lecturers. The salary scale of a professor is £2,[illegible]00 per annum plus £500 overseas addition. An expatriate lecturer [illegible] £1,200 per annum, plus £35[illegible] overseas addition. National lecturers would be on the same scale, but without any overseas addition.

93. Many students from this country are reading economics at East African University Colleges and abroad, and it can be expected that some of them would qualify for posts in the Department of Economics. By 19[illegible], the Department expects to increase its staff to between six and seven lecturers.

Scope of research

94. The scope of the Department's research has been [illegible]

The department will be conducting economic research as part of its general functions.

At present priority of research will be given to subjects of importance in relation to teaching needs.

These will include research into:

(1) Economics as related to problems in East Africa with particular reference to Tanzania.

(2) Agricultural economics with particular reference to peasant farming.

(3) Follow-up studies of village settlement schemes from the economic point of view (as well as from sociological and other aspects) to determine the degree of success of the scheme.

(4) Research regarding the contribution made by various social organizations to the economic development of the country, with particular reference to co-operatives and trade unions.

(5) Examination of the household budget in urban and rural areas.

The department hopes that research fellows attached to the college will conduct this research.

L. Industrial Studies and Development Centre, Ministry of Industries, Mineral Resources and Power

95. The Ministry of Industries, Mineral Resources and Power has been charged with the industrialization of the country and has been encouraging the development of industries including carrying out various feasibility studies.

96. An application has been made to the United Nations Special Fund for the formation of an Industrial Studies and Development Centre as a unit of the Ministry of Industries, Mineral Resources and Power.

97. The Industries and Power Division is situated in Dar es Salaam and currently consists of the following personnel: one commissioner, one deputy commissioner, two senior industrial officers, one industrial officer and one senior industrial assistant. The application to the United Nations is for the following staff: projects director, industrial engineer, industrial chemist and industrial economist.

98. According to the current Five-Year Plan the Industrial Studies and Development Centre will have the following functions:

(a) To advise on industrial policy and organization;

(b) To assist in the investigation leading to better utilization and disposal of Tanganyika's raw materials and natural resources;

(c) To undertake the preparati... the formulation of industrial projects ...

(d) To provide extension service to existi[ng] ...

(e) To advice on the regional aspects of industrial projects, ... account the interaction of the economies of the East African countries.

99. The United Nations specialists will work for the country ... several years, during which time they will train local personnel, who will ... attached to them as trainees.

100. There is a shortage of staff but this is bound to be solved in the near future when Tanzanian graduates qualify from universities in East Africa and abroad, some of whom are expected to join the Ministry. A careers pamphlet is in process of being produced by the Ministry to attract them.

101. Being a part of a government ministry, the Industries and Power Division is financed by government funds. Salaries of experts from the United Nations will, however, be paid by the United Nations Special Fund.

102. As is common throughout the civil service, expatriate officers receive an overseas pay addition which is, at the industrial officer level, about £500 higher than that of national staff.

103. Liaison is maintained with the development corporations and other parastatal organizations. Economic and industrial data are available to the general public, including private firms. Four officers of the Division are members of the Industrial Promotion Committee. One senior industrial officer is a member of the East African Industrial Research Board. With the firm establishment of the Centre, the extension services for economic and technological information will be increased to a great extent. Officers of the Ministry are, from time to time, invited by the University College in Dar es Salaam to lecture to students on various aspects of the economy, The general public and firms can consult the Ministry on problems concerning their various enterprises. Liaison is also maintained with the Ministry of Commerce and Co-operatives and with the Directorate of Development Planning.

104. There are currently no laboratory facilities for the proposed centre. However, when the United Nations industrial engineer arrives, he will carry out the following tasks: formulation of technical specifications for plant and machinery, selection of plant and machinery supplies, industrial extension service to established industries on problems of equipment and planning operations and training requirements in industrial engineering.

105. The industrial chemist will have the following functions: feasibility studies, specifications for feasibility studies, liaison with Ministry of Commerce and Co-operatives on market development problems and extension services to established industries on technological problems.

106. The centre will be able to initiate discussions regarding the setting up of standards for products and raw materials. In this case, the Directors of the enterprises concerned and representatives of government ministries, including the

Government Chemist, will be invited to attend. In fact, discussions have already been taking place regarding the establishment of standards for soap manufacture.

107. The policy of the Industries and Power Division is formulated by the Commissioner for Industries and Power. These two officers are also responsible for the over-all supervision of the implementation of the Five-Year Development Plan and industrial development policy. Both, of course, work for the Permanent Secretary of the Ministry of Industries, Mineral Resources and Power.

108. The Industries and Power Division, which incorporates the industrial studies and development centre, is financed entirely by the Government. With the arrival of United Nations experts, however, some funds will be paid by the United Nations Special Fund. The industrial economist is expected to arrive next month. The centre will not carry out research by contract. It could, under certain circumstances, commission an outside agency to carry out a feasibility study or survey on its behalf.

109. The Industries and Power Division sends members of its staff abroad for courses on industries whenever an opportunity arises. There is currently one assistant industrial officer taking a post-graduate course in economics at Cambridge University.

110. The Division also sends its staff to various seminars overseas as a part of their training. At the same time, training on the job is a continuous process. Senior officers are requested to pass on their knowledge to junior officers whenever possible.

111. The Division publishes pamphlets on investment opportunities for potential investors. It also contributes to the annual report of the Ministry. The Economist Intelligence Unit is currently writing an investment handbook on behalf of the Ministry.

XXX. INDUSTRIAL RESEARCH AND DEVELOPMENT [illegible]

Prepared by [illegible] Al-[illegible]*

Introduction

1. At a time when non-industrialized countries suffer from poverty and its consequent deprivation, others with developed industries enjoy a relative abundance of products. This has led the backward countries to concentrate their attention on taking rapid steps towards industrialization. History bears testimony that the industrial economy provides a better life than that offered by an economy based on animal husbandry or agriculture.

2. The proportion of disparity between the two (industrial and agricultural) economies is not constant, but increases widely. This is because the industrial possibilities are almost infinite in nature and only through the ability of man for invention and exploitation can they be rendered finite. On the other hand, such natural possibilities are limited where agriculture is predominant.

3. Industrialization is the key to better standards of living. By industrialization, it is no doubt meant the wide sense of the term, namely, the organization of the production of goods and economic services by utilizing mechanical power, technical means and administrative efficiency; that is, those means which in their totality offer a better life, an index of which is the increase of private income and consequently the availability of more goods for the individual. Ultimately, they are the means that achieve the desired aim of decreasing a man's toil and increasing his span of life, two visible phenomena in industrialized countries.

4. The decrease of man's toil is represented by the decrease in the efforts he exerts to reach or maintain a certain standard of life. This is evident in the decreased number of daily working hours and the increase of the amount of [illegible] in industrial countries, where opportunities for choice have grown on account of the variety of production.

5. With regard to the increase of a person's age, this will become clear when it is realized that the average life span of the individual in the most advanced developing countries is forty years, whereas it is seventy years in developed countries.

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* Head, Financial and Economic Affairs Section, Industrial Development Organization.

A. The Government and the policy of industrial Development in developing countries

6. Industrialization is not a simple matter. It cannot be achieved by mere hopes or through easy endeavours. It requires, especially today, great efforts, so that it is difficult for private establishments and private sector companies in developing countries to carry it out alone and without aid. It is well-known that industries in advanced industrial countries have emerged and developed by small degrees and have taken years and years to reach their current stage. Humanity has made great sacrifices in order that these industries might flourish; but it is not willing, in the second half of the twentieth century, to make the same sacrifices which it gladly offered during the eighteenth and nineteenth centuries. This is owing to several factors, of which the most important are the close contiguity of the nations, their rapid evolution, and their consciousness of the happenings in the various parts of the world society. Another factor is the easy transmission of human knowledge from one country to another, so that it has now become possible for any part of the world to benefit from the experiences and the accumulated knowledge of the others.

7. The advantage possessed by the developing countries is that they can abridge the time necessary for development from centuries to decades. This has been proved by the experiments made in Japan and the Union of Soviet Socialist Republics. Both have been able to achieve in two decades what has been covered in two hundred years in the industrial countries of the West.

8. However, the new situation created by this change in the circumstances favourable to industrialization imposes yet a further change. There is no doubt spanning long periods of time within a short space of time demands a change of the institutions carrying out or supervising the process of industrialization, for the new change in circumstances requires large means which cannot ordinarily be provided by private enterprises. Historical evidences testify to the preceding two cases; for had not the Japanese Government interfered and fostered western industries, the Japanese would not have reached their current state of advancement. Similarly, the advent of the Bolshevist Revolution, with the concentration of power in the hands of the Government and the latter's supervision of the economic sectors transformed the USSR into one of the great Powers within less than thirty years.

9. This does not mean that a Government, in order to industrialize a country, must itself carry out the process of industrialization. What is required from the Government is to supervise and promote industrialization by all direct and indirect means. The experiment of Japan, whose economic system is based on capitalism, and that of the USSR, which is heading the countries of the socialist system, are but proofs that industrialization, when started by the Government, is a matter arising out of the conditions of the countries that lagged behind in the march of civilization, irrespective of the systems prevailing therein.

10. For Governments, particularly in developing countries, have comparatively greater potentialities than private sector enterprises, whose revenues, and consequently the possibilities for savings and investments, are smaller.

11. The change of political circumstances and therefore of foreign investments have sharpened this tendency. Foreign investments have increased in the form of

public sector investments ... In this field have taken ...

12. Under such conditions, the ... no choice but to shoulder the responsibility ... fact is conceded, the question which arises is what ... down a firm industrial foundation? ... and evolve industries at a later stage? ... in which success in any field is possible only ... scientific principles and is subject to research and ...

13. Moreover, the share due to a country from the progress ... amount of its contribution to that progress will depend ... with regard to scientific research in general, and ... industrial ... research in particular.

B. Industrial research and industrial development organizations in Libya

14. Aware of the importance of industry in the progressive evolution of the country and in raising its economic and social standards, Libya has made great efforts to overcome the obstacles impeding its development and prosperity, whether they are economic and social, or scientific and technical. These efforts have not been confined to one activity regardless of another, nor has the Government endeavoured to solve one problem and leave the other. ... efforts, however, have been devoted to the industrial, as well as other, fields of activity in order to solve the various problems involved therein.

15. In conformity with this principle of balanced development, the Government has taken care of both the basic and the applied aspects of scientific research. In the basic research field, it has established institutes and colleges and sent academic missions abroad. It has also appropriated the sum of ... million for higher education in the Five-Year Plan, 1963-1968.

16. As for the care it is according to applied research, this is shown in the sum appropriated in the said Development Plan for industrial research in general, including industrial training, collective trade centres, training centres, production units, and industrial development factories and organizations. This will be elaborated in the remaining part of this report, which will be divided into two parts: (a) industrial research policy; and (b) research and industrial development institutions.

C. Industrial research policy

17. The aim of the development and improvement of industry is, as stated in the Five-Year Development Plan, 1963-1968, to receive as much as possible of the contributions of the industrial sector in order to achieve economic and social progress in the country, by:

(a) Increasing and improving industrial production;

(b) Diversifying and maintaining sources of industrial pro...

c) Increasing the potentialities for the disposal of industrial products inside and outside the country.

18. In order to attain these objectives through sound scientific methods, the role of the co-ordination and systematization of industrial research was brought to the fore as the first corner-stone of the industrial policy. This, as stated in the draft of the above Plan, is summarized as follows:

(a) To conduct and promote scientific and industrial research with a view to finding out suitable local materials and devising technical methods for use in industry; to tap all technological means for industrial purposes; to study the social factors concerning the reaction of the environment towards the industrial movement; and to find proper solutions for the resultant problems. Preliminary studies on marketing and marketing predictions will be made to ensure that industrial production will meet the demands of the consumer. Economic studies will also be made regarding production efficiency. Businessmen will easily obtain the results of the studies made on minor industries. In addition, government technical departments could assist factories, especially those related to minor industries, in solving certain problems;

(b) To gather and analyse statistical data related to the formation of capital, production, distribution and consumption of industrial products;

(c) To develop, through training, the technical skills and experiences required by industry;

(d) To effect a balance in industrial activities between town and countryside. It is also necessary to set up collective trade centres in all parts of the country;

(e) To exploit all natural resources, such as metals, subject to conditions that will perfectly guarantee the interests of the country in the long run and that will ensure that these resources shall not be consumed in vain, but shall be so exploited that they will employ human and material resources available in the country;

(f) To provide short-, medium-, and long-term loans at low interest, by way of assistance to the private sector. This is conditional upon the participation of businessmen with a sufficient share of the capital. Furthermore, if the Government should consider that a certain industry is of vital importance to Libya and that the private sector has hesitated to set up this industry for one reason or another, the Government will then establish it with its own means or in association with private capital.

D. Research and industrial development institutions

19. These institutions are divided into two categories: (a) private sector institutions, and (b) public sector institutions.

20. The research and industrial development institutions of the private sector include the laboratories of the petroleum companies and the metal prospecting companies found in various parts of Libya. These are all foreign companies. They have laboratories which conduct micro-analyses and apply the concrete results obtained. Instances of the application of the extensive studies and fine analyses in the technical and economic fields are the drilling and refining of petroleum;

the prospective establishment of [illegible] fertilizers and plastics; the exploitation [illegible] through pipes to the chief towns to provide [illegible] to generate electric power for [illegible] and farms, on the other.

21. Outside the field of petroleum activities, [illegible] private sector is very limited. Furthermore, [illegible] about it so that a well-defined picture could be [illegible]. Nevertheless, [illegible] could be made to some small laboratories, like those of [illegible], fertilizers alcoholic drinks, and chemicals, which carry out technical [illegible] economic studies. Examples of these are the laboratories of the [illegible] Bentonite Company, the General Gas Company for the Manufacture and Packing of Oxygen, the Libyan Farmer Company for Canning Fruits and Tomatoes, and the Collective Trade Centre, Garardi.

22. In addition, there is a fair number of consultative and public service companies which carry out technical research for both the private and the public sectors.

23. The lack of industrial research potentialities in the private sector is owing to the small size of the industrial concerns in this sector, a thing which does not permit them to allocate sufficient amounts of money for industrial research.

24. As regards the public sector institutions, these are divided as follows:

(a) Industrial sector institutions, which are the following:

(i) Industrial Development Organization;

(ii) Industrial Research Department and its affiliated laboratories, Ministry of Industry;

(iii) Industrial Organization Department and its affiliated units and laboratories, Ministry of Industry.

(b) Institutions in the process of formation in the industrial sector, including:

(i) Research and Aquatic Organisms Section, Fishery Department, Ministry of Industry;

(ii) Economic Affairs and Research Administration, Ministry of Petroleum.

(c) Institutions in sectors other than the industrial sector, but which conduct research and analyses related to industry; some of these are:

(i) Laboratory of Chemical, Industrial, and Agricultural Analyses, Ministry of Agriculture;

(ii) Laboratory of the Vegetable Oils Office;

(iii) Laboratory of Food Analysis, Ministry of Health;

(iv) Laboratories attached to the colleges and intermediate and higher educational institutes.

25. In view of the shortage of time, this report will only present a summary of the activities of the first section only.

The Industrial Development Organization

Its functions

26. The Industrial Development Organization, which is a public organization, was established in accordance with Law No. 2/1965 for the purpose of developing Libyan industries in the private and public sectors by creating or co-operating in the creation of new industries; by offering technical and financial assistance to industrial organizations; by co-operating in the marketing of industrial products; and by encouraging and facilitating the investment of private capital in Libyan industries. All these are to be effected within the framework of the general policy of the country in the sphere of industrial development and the approved Development Plan.

27. The Organization is adopting several methods to achieve the aims for which it was founded. Among these are the short-, medium-, and long-term loans which it offers to industrial establishments at an interest of not more than 4 per cent for small industries, and at an interest equal to the rediscount rate plus 1.5 per cent for large industries. It also participates with other companies in forming joint-stock companies by contributing not more than 25 per cent of the capital. Moreover, it sets up industries which it deems to have possibilities of success and which the public sector had avoided for one reason or another.

28. These are effected along lines of research and fine scientific analyses from both technical and economic points of view. Thus the Organization is, on one hand, a centre of research and studies and, on the other, an executive and supervisory body.

Its administrative machinery and sections

29. The law invested the Minister of Industry with powers to supervise the Organization. It also delegated its administration to a board to be formed in accordance with article 7 of the law, as follows:

(a) A chairman, who shall be highly qualified and experienced in economic, financial or industrial affairs;

(b) One representative each from the Ministry of National Economy, the Ministry of Finance, the Ministry of Development and the Bank of Libya; 1/

1/ These board members must be highly qualified in financial, economic, industrial or banking affairs.

(c) Director of the Industri[illegible]

(d) Director of Research, [illegible]

(e) One representative of the owners of [illegible] owners of small factories: 2/

(f) Two representatives of industrial workers. 2/

30. Chairman and members are nominated, and their emoluments determined, by a decision of the Council of Ministers, in accordance with the proposal of the Minister of Industry. The term of membership is two years, subject to renewal. The general policy laid down by the Board of Directors of the Organization is carried out by the general manager, who is appointed by a decision of the Council of Ministers after his candidature has been submitted by the Minister of Industry. His term of appointment is three years and is renewable. He must be highly qualified and experienced in economic, financial, or industrial affairs.

31. The Organization is divided into the following sections:

1. Financial and Economic Section.
2. Factories Section.
3. Accounts Section.
4. Legal Department.
5. Administrative and Public Relations Section.

32. The first and second sections carry out, in particular, economic research and technical studies concerning the industrial projects of the Organization or those in which it participates or assists, and, in general, research related to other industrial projects.

<u>Works accomplished by the Organization</u>

33. <u>The sugar project</u>. The sugar project was the first project to be entrusted to the Organization for implementation. The final contract regarding the installation of the factory was made with the Polish Consultative Study Board (POLSERVICE). The latter will offer advice, and will study and supervise the construction of the factory. It started the first stage of the project in accordance with the agreed time-table. This stage is nearing completion and it comprises:

(a) Selection and specifications of the site, and the drawing up of a contract for construction and installation;

1/ These board members must be highly qualified in financial, economic, industrial or banking affairs.

2/ These must be Libyans enjoying civil and political rights.

(b) Reporting on the general possibilities of the success of the project, and determining the area in which beetroots could be cultivated;

(c) Calculating the costs of the entire project and also the production costs and comparing them with costs in other countries. Also comparing the costs of the cultivation of beetroots with the costs of cultivating other products;

(d) Recommendations regarding the establishment of a nucleus for industrial administration and agricultural guidance.

The estimated time for the completion of the whole project is three years.

34. This project is not included in the Five-Year Plan, and is financed by the Ministry of Finance. The Council of Ministers approved it and submitted it to the Organization for execution. The project will thus not be financed by the monies voted for the Organization in the Extraordinary Budget, or in the budget of the Five-Year Development Plan.

35. A research unit was built this year through the joint efforts of the Organization, the Ministry of Agriculture, and the Polish Consultative Board. This unit will conduct research on the cultivation of beetroots in order to co-ordinate the efforts of the three participants.

36. The research unit is, in fact, a committee of specialists and experts in all theoretical, practical, and technical matters regarding the cultivation of beetroots, who are working together to study the possibility of producing the best types of beetroots that could be grown in Libya, in terms of quantity, quality and adaptability to the environment. It is a scientific nucleus which could be of benefit to the Ministry of Agriculture in directing and favourably modifying the cultivation of beetroots. The Ministry could also exploit it to extend to animal husbandry as well as agricultural production.

37. The unit will also diffuse agricultural knowledge among the farmers and will instruct them about the best methods of cultivating beetroots. It will also seek to publicize the cultivation of this type of crop in scientific and international circles interested in it. Furthermore, it will endeavour to keep abreast of the most up-to-date research and will study them with a view to their application in improving and increasing the production of beetroots in Libya.

38. Loans. The Organization extends loans to industrialists. The loans it offered during the first nine months of 1964 amounted to about £L300,000. The law of the Organization provides that 40 per cent of the capital of the Organization shall be destined for loans. The number of establishments that benefited from these loans amounted to twenty-three, ranging from small to large ones, and representing various industries, including the dairy industry, textiles, soap, batteries, tomatoes, carpentry, marble and flagstones. In addition to the loans, the Organization offers to these and to other establishments the results of its studies and research, and guides them to the best methods of production and marketing.

39. Projects under consideration and to be commenced during 1965/1966. The Organization has studied many projects. Some of these were completely studied and will shortly be put into execution. Others are still being studied.

Following are the projects which [illegible] next financial year: prefabricated [illegible], [illegible] cement (Benghazi), sardine canning factory, [illegible]. beverage factory (Fazzan).

Financial sources of the Organization

40. The Organization is an independent moral entity. [illegible] annual budget prepared in accordance with the rules governing [illegible]. Its accounts are examined and audited by the Auditor General and two other auditors from different places.

41. Its revenues, as per article [illegible] of the aforementioned law, [illegible] the following:

(a) The sums appropriated by the Government for the Organization;

(b) Government subsidies;

(c) Interests and dividends on the investments of the Organization;

(d) Loans contracted by the Organization for its account.

42. The sum of £L750,000 was appropriated for the Organization in the Extraordinary Budget, in the first year of its inception. In the same year, the sum of £L300,000 was appropriated for it in the Development Budget; the total appropriation for the Organization in the Development Plan 1963-[illegible] is £L5 million.

Its relations with government departments and other local and foreign organizations

43. The Organization seeks assistance from some foreign consultative companies in conducting studies and research, as was the case with regard to the project of the sugar factory, which was entrusted to an international consultative body; and the project of prefabricated houses, which was entrusted to a Danish company. This assistance is sought in view of the fact that the Organization has not, until now, obtained sufficient numbers of experts and technicians to permit it to study such projects by itself.

44. It also relies for its studies and research on experts in the government departments of the various ministries and on professors from the Libyan University, as was mentioned above.

45. It exchanges information and results of research with the competent governmental and semi-governmental departments. On the other hand, it receives the results of research projects undertaken by the specialized agencies of the United Nations, and by friendly nations. Furthermore, it provides the private sector with the results of its own research project and strives to guide them in the fields of production and distribution.

Technical aid:

[illegible]. The Organization has not yet received any foreign technical aid, whether through international organizations or through technical bilateral agreements made between Libya and other countries, such as the United States of America.

Industrial Research Department, Ministry of Industry

47. On 14 February 1964, a Royal Decree was issued for the establishment of the following departments in the Ministry of Industry: Industrial Research Department, Industrial Organization Department, Industrial Training and Services Department, Public Relations Administration, and Fisheries' Department.

Functions of Industrial Research Department

48. The current regulations of the Ministry of Industry provide that the functions of the Industrial Research Department shall be as follows:

49. Under the supervision of the director, it shall carry out various research projects and studies with respect to the local raw materials and technical methods with a view to their exploitation on an industrial basis; it shall study industrial problems and their solutions in order to improve productive industrial efficiency; it shall study and solve social problems arising out of the response of society to industrialization; it shall conduct market studies and prepare future market reports to ensure that industrial products meet the demands of the consumer; it shall define the position of the local products with respect to foreign competition in the local and foreign markets; it shall gather and analyse industrial statistical data with respect to production, consumption, invested capital, and other necessary data; it shall follow international industrial developments and adopt those which could be adapted to local conditions, all to be effected for the purpose of improving local industries and creating new ones which would consolidate the national economy.

Sections of the Industrial Research Department

50. The Department is divided into the following sections: production, marketing, statistics and conferences, mining and geological, industrial laboratories. Each of these sections has its own functions.

Works accomplished by the Department

51. Some of the works accomplished by the Department during its hitherto brief history are discussed below:

52. The Industrial Research Department was able, in its attempt to meet its requirements for specialists, to gather a group of specialized Libyan University graduates and to train them in fields of activities consonant with the functions of the Department;

53. It drew up a plan for the foundation of a research centre. The latter has comprised, so far, laboratories for the following fields:

(a) General analytical chemistry;

(b) Physical chemistry;

(c) Organic chemistry;

(d) Refractories and building materials chemistry;

(e) Industrial chemistry;

(f) Textiles and dyes;

(g) Food industry.

A sum of £L450,000 was appropriated in the Five-Year Plan 1963-1968 for the installation and equipment of the centre.

54. <u>Mineral research</u>. This section was established simultaneously with the Ministry of Industry, when the functions of the latter were devolved upon it from the Ministry of Economy. It has accomplished the following works:

(a) It contracted with some companies to exploit potassium salts, which are abundantly available in Marada, Libya;

(b) It is currently studying the possibility of exploiting bentonite which is used in drilling petroleum;

(c) It has studied thoroughly the question of the manufacture of glass out of sand;

(d) It began the study of the raw materials for cement production and drew up a plan to study the various calcareous raw materials along the Libyan coast, for possible exploitation in a suitable industry;

(e) Upon studying the geological map of Libya, it transpired that there were possibilities of discovering many mineral resources in the region around the Fazzan Mountain and Zella. Studies will begin with a geological aerial survey followed by a prospecting operation.

55. It is noteworthy that the Department pays particular attention to the study of natural gas in Libya.

56. An appropriation of £L100,000 was voted in the Development Plan to consolidate activities in the field of mineral research.

57. The Industrial Research Department participates, in the name of the Ministry of Industry, in the following:

(a) The Advisory Council for Importation and Exportation. This organizes the processes of importation and exportation and seeks to protect local industries.

(b) Committee of Foreign Capital. This Committee considers requests for investing foreign capital in industrial and other enterprises, and studies the relationship between foreign investment and development.

(c) Committee of Inflation and High Cost of Living;

(d) Higher Committee of Statistics and Census.

Relationship between the Industrial Research Department and other departments and organizations

58. The Industrial Research Department exchanges information and results of research with the research departments of the Bank of Libya, Ministry of Agriculture, Ministry of Economy, Ministry of Planning and Development, Ministry of Petroleum, Industrial Development Organization, and other government administrations.

59. It receives conclusions arrived at through studies and symposiums held by the United Nations and its specialized agencies, the African Union Organization, the Arab League and some friendly nations.

60. It provides some establishments in the private sector with the results of its research and guides them to the best methods that could be adopted in the fields of marketing, technology and chemical tests. It also prepares the necessary research before the implementation of any industrial project in the public sector.

Financial resources

61. The schedule of the summary of the appropriations of the Ministry of Industry in the Five-Year Plan 1963-1968 shows the amounts which were voted for the Industrial Research Department for the purpose of founding the Industrial Research Centre and consolidating the current activities regarding mineral resources.

62. The Ministry of Industry appropriates a special sum every year in its Ordinary Budget to cover the operating costs of the Research Centre's laboratories.

63. Monies were also sanctioned for the Research Centre Project in the Budget of the Development Plan. They are to be spent on annual instalments for installing and equipping research laboratories.

64. In addition, appropriations were made to meet the costs of studying prospective industrial projects. These include the financing of consultative companies and the remuneration of specialists engaged for limited terms.

Foreign technical aid

65. In accordance with bilateral agreements for technical aid between Libya and Germany and America, the Industrial Research Department received material aid which was spent to import laboratory equipments. It also received specialists.

66. No aid is received from international organizations and the Libyan Government did not make an official demand to that effect.

Industrial Organization Department, Ministry [illegible]

Its functions

67. The functions of the Department include the [illegible] co-ordinated plans and programmes for industrial development; the [illegible] of the various public and private enterprises into different [illegible]; studying and preparing some industrial projects and encouraging private [illegible] to carry them out; encouraging and protecting industries and developing [illegible] industrial areas; establishing and administering collective trade centres; following and appraising the industrial activities of the country; preparing [illegible] necessary laws for the organization and development of local industries; preparing agreements with respect to the development of mineral resources and supervising their execution; granting and laying down the conditions of the industrial licences; inspecting factories to ensure that industrial laws and regulations are complied with; defining specifications of the raw materials and industrial products for use by industrial public utilities.

Its sections

68. The Industrial Organization Department is composed of the following sections:

(a) Planning and programmes;

(b) Licence and control;

(c) Specifications and measurements.

Each section has defined functions.

Its activities

69. Some of the works accomplished by the Department are described below.

70. The Department has set up two collective trade centres, one in Benghazi, the largest city in the eastern part of Libya, and the other in Sebha, the largest city in southern Libya. The collective trade centres are places where different trades are grouped together for the purpose of providing suitable conditions for the establishment of useful industries in different parts of the country. This is effected by providing fit places for factories, [illegible] facilities of a general nature, e.g., the supply of water and electricity, and the installation of a sewage system at reasonable prices, in addition to the provision of such collective services as training centres, stores, workshops, hospitals, restaurants and libraries. It is intended that industries will thus be planned, encouraged and stabilized in various parts of the country. The Department is also preparing two centres for mechanical training, one in Misrata and the other in Derna, two large cities in Libya.

71. The Department has studied several projects within the framework of [illegible] policy, aiming at encouraging industrialization and protecting local industries. It has granted exemptions to some of these and has protected others by [illegible] importation, according to the results revealed by a study of the [illegible].

72. It has agreed to set up some factories, after their plans had been studied and found proper from the technical and economic points of view.

73. It has supervised the factories and laboratories attached to the Department, some of which are referred to below.

Laboratories attached to the Department

74. The Government Dates Laboratory. This laboratory is affiliated to the Fruit Canning Centre in Tripoli, which was founded in 1955, and to which the above laboratory was attached in [illegible]. Its purpose is to conduct experiments on the pulp and juice of dates and on the remaining pressable fruits. Samples were sent in the same year to the technological expert of the Food and Agriculture Organization (FAO) in Iraq, and also to the Central Technological Institute in the Netherlands for analysis and to discover possibilities of application in industry. The results were positive in both instances. Subsequently, the Netherlands presented to Libya a pilot factory for the manufacture of date juice, whose output was from 500 to 1,000 kilogrammes per day. The factory was installed in the Collective Trade Centre of Tripoli, and commenced production in 1960.

75. Several experiments and analyses were also made to extract sugar from the juice of dates. They were successful, but the economic costs rendered them impracticable. Some experiments were also successful in substituting the date juice for sugar in sweetening many beverages, especially the coloured ones.

76. The date juice is now distributed in great quantities for local consumption. Experiments are still being made to introduce it into many industries, especially the confectionery (chocolate) industry, in order to provide a wide scope for it in the local market. Attempts are also being made to introduce it into foreign markets.

77. As for the pulp of the dates, experiments are being made with it, after mixing it with such products as almonds and peanuts. An FAO expert is in charge of the date juice factory, as part of the aid programme to Libya.

78. Research was also carried out to convert the remaining parts of the date into fodder for animals, after mixing them with other products. Experiments were successful in producing a good fodder and a factory will be erected next year to produce it. A United Nations expert is now studying the project in detail.

79. The laboratory and the above-mentioned pilot factories are financed from the appropriations voted to the Ministry of Industry in the Ordinary Budget.

80. The Government Acid Laboratory. This laboratory was established in 196[illegible] to conduct experiments on various acidic juices. In the same year, a pilot factory was constructed to produce juices and conserves from oranges, lemons, peaches, apricots and plums. These products are now sold in the local market. In general, however, the factory does not produce for the market, but for the purpose of conducting experiments.

81. Experiments are still being made on the juices and on the pulp and essence of oranges. Furthermore, experiments in producing a squash have been successful. Some of the factories in the private sector have benefited from these experiments

[illegible] have applied their results with [illegible]. [illegible] which began producing various fruit juices. The laboratory and the [illegible] factory are financed from the appropriations of the Ministry of Industry in the [illegible] Budget. They are supervised by the same FAO expert who [illegible] supervises [illegible] juice factory.

82. Government Tannery Laboratory. [illegible] industries in Libya. The private sector has been adopting traditional [illegible] in this industry, using the tanning materials available in the country: [illegible], pomegranate rinds, "gedari" roots, olive leaves, and other vegetable [illegible] materials. The proportion of damage during the skinning process has been great. There have been no laboratories to conduct experiments and to evolve this industry in a general fashion.

83. In 1962, the public sector founded the government tannery laboratory, and attached it to the Government Tannery of Tripoli. Its purpose is to carry out experiments and guide the artisans of the private sector to the best methods of manufacturing good hides.

84. Experiments and analyses have taken two directions. In the first place, the experts have devoted their energies to modifying the skinning process for the purpose of averting the damage caused to the hides during the process. They have tried also to devise methods of facilitating the flaying of the skin without causing holes in the skin. Secondly, experiments have been made on the tanning process and tanning materials, since formerly the skins of the camels which were tanned by the application of various vegetables were used for manufacturing cheap hides. These in turn were used as leather for slippers.

85. Since 1963, many experiments have been made in an effort to find new applications of the hides of camels. The experiments that were carried out on hides tanned by chrome were successful and the hides were used in the manufacture of sandals. The government pilot factory now supplies the local market with approximately 10,000 square feet per month of cheap leather, which is used in making sandals.

86. Experiments were also conducted to colour the leather and render it into various shapes from which slippers and various leather goods could be made.

87. Experiments are also being made to dress hides by lime and beating in order to produce fine leather. It is worth while to state that these experiments are of benefit not only to the Government, but also to all the tanneries of the private sector, to whom the results obtained by the experiments are made known. The government pilot tannery is supervised by a FAO expert.

88. It is financed from the appropriations voted to the Ministry of Industry in the Ordinary Budget.

89. It is noteworthy that the tannery is a profitable government project; it yields a revenue greater than its expenditure.

90. The gypsum laboratory. This laboratory is attached to the gypsum factory which was built in 19[illegible]0 and began production in 19[illegible]. The laboratory conducts experiments on gypsum blocks produced by the factory under licence from the [illegible] Company,

United Kingdom, against payment of a certain percentage of the sales for a term of ten years. Two experts from this company supervise the factory; one is in charge of the machinery and the other in charge of the laboratory. Research is now being conducted in the laboratory on the blocks and attempts are being made to utilize them extensively for various purposes. Experiments are also being made to colour and mould them into various shapes and sizes.

91. Both the factory and the laboratory are financed from the appropriations voted to the Ministry of Industry in the Ordinary Budget.

Finance

92. The Industrial Organization Department and the laboratories and pilot factories attached to it are financed basically from the appropriations of the Ministry of Industry in the Ordinary Budget. No amounts were appropriated for the Department in the Development Budget, save that sum which was earmarked for the collective trade centres; this amounted to £L600,000.

Technical aid

93. The technical aid received by the Industrial Organization Department is in the form of experts from the United Nations and FAO, who are supervising the laboratories and factories.

ANNEX

Appropriations of the industrial sector in the Five-Year Development Plan 1963/68
(in Libyan pounds)

Serial No.	Project	Estimated costs	1963/64	1964/65	Balance to be utilized for project	Remarks
1	Collective trade centres	600,000	10,000	200,000	390,000	
2	Training in factories	350,000	35,000	75,000	240,000	
3	Industrial research centre	450,000	50,000	100,000	300,000	
4	Industrial loans	5,000,000	300,000	750,000	3,950,000	
5	Consolidation of current activities of mineral research	100,000	50,000	20,000	30,000	
6	Development of fisheries	400,000	100,000	100,000	200,000	
	Total	6,900,000	545,000	1,245,000	5,110,000	

XXXI. INDUSTRIAL RESEARCH IN NORTHERN RHODESIA

Prepared by John P. Allchin*

Introduction

1. This report is necessarily limited in its treatment of past and current policies and activities in Northern Rhodesia 1/ as relating to industrial research. This situation arises from the country's former (1953 to December 1963) status as a component of the Federation of Rhodesia and Nyasaland, the Government of which was solely responsible for all commercial and industrial matters of all the component territories. During that period, virtually all such industrial research as was undertaken by the federal Government and industry was directed to the interests of Southern Rhodesia, where by far the greater number of industries were situated. Northern Rhodesia has, however, been administered as a United Kingdom Colonial Territory; the country has received services from United Kingdom governmental industrial and development organizations in the United Kingdom.

2. As a consequence of the foregoing background, little progress has, as yet, been achieved locally in the field of industrial research and investigation. However, arising from the planned rapid development of secondary industry, it is realistically anticipated (and, in fact, during recent months this has already been occurring) that as a result of the active policies of the Government, the subject of national industrial research will be of major concern and interest to the Government of the Republic of Zambia.

3. The Minister of Commerce and Industry will review the findings and recommendations of the Inter-Regional Seminar and determine what specific measures may, with advantage, be realized in the Republic of Zambia.

4. This report is arranged according to the recommended format; owing to the local circumstance,, as discussed, the general tenor of the report is essentially qualitative and forward-looking.

A. National industrial research policy

Fundamental and applied research

5. Over the next twenty years, the national emphasis is seen as being directed towards applied research. It is recognized that, with its close links with the developed countries, Zambia will progressively enjoy and, through local institution(s), yet to be established, interpret and apply the work and findings of the many centres of fundamental research, which, certainly for the next many years, Zambia should not contemplate undertaking itself.

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* Projects Manager, Northern Rhodesia Industrial Development Corporation Limited.

1/ Now the independent State of Zambia.

Creation of industrial research consciousness [illegible]
[illegible]rtments

. While it appears that the new Government will [illegible] stemming from industrial research, it must be admitted that, [illegible] Rhodesia considerable apathy and disinterest has been evidenced by [illegible] Federal Government and the "small" industrialists (which, so far, [illegible] sector of industrial activity). Since the new Government of [illegible] will clearly be beset by demands for over-all expansion of the national economy, it is evident that funds and energies must be applied in accordance with a predetermined programme. It is visualized that industrial research consciousness will be progressively fostered by high-lighting actual achievements - initially perhaps quite modest. In simple terms, it is considered that "nothing succeeds like success" and, with the Government and industrialists alike, this appears as the operative formula for establishing positive recognition for the value of industrial research.

Incentives to research

7. The taxation legislation provides that: "The amount of any expenditure, not being of a capital nature, incurred by the taxpayer during the year of assessment on experiments and research relating to his trade..." and "... any sum contributed by the taxpayer during the year of assessment to any scientific or educational society or institution or other like body of a public character approved by the Commissioner if the taxpayer has stipulated that the sum must be utilized by such society, institution, or body, as the case may be, solely for the purpose of industrial research or scientific, experimental work connected with the trade of the taxpayer..." and "... any sum contributed by the taxpayer during the year of assessment in the form of a grant, bursary or scholarship to enable any other person to take a course of technical education related to the trade of such taxpayer at any educational institution" shall be deducted from the income of such person for the purpose of determining the taxable income.

. Subsidies and grants in respect of locally conducted industrial research are, in the absence of locally based industrial research facilities, not yet provided; nevertheless, both the Government and the larger industrial concerns (notably the mining groups) have made, and increasingly provide grants, bursaries, scholarships and the like, which are taken up outside the country.

Incentives to encourage the manufacturing industrial sector to apply the results of research

9. No specific incentives as yet exist.

Government or private sponsored research

10. No actual industrial research is currently being undertaken in the country either by the Government or by private concerns. However, a number of locally based industries possess affiliations with larger groups operating in the more developed countries, which themselves carry out and/or have ready access to industrial research which is available for application in this country (but frequently [illegible] from the disadvantages of not being readily "translatable" to local conditions and circumstances.

B. Industrial research establishments

11. No industrial research institution has been established in Northern Rhodesia.

12. Meanwhile, the Government-controlled Northern Rhodesia Industrial Development Corporation Limited (incorporated in 1960 with an issued capital of £1,015,000) has as its main objectives the following: (a) to act as Government's spearhead in implementing an active policy of industrialization; (b) to provide financial support to economically viable private enterprise projects; and (c) to underwrite or establish projects agreed to be in the national interest until such time as participation of private enterprise can be attracted.

13. In addition, it provides, through its own (limited) staff, its connexions with industrial research organizations in other countries and, more specifically, its own industrial consultants in London, Industrial and Process Engineering Consultants (IPEC), a modest industrial consultation service to both the Government and the industrial sector. Moreover, when the occasion arises, the Corporation engages specialists to appraise, develop and realize specific industrial research projects.

14. Close association is foreseen for the Ministry of Commerce and Industry with both the current Industrial Development Corporation and any nationally sponsored industrial research institution that may be established.

C. Aspects of finance

15. With regard to the pattern already established in Northern Rhodesia, as between Government and industry, it is visualized that any nationally sponsored industrial research institute would look to the Government (principally) and the more substantial industrial groups for its initial capital requirements. It is anticipated that the Government would look in turn to international sources for the provision of portion of this finance.

16. Operating finance would, in all probability, be secured in these forms:

(a) Subventions from the Government, to a progressively decreasing degree;

(b) Fees received for services rendered both to the Government (on prearranged contract terms) and to the private sector on contract terms and on an *ad hoc* basis;

(c) Grants-in-aid from international and national sources.

D. Staffing

17. This is seen as a major difficulty. Over the next five to ten years, experienced and competent staff must be recruited outside the country at levels of salary very considerably in excess of those obtaining for nationals. Consequently, it is foreseen that any industrial research institute must, *ab initio*, provide training facilities for nationals.

18. In this context, it should be noted that no local university has yet been established; plans are, however, well advanced for this development. Nevertheless, local graduates will not be available for some years hence.

E. Application of [illegible]

19. The results of industrial research [illegible] currently available to the ultimate potential [illegible] these main ways:

(a) Trade, technical and scientific publications, but these are [illegible] imperfectly understood by local management and staff;

(b) The services provided by the Northern Rhodesia Industrial Development Corporation Limited, albeit this organization is essentially concerned with financing the expansion/development of secondary industry;

(c) The provision of guidance, advice, etc., from affiliate groups operating in the more developed countries.

20. It should be noted that no local offices or representatives of foreign firms specializing in the provision of industrial research services have, as yet, established in Northern Rhodesia. Firms engaging in the field of management services and management-accounting are already established.

F. Technical assistance received

21. Owing to the considerations briefly reviewed in the Introduction to this summarized report, the experience of Northern Rhodesia with technical assistance in depth, has been limited to recent months. In so far as the United Nations is concerned, it is considered that the Lusaka office of the United Nations Technical Assistance Board should contribute its views directly.

22. Generally, it is the writer's experience and considered opinion that the time of government ministers, senior government officials and institutions like the Northern Rhodesia Industrial Development Corporation Limited is excessively occupied in treating - quite frequently with wholly unproductive results - with a plethora of visiting specialists or would-be providers of expertise. Usually, these individuals and/or missions possess scant appreciation of local conditions, circumstances and requirements, and the value of such reports as emerge from the respective assignments is largely vitiated because no locally established institutionalized organization exists to interpret the conclusions and "tailor" the findings for local application.

[illegible]. THE ORGANIZATION OF INDUSTRIAL RESEARCH IN THE UNITED ARAB REPUBLIC

Prepared by Mohamed El Hanafy Helfawy*

A. National industrial research policy

1. Research is the activity of extending the bounds of knowledge; if it is basic research, it is related to fundamental problems and has no necessary immediate application. Applied research, on the other hand, is undertaken having in mind a particular application at a foreseeable time. Most industrial research is applied, though the objective and time horizon may be distant. The object of industrial research is to make it possible to improve processes or products, or to create new ones; hence the terms "process-directed" and "product-directed" applied research, respectively. "Background" applied research is intended to increase the store of knowledge on which future applications can draw. For example, a metals research institute might engage in product-directed research to produce a new alloy of defined characteristics; in process-directed research to improve some particular section of a steel mill; and in background research on the oxidation of metals exposed to air at different temperatures, for general use in future processes of production or in the applications of these metals.

2. In the United Arab Republic, basic research takes place, for the most part, in the universities. It is true that certain basic research projects take place in the National Research Centre, and in the laboratories of the Atomic Energy Establishment, but these are marginal cases of what has been referred to as background applied research and are undertaken with one eye to possible future applications.

3. Prior to 1956, practically no industrial research existed in the country. This was only natural, since before the 1952 revolution, industry was very much neglected and production had its major source in agriculture to serve colonial and feudal interests.

4. After the advent of the revolution in 1952, there was a general agreement on the need for an industrialization programme which would create more goods for exports, reduce imports, add value to agricultural products, increase employment opportunities and raise the income and purchasing power of the people. The revolutionary Government decided to give industry all the attention and encouragement it needed, foremost among which was the establishment of a new Ministry of Industry and various research and development institutes and departments, the functions and scope of which will be detailed in the next section of this report.

5. In April 1958, the Government also issued Law No. 21 for the organization and promotion of industry. Article 19 of that law stipulated that the Minister of Industry would issue specifications of raw materials and of finished industrial products, with which industrial firms have to conform. According to article 25 of

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* Director General of Planning Organization for Industrialization, Ministry of Industry.

... law, a tax of up to 1... per cent ... wages and salaries, may be imposed on industrial ... would be spent on all aspects of industrial ... research. In main industrial development ... established and affiliated to the Ministry of ... the Productivity and Vocational Training ... Mineral Research Department, the Egyptian ... the Petroleum Organization, the Department of Industrial ... Organization for Executing the Five-Year Industrial Plan. ... amalgamated in 1964 into one industrial organization.

6. Technological industrial research is mainly carried out in the ... Research Centre. However, in some departments of the universities ... developed industrial companies, isolated problems of industrial research ... out. In addition, there exist some specialized research institutes ... particular industries, e.g. the Building Research Institute (BRI). ... institutes are now planned and will be soon constructed, ... Research Institute, the Textile Research Institute and the ... Research Institute.

7. In July 1961, the socialist laws were proclaimed, providing for the nationalization of companies working in basic heavy industries and those large companies in the various fields of the transformation industries. The object ... create a public sector capable of shouldering the responsibilities of planning and development in the industrial fields.

8. With the creation of a competent public industrial sector, and the setting up of a new Ministry of Scientific Research in 196.., it is hoped that the gap between industrial research and development, on the one hand, and the manufacturing industries, on the other, will be soon filled.

9. Industrial as well as basic research in the United Arab Republic is ... sponsored. Incentives to attract local personnel to work in industrial research are many and varied. Research workers are paid more generously than their corresponding government civil servants. They are often awarded grants and fellowships with ... pay to continue their research work abroad for periods ranging from ... years.

10. In its wish to encourage scientific research and to stimulate ... spirit among research workers, the State devoted for the first time in 1964-1.. an allocation of several thousands of Egyptian pounds for state prizes.

11. In the following section, a review of the various research and development establishments is given.

B. Industrial research and development establishments in the United Arab Republic

The General Organization for Industrialization (GOI)

1.. This is located at 6 Khalil Agha Street, Garden City, Cairo. It is the ... of the amalgamation of the former Department of Industrial Planning and the ... General Organization for Executing the Five-Year Industrial Plan. The Department ... of Industrial Planning had been founded in 1956 as a department of the ...

reorganized Ministry of Industry. The object had been to create a body responsible for the organization and promotion of industry. It was necessary to refer to that Department for permits to establish new industrial plants or to expand existing ones or change their locality. Naturally, such permits were only given after a thorough study of these projects both from the technical and from the economic points of view. It was also the task of the various specialists in the department to suggest new projects to be included in the Five-Year Industrial Plan after submitting market research, cost and economic profitability studies.

13. When the first Five-Year Plan was drawn up, early in 1957, it was felt necessary to establish a separate organization to execute those projects in the Plan which the private sector was reluctant to execute, either because of the relatively large initial investments needed or because they offered no quick return on the investment. In this way, the General Organization for Executing the Five-Year Industrial Plan was established in 1957 as a public body affiliated with the Ministry of Industry. In 1964, the Department of Industrial Planning was annexed to that organization, which is now called the General Organization for Industrialization and is under the Deputy Prime Minister for Industry and Mineral Resources.

14. The policy-making body of the organization, which also has the executive responsibilities, is composed as noted below.

15. The Deputy Prime Minister for Industry and Mineral Resources acts as President of the Board of Directors, which consists of fifteen to twenty-five members, as follows: a managing director, the four Ministers of Industry (namely, the Minister of Heavy Industries, the Minister of Light Industries, the Minister of Petroleum and Mineral Resources, and the Minister of Electrical Power); the four Under-Secretaries of State of the above Ministries, the presidents of the ten specialized industrial organizations that control all the industrial companies and four other members.

16. The General Organization for Industrialization is responsible for putting into effect the mining and industrial projects of the Five-Year Plan(s). It implements such projects by:

(a) Determining their economic and technical feasibility, order of essentiality and relative priority, through detailed study and analysis;

(b) Selecting the most suitable location, size, process and/or equipment for the plant, etc.;

(c) Arranging for the building of plant structures, the purchase, installation and testing of all essential machines and services, the recruiting and training of operators and managers, and the provision of necessary working capital;

(d) Control of engineering, operating and financial aspects up to the point where the enterprise is deemed completed, and ready to turn over to the General Organization for the specific industry.

17. Executive responsibility of GOI is vested in the managing director, who is aided by the directors-general of four principal administrations, viz.:

(a) Finance: responsible for all accounting, budget, purchasing, legal, financial, and general service functions, and personnel administration;

(b) Technology: comprising [illegible] project selection, study, specifications [illegible]

(c) Construction: building and design [illegible] follow-up of construction progress [illegible]:

(d) Industrial design: fostering and [illegible] components and repair parts, by feasibility, [illegible] and specification [illegible].

18. The managing director is also aided by staff functional [illegible] for:

(a) Industrial relations and internal security;

(b) Planning studies and follow-up reports, the latter as required by [illegible], to the Minister of Industry and in turn to the Planning Commission;

(c) Foreign buying missions and/or technical offices.

Each of the four principal administrations is composed of a number of organizations, each reporting to the director-general, and charged with specific functions and responsibilities.

Financial administration

19. This branch is responsible for all accounts and financial records, all purchasing, contracts and loans, approval of all payments, handling of all funds and financial arrangements, and the control of organization operating expense and services.

20. It is also responsible (with the technological administration) for the preparation of annual and over-all project budgets, and the continuous control of project expenditures, both within annual budgets and within the total project authorization, and for maintaining the financial records thereof.

21. The financial administration includes the following functional groups (or organizations):

(a) Budget: responsible for control of each project within total authorization and annual budget;

(b) Finance and accounting: preparation of accounting records on project expenditures and organization operating expense and related financial reports, government accounting and project audits, and all financial matters, funds and records;

(c) Purchasing: handles all purchase orders and commitments issued by GOI and the issuance of tender invitations. Operates through sections for foreign purchase, local purchase and foreign exchange control;

(d) Legal: review, approval and custody of all contracts and legal [illegible];

(e) Personnel: responsible for payrolls and employee records, insurance [illegible] other deductions, medical services and general personnel matters;

[illegible]) [illegible]lection and trainin[illegible]: handles recruiting, selection, hiring and [illegible] for advancement, in conformity with organization plans and needs:

[illegible]) Other GOI services: these include stores and supplies, files and mail, office services, garage and automobile service, typing pools, etc.

Technological administration

[illegible]. The technological administration makes preliminary studies of projects for inclusion in proposed new five-year plans and final studies of project feasibility, process and equipment selection, plant size and products, etc.

23. It is divided into industry groups:

(a) Mining - prospecting and development;

(b) Petroleum - extraction and refining;

(c) Chemical and pharmaceutical;

(d) Food processing and beverages;

(e) Metallurgy - i.e., primary metal extraction, smelting and fabrication;

(f) Engineering - metal and other material fabrication and manufacturing;

(g) Textile - fibres, finishing and dyeing, fabrics and clothing;

(h) Electric power;

(i) Electronics.

24. Project implementation by the technological administration includes development of tender specifications for plants, machinery and auxiliaries, and analysis of bids and selection of contractors. Such contracts may be for parts of plants to be assembled in the United Arab Republic, together with units of local manufacture, or for whole new plants to be erected and put into operation.

Construction administration

25. The construction administration deals with site selection and planning, utilities, plant design and construction supervision. It functions through the following groups:

(a) Site planning and selection;

(b) Sanitary facilities;

(c) Architectural design;

(d) Construction design;

(e) Electrical supply;

(f) Construction specifications and [illegible]

(g) Execution and erection - [illegible] Egypt, respectively;

(h) Tender specifications and analysis;

(i) Drafting and detailing.

Industrial Design Administration (IDA)

26. The Industrial Design Administration (IDA) is responsible for promoting and developing in the United Arab Republic the manufacture of plant components and repair parts for five-year plan projects and industries. For this purpose, it analyses projects to determine such items, and develops product and/or unit designs, specifications and feasibility studies.

27. It operates through the following sections:

(a) Planning and process: screening of five-year plan projects for items capable for production locally, and developing specifications therefor or adapting designs to local capability.

(b) Product design: design of new products and improvement of existing designs and equipment;

(c) Equipment design: design and detail of construction units, e.g. formed plate, sheet metal, tanks and bases conveyors, pumps and valves;

(d) Tool design: necessary tools, dies, patterns, jigs and fixtures, and other manufacturing aids;

(e) Inspection and follow-up: quality control, inspection methods and expedition of production;

(f) Special assignments: development of feasibility studies, marketing surveys and cost analysis of IDA projects and designs.

The Department of Productivity and Vocational Training

28. This department is located in Dokki, Cairo, and was founded in [illegible].

29. The function and scope of the department's productivity section are as follows:

(a) To carry out productivity studies and research in United Arab Republic industries with the help of various organizations and companies;

(b) To organize courses for managers and specialists at [illegible] management levels in the fields of industrial engineering, industrial [illegible] and marketing, and supervisory skills, in order to raise productivity.

30. The department is a public body and is attached directly to the [illegible] Minister for Industry and Mineral Resources.

31. An under-secretary in charge of the department is responsible for the policy-making, while a director-general has the executive responsibility.

32. The departments of the productivity division are: management accounting, industrial safety, industrial engineering and supervisory training.

Management Accounting Administration

33. The objective of this administration is to serve industrial and commercial institutions in developing management efficiency.

34. The work is concentrated on collecting necessary facts and figures, analysing results and presenting reports to management as a basis for policy decisions, control and further development.

35. This work is mainly directed to the following types of activity:

(a) Running courses for different levels of employees to give theoretical background and practical example for development of systems and techniques in their own companies;

(b) Giving direct services to individual institutions by sending economists to help them in solving their specific problems on the spot.

36. The administration gives four courses a year. Every course lasts three weeks with thirty-six lecturing hours. The average number of participants is forty, representing thirty companies and enterprises.

Industrial Safety Administration

37. This administration:

(a) Organizes courses in industrial safety to prepare specialists actually working at firms, since universities do not teach the principles of safety. The section thus aims at spreading safety techniques in the various institutions to prevent or minimize accidents;

(b) Follows up the work of participants in these courses in their institutions;

(c) Spreads industrial safety-consciousness (through films, publications and bulletins);

(d) Participates in conferences and committees with safety and occupational health;

(e) Studies statistical data concerned with safety in the industrial institutions participating in the safety courses.

Industrial Engineering Administration

38. This administration applies such modern management techniques as:

(a) Method study,

(b) Work measurement;

(c) Production planning and control;

(d) Quality control;

(e) Maintenance;

(f) Plant layout and materials handling;

(g) Principles of management and performance measurement,

(h) Jigs, tools and fixtures;

(i) Incentives;

(j) Job evaluation;

(k) Simplification, standardization and specialization.

39. In industrial enterprises, in order to increase productivity and reduce production waste, the section performs studies upon request to reduce production costs through better utilization and co-ordination of production resources, men, equipment and materials. The administration organizes seminars and prepares technical studies to train production engineers in the various industrial institutions in such techniques as work study, work measurement, quality control and maintenance.

<u>Supervisory Training Administration</u>

40. This administration has two sections. The large and medium-sized companies section has the following duties:

(a) Looks after the organization of training courses for the trainers in large and small companies;

(b) Follows up the work of the trainers in large companies;

(c) Helps in organizing conferences and seminars for managers and trainers;

(d) Helps in selecting trainers;

(e) Studies the training problems.

41. The small companies section has the following activities:

(a) Training supervisors in small companies;

(b) Follows up the results of training in small companies;

(c) Collects data concerned with training results;

(d) Helps in spreading training consciousness among managers of small companies through visits, conferences and seminars;

(g) Prepare monthly records for its activities;

(h) Studies the training problems.

42. Relationships. It exchanges results and technical information, as well as of publications with the establishments and bodies concerned.

43. Aspects of finance. The department is financed through the government budget.

44. Staffing. It is staffed by local civil servants and by experts from the International Labour Organisation (ILO).

45. Application of results. Results achieved and economies realized through the implementation of studies and research are published in different department publications and thus made available to concerned bodies and establishments.

46. Technical Assistance. It receives assistance in the forms of ILO experts in productivity ; and vocational training, grants and fellowships to local counterparts and the supply of some necessary equipment.

The Department of Mineral Research and Geological Survey

47. The Department of Mineral Research and Geological Survey was founded in 1956 as one of the new departments of the Ministry of Industry. The purpose of its foundation was the exploration of the natural mineral resources in the United Arab Republic, in order to decide the general policy of their exploitation and processing on an economic basis, thus providing local industry with indigenous raw materials, in addition to a surplus for export. This department comprises the pre-existing Geological Survey, which was founded in 1896, the Geological Museum, which was founded in the same year, the Mineral Research Section, which was founded in 1947, and the Geophysical Research Section, which began its activities in 1954.

48. The department was later expanded and other sections were founded. The first new section was the Central Laboratories Section, which started functioning in 1957. It deals mainly with the studies connected with the geochemistry of the ore deposits, together with their mineralogy, using the most advanced methods of investigation. Research in ore dressing is also carried out there. In the same year, i.e. 1957, the Technical Services Section was founded. It comprises the drilling units, the mining units, the car maintenance units and the departmental stores. In 1958, the Mining Guidance Section was set up.

Aspects of Finance

49. The Department is financed partly through the state budget, and partly through the budget of the Industrialization Organization. The funds provided by the Organization are utilized in financing the studies of the projects handed to the Department by that Organization. The financing of the Department is annual, the financial year starting from 1 July.

Staffing

50. The staff of the Department [illegible] staff, the administrative staff [illegible]. [illegible] mainly science graduates who get their [illegible] now paid according to law No. 4[illegible] for [illegible] United Arab Republic Government's civil [illegible] competent geologist, has the executive responsibility [illegible] United Arab Republic, there is a special Ministry [illegible] Resources, to which this department belongs.

51. The assistance of expatriate experts is occasionally [illegible] salaries are fixed according to their experience, the [illegible] and the time necessary for the fulfilment of their contracts. [illegible] the necessary arrangements are made through the Industrialization Organization.

Application of the results of industrial research

52. When dealing with any occurrence of mineral ore deposits, the entire research project is undertaken by the Department, which applies the most detailed and most recent methods of investigation. The final results are compiled in a detailed scientific report which is made available to its ultimate users, namely, the General Egyptian Organization for Mining and the Industrialization Organization. While the work is in progress, there is complete co-operation and collaboration between all the three parties concerned. In this connexion, it should be mentioned that the General Egyptian Organization is the government body controlling the main companies working in the mining field and utilizing the results of mineral research.

Technical assistance received

53. The only form of international technical assistance which is received by the Department is made possible through contracts between the Industrialization Organization and expert firms in other foreign countries.

The Egyptian Organization for Standardization

54. Since the advent of the revolution in 1952, there has been a general resolution to resort to economic development as the only means for raising the standard of living. As a short cut to achieve this development, the United Arab Republic decided to adopt planning. In doing so, it soon realized the importance of standardization as an essential element for a planned economy. In adopting standardization, the United Arab Republic realizes its [illegible], [illegible] the complete consideration of local conditions, the efficient utilization of national resources, the foundation of national industry on sound basis, gaining the confidence of the public in national production, improving production in quantity, quality and [illegible] and increasing export goods.

55. Consequently, it was decided to create an official [illegible] with standardization. Thus, when the Ministry of Industry was [illegible] it was taken into consideration that the [illegible] comprise a technical section for [illegible] establishing a system for material [illegible]

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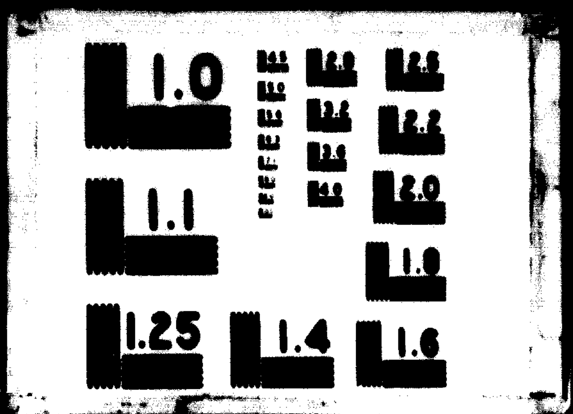

instruments. Soon after this, a further positive step was deemed necessary. Thus Law No. ./1957 for "Standardization" was issued and was directly followed by Presidential Decree No. 29/1957 creating the Egyptian Organization for Standardization as the only competent national authority for all matters concerning standardization. This organization is located at 144 Tahrir Street, Dokki, Cairo, and is affiliated to the Deputy Premier for Industry and Mineral Resources.

Function and scope

56. To fulfil the objectives of the introduction of standardization in the United Arab Republic, the following functions were assigned to EOS:

(a) Elaborating standard specifications for local materials and products;

(b) Ensuring the existence of standard systems for technical classifications, definitions, terminology and symbols;

(c) Providing the necessary measures for quality control of raw materials and products in conformity with the standard specifications, and establishing central and regional laboratories for metrology and quality control;

(d) Securing reference standards for calibration and verification of measures and measuring instruments;

(e) Co-ordinating standardization work in the United Arab Republic, in accordance with international standardization activities.

Organization structure

57. The organization consists of the following:

(a) A council headed by the Under Secretary of State for Industry and consisting of fifteen members representing the different scientific, technical, industrial and standardization sectors in the country. The council sets the general policy of the organization and follows up its execution;

(b) A permanent committee of twelve members concerned with all matters related to standard specifications and quality control;

(c) A permanent committee of twelve members to deal with work related to metrology and calibration of measuring instruments. These two permanent committees are authorized to form technical committees for preparing drafts of standards in accordance with the plan adopted by the council.

58. The above three bodies supervise the following four departments: standards, quality control, technical relations and administration and finance. These departments are concerned with the execution of the plans formulated by the council and the two permanent committees.

Aspects of finance

59. EOS is financed through the government budget. Other sources of its income are the sale of standards and pamphlets.

Staffing

60. The total number of EOS employees [illegible], [illegible] engineers and experts holding university [illegible]. The [illegible] administrative, financial and secretarial staff.

61. At the outset, EOS suffered from the lack of technical [illegible] high calibre needed for standardization work. This situation was partly solved by engaging some qualified personnel from other governmental departments [illegible] basis. In addition, EOS has sent many of its engineers and specialists to be trained in local and foreign institutes.

Application of results of EOS activities

62. EOS activities mainly result in the issuing of national standards. These standards, which are made available to the public, do not have an obligatory nature. However, according to Law No. 21 of 1958 on the Organization and Promotion of Industry, the Minister of Industry is authorized to make any of them compulsory.

The Building Research Institute

63. This Institute, which is located in Giza, was founded in November 1954.

Function and scope

64. The Institute performs organized research on the main problems arising in the different aspects of buildings and structures with the aim of improving the quality, decreasing the cost of building materials and buildings, and fulfilling the requirements of safety, health and use in buildings.

65. The Institute is a public establishment and belongs to the Ministry of Scientific Research. At the present stage of development of BRI, work is conducted by committees gathering representatives from various fields with broad knowledge in their specialization, while a director-general has the executive responsibility.

66. BRI has the following divisions:

(a) Structures;

(b) Concrete and reinforced concrete;

(c) Foundations and underground structures;

(d) Strength of materials and testing;

(e) Building materials;

(f) Dwellings and public buildings;

(g) Sanitary and hydraulic structures;

(h) Physics of structures;

(i) Mechanization of structures,

(j) Experimental design,

(k) Regional and town planning,

(l) Economics of construction.

67. The main efforts of BRI have been primarily concentrated on the first seven divisions, considering the priority of the subjects concerned in accordance with the national needs.

68. The institute is working in close co-operation with United Arab Republic universities.

Aspects of finance

69. The institute is financed by the Government, as a part of the budget of the Ministry of Scientific Research.

The National Research Centre (NRC)

70. The National Research Centre went through a number of evolutionary stages, out of which one can recognize three definite ones. The first and longest stage began in 1939, when it was originally decided to create an independent body called The National Research Council. It ended in 1952 when this body became affiliated with the National Production Council.

71. Its main activities were to stimulate scientific research in the country and to give grants-in-aid to research carried out in the universities and some governmental departments. In 1951, it was decided to build special laboratories for the Council to carry out basic and applied research.

72. During the second stage, from 1953 till 1956, enough funds were allotted to the National Research Institute, as it was then called, to ensure the completion of its laboratories at Dokki, Cairo.

73. In June 1956, the affiliation of the Institute with the National Production Council was dissolved and the National Research Centre became an independent body attached directly to the Presidency of the Republic.

74. In 1963, the National Research Centre was attached to the Ministry of Scientific Research, though still retaining its own entity.

75. The Centre is financed by the State and has its own separate budget, which is in no way attached to that of the Ministry.

76. The scientific activities of the Centre are governed by a board with the director of the Centre as chairman. The board is composed of the various division heads within the Centre, and other eminent men of science, leading industrialists and agriculturalists of the United Arab Republic.

77. The broad aims of the Centre are: "The [illegible] basic and applied, especially in [illegible] all other matters related to the [illegible]."

78. To implement these aims the Centre [illegible]:

(a) Carry out research in its own laboratories, [illegible] the welfare of the society and to meet the requirements [illegible] private organizations and individuals,

(b) Grant scholarships for research in the United Arab Republic [illegible]

(c) Establish centres for documentation;

(d) Publish scientific journals.

79. Since 1956, the Centre has been active in research in its own laboratories. The granting of scholarships and grants-in-aid is another important function of the Centre. Many of the scholarships are assigned to members of university staffs, who also are given grants-in-aid to defray part of the laboratory expenses. These scholarships represent one of the ways in which the Centre encourages and supports research in the universities. These activities help to maintain an adequate supply of trained personnel for the Centre and the other laboratories of the United Arab Republic.

80. The research activities of the National Research Centre are carried out in the departments of chemistry and chemical technology, physics and engineering physics, agriculture and medicine. Each of these departments is divided into divisions, which in turn are subdivided into units. Each department carries out both fundamental and applied research. An organization chart of the Centre is given in annex II to this report.

81. The Centre makes its services available to the various government departments, to industrial firms and to individuals.

<u>The Textile Research Institute</u>

82. Until 1962, this was a unit of the National Research Centre and was housed in the Centre's building.

83. The Institute is intended to be the national scientific organization for research work in textile technology and the industries producing ready-made garments, man-made fibres, dyestuffs and auxiliary products. The main concern of the Institute is to carry out basic and applied research aiming at development in the above-mentioned fields.

84. A public establishment attached to the Ministry of Scientific Research, the Institute will, in the near future, be governed by a board of directors whose members will be from the universities, the National Research Centre and the Ministry of Industry, but until then the Ministry of Scientific Research will remain the policy-making body and have the administrative and executive responsibilities.

85. The Institute comprises the following departments:

(a) Testing department;

(b) Textile mechanical treatments department (spinning, weaving and knitting);

(c) Textile chemical treatments department (dyeing, printing and finishing);

(d) Man-made fibres, dyestuffs and auxiliaries department.

86. The research work currently carried out aims at exploiting the local raw materials for producing new textile products or developing new techniques.

87. The Institute does not carry out research by contract, but the results of any research work carried out at the Institute are made available to the ultimate users through publications (journals, pamphlets, theses, etc.).

88. The Institute does not have a budget of its own, but has a special section in the Ministry's budget.

The Metallurgical Research Institute

89. This was one of the National Research Centre's units until 1962, when the Institute became a separate entity. The Institute is currently located in the National Research Centre building.

90. The Institute is concerned with studying the means for improving the qualities of the industrial products in the metallurgical field and developing the applied processes. It deals also with problems of the respective industries and studies the possibilities and processes of creating new industries depending on the local conditions. The Institute is also interested in studying the wastes of the metallurgical industries aiming at utilizing them.

91. The Institute comprises five departments:

(a) Ore microscopy;

(b) Ore dressing;

(c) Extractive ferrous metallurgy;

(d) Extractive non-ferrous metallurgy;

(e) Foundry.

92. The Metallurgical Research Institute is a public establishment and part of the Ministry of Scientific Research, which is the policy-making body for the Institute and has all the administrative and executive responsibilities until the formation of a Board of Directors from the universities, National Research Centre and the Ministry of Industry [illegible] such responsibilities.

93. The Institute does not have a separate budget, but has a section in the budget of the Ministry of Scientific Research.

94. Though the Institute does not carry out research by [illegible] made available to the users in the form of publications, [illegible] in several periodicals.

The Petroleum Research Institute

95. Until 1962, the Institute was considered one of the research units of the National Research Centre and it is located in the NRC building.

96. The Institute is a public establishment affiliated with the Ministry of Scientific Research, which until now has been the policy-making body of the Institute, having the administrative as well as the executive responsibilities. These responsibilities will, in the near future, be turned over to a board of directors whose members will be from the universities, the National Research Centre and the Ministry of Industry.

97. The type of research work carried out in the Institute is mainly technological and, in some cases, economic in all branches of the petroleum industry (exploration, production, refining, petrochemicals, process design and development, analytical, etc.). Analytical activities include long-range programmes on the chemical evaluation of local crude oils and fractions. Departments for catalysis, corrosion, radiation chemistry and radioisotopes will also be added to the other departments of the Institute.

98. The Institute does not carry out any research by contract.

99. As for the financial aspects, the Institute has a special section in the budget of the Ministry of Scientific Research.

100. Results of any research work are immediately made available to the ultimate users in the country or abroad in the form of publications, theses, journals, etc.

The National Information and Documentation Centre (NIDOC)

101. This Centre was known until 1962 as the Scientific and Technical Documentation Division of the National Research Centre and was housed in the Centre's building.

102. Basically, it was founded to accumulate the maximum amount of world literature in all fields of science and technology in all languages in its central library, to be available for researchers and scientists at any and all times.

103. NIDOC comprises the following departments:

(a) Central Library for Science and Technology;

(b) Bibliography;

(c) Translation;

(d) Photo reproduction;

(e) Publication;

(f) Printing.

104. NIDOC is a public establishment attached to the Ministry of Scientific Research, which is the policy-making body of the Centre.

105. The director of NIDOC has the executive responsibility in the Centre, as well as the internal administrative responsibilities.

106. NIDOC does not have a separate budget, but is included in the Ministry's budget.

107. The Centre, being the largest scientific information centre in the area, makes all scientific and technical data arriving at its library available to users through bulletins and publications.

108. NIDOC has, in the past four years, been awarded four missions for post-graduate studies abroad, as well as two fellowships for scientific and technical documentation from the United Nations Educational, Scientific and Cultural Organization.

The National Institute of Management Development (NIMD)

109. This Institute, which is in Cairo, was founded in September 1961.

Function and scope

110. NIMD objectives are to render all management services to private as well as to public sector enterprises in the United Arab Republic. The Institute covers the field of management development services, including training, research activities and consulting. Research activities are carried out to supply the Institute's training programmes with suitable material to survey management practices and conduct contract research. The management consulting centre is active in the field of formulating standards of products and raw materials, as part of certain of its assignments. It is also engaged in feasibility studies, industrial engineering research and development services, as well as conventional management consulting services.

111. NIMD is an autonomous public establishment reporting directly to the President of the Central Agency for Organization and Administration who in turn reports to the Prime Minister.

Policy-makers

112. The policy-making body in the Institute is its board of directors. This board is responsible for formulating general policies. The execution of such policies and supervision of the Institute's activities are entrusted to the chairman of the board, who also acts as managing director. The board consists of the chairman and eight members, five of whom are representatives of the business community and other interested bodies, i.e., the Institute of Public Administration, School of Business, Alexandria University, the chairman and the managing director of a bank and two representatives from other government departments.

Departments of the Institute

113. The Institute consists of three divisions, namely:

(a) Executive development centre;

(d) [illegible]

(e) [illegible].

Both the [illegible] research, research and development [illegible].

Working relationship with other establishments

114. The Institute's training programmes are offered to executives from public as well as private enterprises.

115. Consulting assignments are also accepted from private and public bodies. The Institute is in a process of establishing closer relationship with Alexandria University in connexion with promoting post-graduate studies in management sciences.

Aspects of finance

116. The Institute's main source of finance is its annual budget allotted by the United Arab Republic Government. In addition to that, the Institute receives generous grants from the Ford Foundation, the United States of America's Agency for International Development and other sources.

Staffing

117. The total professional staff of NIMD amounts to eighty-two, including twenty-four senior professionals in training research and consulting with Ph.D's and some background of experience. The number of researchers of different levels amounts to forty. The professional staff engaged in consulting is currently eighteen. The rapid growth of the Institute since its establishment has caused some minor problems. In the United Arab Republic the supply of well-qualified men in these newer fields is relatively short. National staff is recruited whenever possible and supplemented by expatriates whenever required. To obtain the right calibre of man, it is necessary to offer salaries that can compete with local and international offers.

The application of results of research

118. Research projects carried out by NIMD are either of general interest or specifically asked for by clients. The first type is made available to all interested parties. As to contract research carried out according to specific instructions from clients, it is the Institute's policy to refrain from publishing its findings except with the permission of the client.

C. Conclusion

119. In addition to the above-mentioned departments and institutes, research work is carried out by several industrial firms. This work is mainly directed towards improving processes or product quality, finding new applications of the products and new uses of by-products, or solving some problems of production.

170. There are also several private consulting offices and industrial design offices in the United Arab Republic.

171. The review given above summarizes the national industrial research policy of the United Arab Republic and outlines the main industrial research centres and establishments. The importance of applied research for the country, and in fact for all developing countries has been stressed over and over in the National Charter, from which the following can be quoted:

> "Our liability to master the various branches of science is the only way left us to compensate for under-development. If the national struggle reaches our advanced science, it would have a greater opportunity for progress; it would make the former under-development seem an advantage, for then by comparison, the new achievement would appear spectacular. If the nations on whom under-development was imposed, could now make a start supported by advanced science, they would thereby be at a starting point, superior to that from which other advanced nations began.
>
> "They would thus have a strong impetus to catch up with those advanced nations and surpass them.
>
> "The major economic and social problems confronting our people, at present, must be resolved on a scientific basis.
>
> "The scientific research centres are required at this stage of the struggle to develop themselves so that science would be in the service of society. At this stage, science for its own sake is a responsibility which our national potentiality cannot shoulder.
>
> "Therefore, science for society should be the motto of the cultural revolution at the present stage. The achievement of the objectives of the national struggle will enable us at a further stage of our development, to make a positive contribution to the world in the domain of science for its own sake."

ANNEX I

UNITED ARAB REPUBLIC PUBLICATIONS RELATED TO INDUSTRIAL RESEARCH AND DEVELOPMENT

A. Periodicals

(1) Industrial Egypt. Quarterly bulletin of the Federation of Industries in the United Arab Republic (in English and Arabic).

(2) Yearbook of the Federation of Industries in the United Arab Republic, published annually (in English and Arabic).

(3) United Arab Republic. Standardization Bulletin, published semi-annually by the Egyptian Organization for Standardization (in English and Arabic).

(4) Productivity Magazine, published quarterly by the Department of Productivity and Vocational Training (in Arabic).

(5) Productivity News, published fortnightly by the Department of Productivity and Vocational Training.

(6) Journal of Chemistry of the United Arab Republic, published bi-annually (in English). a/

(7) Journal of Botany of the United Arab Republic, published annually (in English).

(8) Journal of Geology of the United Arab Republic, published bi-annually (in English).

(9) Journal of Pharmaceutical Science of the United Arab Republic, published annually (in English).

(10) Journal of Veterinary Science of the United Arab Republic, published bi-annually (in English).

(11) Journal of Soil Science of the United Arab Republic, published bi-annually (in English).

(12) Journal of Animal Production of the United Arab Republic, published bi-annually (in English).

(13) Bulletin of the Nutrition Institute, published irregularly (in English and Arabic).

(14) Documentation Bulletin of the National Information and Documentation Centre (Comprises two parts: Part 1 gives a bibliography of all articles in the journals arriving at the Central Library of NIDOC. Part 2 contains abstracts in French and English of research projects carried out in the Middle East.

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a/ Items 6-15 are published by the National Information and Documentation Centre.

(15) Technical Information for the Textile Industry, published monthly (in English).

B. Books and reports

(1) Twelve Years of Industrial Development in the United Arab Republic, published in 1964 by the Office of the Deputy Premier for Industry and Mineral Resources (editions in English, French and Arabic).

(2) Industrial Design Administration Catalogue, published in 1964 by the Industrialization Organization (in English and Arabic).

(3) Technical Reports of the Geological Survey and Mineral Research Department (published in English).

(4) Petroleum in the United Arab Republic, published in 1960 by the Petroleum Organization (in English and Arabic).

(5) Index of Egyptian Standards (in Arabic and English).

(6) National Standards (in Arabic).

C. Conference proceedings

(1) Proceedings of the First, Second and Third Cotton Conferences (in Arabic).

(2) Proceedings of the Afro-Asian Housing Congress (in Arabic, English and French).

(3) Proceedings of the Second Animal Production Conference (in English).

(4) Proceedings of the Third Arab Veterinary Science Conference (in English).

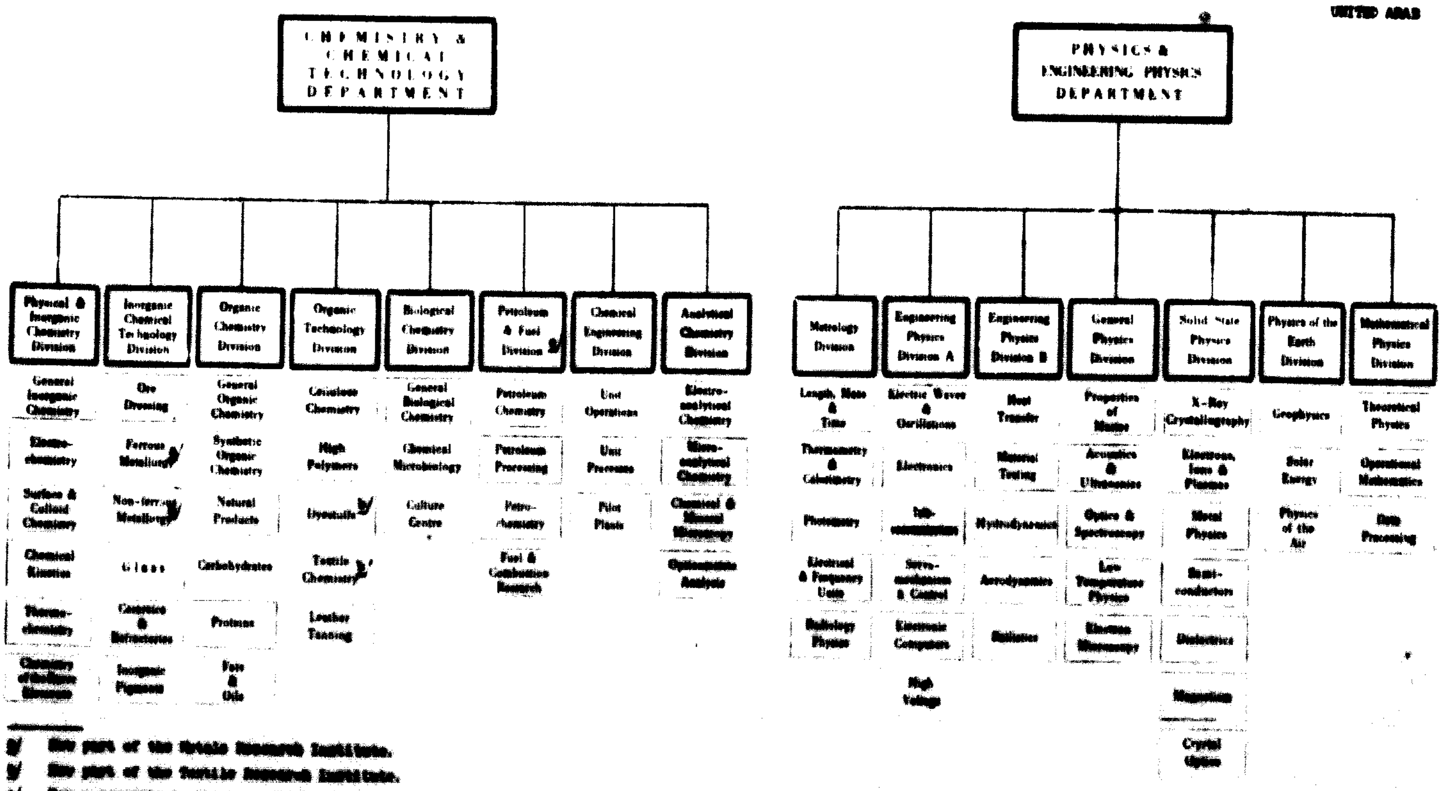
(5) Proceedings of the Eighth Pharmaceutical Science Conference (in English).

(6) Proceedings of the First Conference on Bilharziasis (in English).

ANNEX II

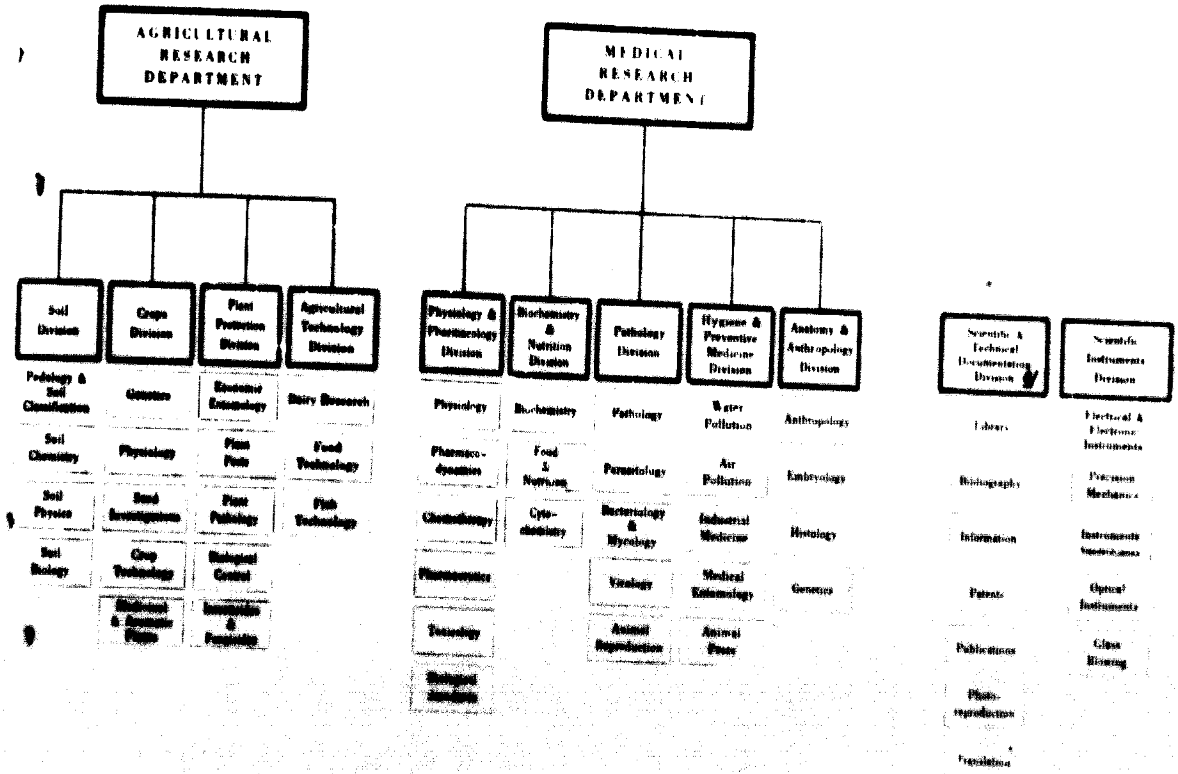
CHART OF ORGANIZATION OF NATIONAL RESEARCH CENTRE
UNITED ARAB REPUBLIC

ANNEX
CHART OF ORGANIZATION OF
UNITED ARAB



a/ Now part of the Metals Research Institute.
b/ Now part of the Textile Research Institute.
c/ Now a separate institute - the Petroleum Research Institute.
d/ Now a separate centre.

II
NATIONAL RESEARCH CENTRE
REPUBLIC



المركز القومى للبحوث
المعامل والخدمات الفنية

NATIONAL RESEARCH CENTRE
CAIRO, U.A.R.
LABORATORIES AND TECHNICAL SERVICES

XXXIII. INDUSTRIAL RESEARCH IN THE SUDAN

Prepared by A.M. Fadlalla*

1. Industry is now gradually developing in the country and with it the need is being felt for some work to be done regarding the establishment of an industrial research institute. The mineral aspect of the country is being handled by the Department of Geological Survey. The Department of Agriculture is looking after agricultural research, plant breeding entomological and agronomical studies. The chemical laboratories are mainly engaged in analytical work, while the veterinary service laboratories are looking after the animal health in the country.

2. The Government of Sudan is encouraging the establishment of industries to relieve its dependence on imports and to develop uses for its raw materials. The Government has liberal policies towards foreign investment and foreign participation in industry, has a programme of assisting approved industries in their initial phase and has allowed for further development in its Ten-Year Plan. However, it is convinced that all these efforts will not be fully remunerative in the absence of a technical organization which can make studies of feasibility, test raw materials and assess standards of finished products.

3. To effect an orderly development of industry, to provide technical assistance to existing industries and to promote the use of local raw materials, an industry service and research institute is needed. While it is needed now, this establishment will take some time to build, equip, organize and staff, during which time the expansion in industry will intensify the need.

4. On the other hand, while the country will not be able to spare enough trained staff to carry out fundamental research yet, it is the Government's acknowledged policy to encourage this type of research through the university. Staffing and equipping of the different university departments is currently being undertaken to meet this need.

5. The Government is actively engaged in the preparation and study of the proposed plan of operation and the act governing the establishment of the first industrial research institute of Sudan, which will be located in Khartoum.

6. Generally speaking, the institute will be designed to aid and promote the industrial and economic development of the country through the application of scientific research and technology (adapted to the country's conditions and resources) and by the creation of a broadly available local source of practical

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* Ministry of Commerce, Industry and Supply.

information, assistance, professional advice [illegible] studies on efficient techniques of industrial production, costing, evaluation and management technology. The institute will also encourage the development of Sudanese scientific and technical personnel essential to the accelerated economic development of the country.

7. The institute, when established, will be designed to serve the following objects:

(a) Conducting tests, investigations, research and analyses;

(b) Furnishing advice and consultation service on problems of industrial planning, process engineering, production management, efficiency, market development, cost and quality control;

(c) Assisting in the formulation of standards for industrial and commercial products;

(d) Making surveys and studies of natural resources, raw materials and by-products of industry, mining and agriculture, and their utilization;

(e) Maintaining a modern technical reference library and public information service on industrial technology and related matters;

(f) Undertaking or collaborating in the preparation, publication and dissemination of useful technical information;

(g) Co-operation with other bodies and institutions in promoting scientific and technological research and the training of technical experts, craftsmen, artisans and specialized production personnel;

(h) In general, advising and assisting otherwise on scientific and technological matters affecting the development of the natural resources and industries of the Sudan, and on the proper co-ordination and employment of scientific and technological resources to those ends.

8. In order to fulfil these objectives in the best possible way and in order to gain recognition and faith of the private sector, the institute will be under the aegis of the Ministry of Commerce, Industry and Supply as a corporate institution operated by an appointed board of directors who will be the policy-making body. The board is expected to include representatives of the Government, the Industrial Bank and private industry, as well as the director of the institute.

9. Though the Director would be a prime mover in policy making, he will also bear the executive responsibility under the authority delegated by the board to whom he reports. Thus, he will be the top man in the hierarchy of the institute. Under his direction will come the different departments which will be created from time to time as the need arises. As the institute is not yet established, these departments have not been created. However, one important department will be the public relations department which will be responsible for, among other things, the creation of industrial research consciousness in industry and Government. Furthermore, in order to attract private industrialists and encourage them to engage the institute to do research in their factories or solve their problems; the proposed act will definitely allow tax exemption on money spent by

industry on industrial research. The proposed Sudan industrial research institute will be operated as a non-profit undertaking, and will be subsidized to a considerable extent by the Government, although industries will be expected to pay for services by the institute at cost only, as of course such services are expected to result in less expense and more profit. The work done by the institute will be for private industry as well as for the Government, and for this reason, and perhaps other reasons, it will maintain a close informal relationship with both private and public sectors, as well as with independent bodies like the University and individual consultants. Such informal contact would not only facilitate effective co-ordination, but would result in co-operation between the different bodies.

10. The institute is expected also to be engaged in doing confidential work, assigning patents and carrying out research by contract. The results of research done by the institute of course, other than private and confidential work, will be made available through the institute's own offices, either through bulletins, publications, demonstration or otherwise.

11. To carry out its functions fully the institute will be equipped with a technical inquiry service, general industrial information service and a library. It will also carry out consulting service.

12. Financially, the proposed institute will depend on a combination of statutory government grants and the fees charged for service to industries and other establishments.

13. The United Nations Special Fund with the Food and Agriculture Organization as the Executing Agency, is now helping to establish the Institute. The duration of the programme will be five years, and the assistance includes the services of experts and the contribution of equipment, as well as eight fellowships for Sudanese staff, as follows:

(a) One fellowship for a study at a masters' degree level in industrial management;

(b) Three fellowships for the study of chemical engineering;

(c) One fellowship for the study of industrial microbiology;

(d) One fellowship for the study of industrial engineering;

(e) One fellowship for the study of industrial oils and fats;

(f) One fellowship for the study of analytical chemistry.

14. The Special Fund's contribution totals $US748,900 while the Sudanese Government is putting up a total of $US1,404,900.

15. The United Nations terms allow for the likelihood of further contributions from other sources, especially bilateral aid from certain Governments if the Institute makes good progress. Local donations are also acceptable.

XXXIV. INDUSTRIAL RESEARCH IN GHANA

Prepared by Emmánuel Lartey*

A. Industrial research policy

1. Ghana has adopted and is in the process of implementing a Seven-Year Development Plan, which was launched by the President of the nation on 11 March 1964. To quote some of the President's words while he was launching the Plan: "The Plan provides the blue print for the future progress and development of Ghana as a nation. It is a programme of social and economic development based on the use of science and technology to revolutionize our agriculture and industry. The Plan, therefore, lays its great emphasis on the modernization of agriculture and the most rapid expansion of industrial activity in Ghana". The Plan introduces a period of extensive economic reconstruction and development. The following sub-paragraphs, which are quoted from the Plan give the five important economic objectives of industrial development in Ghana:

(a) To the largest degree possible domestic substitutes should be produced for those manufactured staples of consumer demand for whose supply Ghana is now entirely dependent upon foreign sources and expends large sums in foreign exchange each year.

(b) The agricultural and mining commodities that are at present exported mostly as unprocessed primary products should be progressively processed and manufactured before export.

(c) The building materials industry should be expanded and modernized to enable it to support the inevitable increased activity in construction and a start should be made on the development of other basic industries in the field of metals and chemicals.

(d) In the development of basic industries particular attention should be paid to preparing the economy for the further stages of industrialization envisaged under subsequent plans. A beginning should therefore be made in a small way in the field of machine industries, electrical equipment and electronics.

(e) Industries will be developed in such a way that they fit in with development in other African countries.

2. To assist in the realization of these objectives, industrial and technological research will be concentrated during the plan period on the following broad areas:

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* Co-ordinator of Industrial Research, Ghana Academy of Sciences.

(a) The principal export industries and research needs for changing these from the exportation of primary raw materials to the exportation of processed or manufactured goods;

(b) The production of commodities for domestic consumption in replacement of imported commodities;

(c) Building materials and the construction industry;

(d) Research needs of transport, communications, etc.

3. The Ghana Academy of Sciences has been charged, by the Government, with responsibility for the execution, promotion and co-ordination of research, including agricultural research, medical and nutritional research, industrial and technological research, and sociological and economic research. In all these fields, a prime and fundamental aim is to relate research closely to the development needs of the country.

B. Industrial research establishments

Building Research Institute

4. The Building Research Institute of the Ghana Academy of Sciences is located in the city of Kumasi and is currently within the campus of Kwame Nkrumah University of Science and Technology. Plans are under preparation for rehousing the Institute on a new site recently obtained outside the University campus. It is proposed that four institutes be housed on this large site, namely, the Building Research Institute, a proposed road research institute, a unit of the Forest and Forest Products Research Institute, and the crops research unit of the Agricultural Research Institute.

5. The Building Research Institute was established in 1952 as a West African Inter-territorial Institute under the name of the West African Building Research Institute. It became a national Ghanaian organization in October 1962.

6. The Institute conducts research into the problems arising in the building and construction industry, and provides a technical advisory service to the industry. Emphasis is now being laid on research leading to the increased use of local materials - soils, timber, lime - in building as a means of achieving reduction in building costs. It has four main divisions: architectural, structural, materials, and functional efficiency. It carries out laboratory testing for other organizations.

7. The Institute is a government establishment under the Ghana Academy of Sciences.

Road Research Institute

8. Towards the eventual establishment of a road research institute, a small number of research personnel is now being recruited to set up a road research unit to be attached to the Building Research Institute, as mentioned in paragraph 4. This unit would conduct research on road materials, methods of road

construction and maintenance, and problems of highway transportation and safety. The unit would have a materials section, a structural section and a traffic engineering section.

Forest Products Research Unit

9. This forms part of the Forest and Forest Products Research Institute mentioned in paragraph 4. It is mainly concerned with the whole area of utilization of timber, and also deals with problems connected with the technology of such forest products as pulp and charcoal, and with the processing of fibres.

National Standards Organization

10. At the instance of the Ghana Academy of Sciences, discussions have been in progress with the United Nations Educational, Scientific and Cultural Organization since early 1963 concerning the establishment of a national standards organization. The outcome of these is that a request has been made by the Ghana Academy of Sciences for assistance from the United Nations Special Fund for the establishment of a national industrial standards and testing laboratory.

11. The function of this Institute would be to establish Ghanaian national standards and to serve Ghanaian industry by testing and quality control of Ghanaian products as well as the raw materials used. It would consist of a Bureau of Standards and four divisions of the testing laboratories concerned with the various branches of engineering and technology: civil, mechanical, electrical and general.

12. A training programme has been incorporated in the scheme in order to train the laboratory technicians required for the large amount of routine testing work in the laboratories.

13. The location of the national industrial standards and testing laboratory would be in the town of Tema. As a major port of the country, Tema would handle the bulk of the country's exports and imports. The town, planned for industrial and commercial development, already possesses a number of industries, manufacturing and assembly plants, and an oil refinery. The gigantic Volta River hydroelectric project includes large-scale production of aluminium at Tema. With a national industrial standards and testing laboratory located in Tema, therefore, the close association which should exist between industry and commerce and an industrial testing organization would be assured. Government ministries and departments with which effective liaison must be maintained are also easily accessible, Tema being less than twenty miles away from Accra, the capital of the country.

C. Finance

14. The industrial and technological institutes and units are financed from grants made annually from the over-all governmental budget. The funds are centrally controlled by the Ghana Academy of Sciences and are disbursed within the institutes as required. Internal financial control in each institute is exercised by the director of the institute through his accounting organization.

15. Financing for the running of the proposed national industrial standards and testing laboratory would be the responsibility of the Government, through the Ghana Academy of Sciences in the manner described in the preceding paragraph. It is expected, however, that the laboratory would eventually become a partially self-supporting unit through its charges to the users of its services and by the issue of government approval certificates.

D. Staffing

16. The provision of qualified staff for the institutes has been a problem in respect both of research personnel and of laboratory technicians.

17. In order to improve the situation, as far as research personnel from local sources are concerned, the Ghana Academy of Sciences has put forward proposals for the promotion and popularization of science and technology through training in the primary schools, secondary schools and universities. The Government has also established a University of Science Education. All these measures are aimed at producing scientists locally in reasonable numbers for work in the research institutes, as well as in other fields in the country. Advantage is also being taken of technical assistance agreements and schemes to obtain expatriate research personnel for the institutes.

18. As regards the training of laboratory technicians, the Ministry of Education (Technical Education Division) is developing its polytechnic institutions to permit them, with assistance from the universities and the Ghana Academy of Sciences, to provide adequate training for laboratory technicians. As mentioned in paragraph 12, a technician training scheme has also been incorporated in the Ghanaian Government/United Nations Special Fund project for the establishment of the proposed national industrial standards and testing laboratory.

E. Industrial research and industry

19. It has always been realized that, being institutes of applied research, there should be an active link between the institutes and industry. This permits the institutes to ascertain readily and on a continuing basis the research needs of industry. It provides a means by which the results of industrial research can be easily and quickly made available to industry. It creates an effective channel for fruitful exchange of knowledge and experiences between the institutes and industry, and thus ensures the regular use of the latest and best materials and techniques.

20. In order to ensure that, in the over-all way, the interests of industry and the Government, as well as the general public, are recognized in industrial research, the Industrial and Technological Research Sub-Committee of the Ghana Academy of Sciences is composed of representatives of the Government (Ministry of Industries, State Planning Commission and government departments), industry (manufacturers' representative), the universities and the Academy.

21. A council has been proposed for the projected national industrial standards and testing laboratory, to be composed of representatives of materials suppliers, industry, users and consumers, interested government ministries, the Chamber of

Commerce and Industry, the [illegible] Engineers, and the Academy.

72. With regard to the Building Research [illegible] examination for the establishment of "[illegible] centre" [illegible] to provide:

(a) Technical inquiry service to offer answers to [illegible] relating to techniques and materials;

(b) General industrial information service to offer general technical guidance on trends, opportunities and possibilities in the utilization of local materials, improved operating procedures, etc.

XXXV. INDUSTRIAL DEVELOPMENT IN IRAQ

Prepared by F.J. Sukkar*

Introduction

1. Before going into detail regarding the objectives of industrial institutes, the services rendered by them and their relation to industrial development, a brief introduction to the Directorate General of Industrial Planning in Iraq would serve well.

2. This Department was established in the early 1930's as general testing laboratories and research centre for agricultural industries. It was meant to solve their problems and to help establish new industries totally dependent on agricultural products based on modern techniques and operations.

3. It was natural, however, that this department became interested and conducted a series of studies with regard to dates and the by-products of dates. At the same time, however, other studies for producing tomato juice, the canning of different agricultural products, meat, etc. were also being carried out within this Department.

4. In 1951, the scope and the services required of this department were largely expanded to include all forms of industrialization, and hence the name was changed to Directorate General of Industry-Industrial Research Institute. Then, in 1959, when the Ministry of Industry was established, the scope, mode of operation and services rendered by the directorate were finally defined and the name once more changed to become the Directorate General of Industrial Planning.

A. Organization and operation of the Directorate General of Industrial Planning

5. The Directorate General of Industrial Planning is currently composed of several divisions and sections, the basic duties of which are to encourage development of local industry and to study the possibilities for making use of local raw materials.

6. For this purpose, the two main divisions of the directorate co-operate very closely to attain the best possible results. These two divisions are:

(a) The Industrial Research Division, whose main duty is to conduct researches and technical studies to determine the nature of the industrial products and the possibility of replacing imported raw materials by ones locally available. This is in addition to carrying out analyses and tests to determine whether both imported and local products are in accordance with the given specifications;

(b) The Economic Research Division, which makes economic studies of proposed new industries to be established in the country.

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* Head, Specifications Centre, Baghdad.

7. In addition to these two divisions, a third, the manpower division, directs its studies to the requirements of both national and governmental need for labour and technical experts, and prepares a plan for making such labour and technical experts available.

8. Within the Industrial Research Division, the work is divided among three sections, according to the specialization of each:

(a) The research section, which conducts the necessary research and investigations and gives possible solutions to current industry problems; it also passes free technical advice to the various industries in the country;

(b) The analyses section, which makes every chemical analysis of raw materials and industrial products, as well as supplemental analyses for the studies and research conducted by the other sections;

(c) The specifications section, which carries out the necessary tests to ensure that industrial raw materials and products are in accordance with local and foreign specifications. Primary studies are currently being conducted by this section to establish specifications for the entire country, with the co-operation of the Iraqi Specification and Standardization Organization.

9. In view of the importance of these researches and studies, and their influence on the current industrial development, the Directorate has undertaken to do all possible research work that is of direct use to the existing industries and/or on the request of one of the industrial projects in the country. At the same time, it undertakes the necessary studies and researches for industry under construction and future industry, indicates the best possible methods and techniques for production, and suggests possible local raw materials.

Communication of research and test results

10. Results of researches and studies are communicated by the Directorate to the concerned authorities, so they may make use of them and apply them to the best of their ability to the various projects. The Directorate also communicates, upon request, all available information to private enterprises free of charge. The researches currently being conducted by the Directorate are mainly dependent on the general industrialization plan and the Five-Year Plan for Industrialization. Technical consciousness among industrialists in this country began a long time ago, but, unfortunately, for some time now it has been limited to the large projects and enterprises which began to benefit from local scientific abilities. Smaller projects and enterprises have shown no recognition to the importance of industrial research for two main, well-observed reasons: the first is the costs involved in undertaking research and their inability to afford these extra expenses, and the second is their vague appreciation of the benefits to be derived from such research. Still another reason, however, is the unwillingness of these industrialists to promote and improve their industries so long as their products find a ready market, even though at a comparatively low profit. These facts are basically owing to a lack of competition among producers and to the number of industrialists who produce objects of a similar nature. Even in the case where several industries do produce similar products, it has been observed that industrialists in this case, tend to drop their prices rather than to improve the quality of their products in order to compete; the fact that would eventually influence production and ultimately its quality.

Technical and scientific assistance

11. For the reasons given above, the Directorate has made plans to acquaint producers with the benefits that could be derived from scientific research and its influence on the promotion of industry, in the sense of cutting down production costs without changing the quality. In this respect, the Directorate has carried out tests, analyses and studies, and conducted research at very low and tempting charges. Specialists and technical experts have been sent on regular visits to the various establishments and enterprises to give technical advice and increase their knowledge in industrial production at no costs to the producers. Similarly, the Directorate published on several occasions pamphlets and bulletins on this subject. Unfortunately, all of these efforts have not given a satisfactory result.

12. Therefore, in order to direct the attention of the Industrialists to the benefits of the various research projects and studies and to push them to utilize locally available scientific assistance, the Directorate established a new section, namely the specifications section. Government departments were immediately notified, in particular, the Ministry of Industry, which makes the decisions with regard to applicants to construct new industries in the country.

13. The Ministry indicated in its decisions that no permit should be issued to these applicants unless, and only unless, the raw materials used for their new industry and the resulting products conformed entirely to the local and foreign specifications. To those whose products pass the specifications tests, the Ministry grants an exemption from customs duties and income tax; a step undeniably good for the promotion of production and industrial development in the country. In this manner, it is hoped that these industrialists will eventually recognize the importance and benefits of research and finally develop a consciousness of the value of technology. Similarly, it is hoped that the smaller producers will gradually begin to gain the necessary technical consciousness.

Specifications and standardization

14. Because of the vast responsibility of formulating specifications for the entire country and in view of the expected benefits derived therefrom, the Directorate was obliged to establish an independent organization, the sole responsibility of which is to carry out necessary investigation for the formulation of these specifications. This organization is now known as the Iraqi Specification and Standardization Organization although, as yet, it has not assumed its responsibilities; it is hoped that it will do so in the very near future.

Financial problem

15. One of the main problems confronting the Directorate is its financial status and the allocations available at its disposal. This fact has become a very large obstacle, hindering the development of the abilities within the Directorate and the possibility of increasing the number of technical staff to meet the ever-increasing demand for technical studies.

Staff problem

16. However, the most serious and complicated problem now is the problem of technical staff, owing mainly to the fact that the number of vacancies for such staff in the country outnumbers by far the people possessing the required qualities.

This situation is also due to the low salaries [illegible] to the more attractive salaries that private enterprise [illegible] them. Because of the higher salaries they can offer, [illegible] establishments are never short of technical staff [illegible] choice of the best and ablest.

17. The majority of the rest turn to those government [illegible] allowances, e.g. the University of Baghdad, where a higher income [illegible] since extra lectures are possible. At the same time, there is a [illegible] opportunity to carry out a scientific research within the establishments of the University, even though this research is purely academic and has no direct relation to industrial development in the country.

ANNEX

REGULATION No. (56) OF 1959 OF THE MINISTRY OF INDUSTRY

Article 6: The Directorate General of Industrial Planning. It shall be headed by a director general who shall be assisted by a number of officials. Its task shall be collecting information relevant to industry and industrialization movement, and classifying such information for the purpose of laying down a plan for industrial development both in the national and governmental sectors within the framework of the general economic development plan decided on by the Ministry of Planning and following up the execution of this plan. The following divisions shall be attached to it.

(1) The Economic Research Division shall be headed by a specialist official who shall make the economic research mentioned above, deduce conclusions therefrom and submitting them to the planning division.

(2) The Industrial Planning Division shall be run by a specialist official who shall lay down an industrial plan for the national and government sectors within the framework of the general economic plan made for both sectors.

(3) The statistics division shall be run by a specialist official who shall collect information related to industrial development, such as industrial production, the market demand, the capital invested in industry, production costs, the prices of the industrial products, and labour, and he will collect also the information and statistics related to industry.

(4) The Industrial Research Division shall be headed by a technical director who shall make the technical research necessary for industry including research related to standards, specifications, raw materials, production costs, and technical experience. It shall be constituted of two sections:

(a) The Standards and Specifications Section shall be run by a technical official who shall determine and enforce the technical specifications in the raw materials, and the industrial products, both the national and the imported ones. He will also carry tests required by the industrial projects.

(b) The Laboratory Research Section shall be run by a technical official who shall make analyses and research which help the orientation of the construction of new industries and the development of the present ones, and raising the standard of production. He will also make studies necessary for exploiting the raw materials available in Iraq in the industrial fields.

(5) The labour and technical experts Training Division shall be directed by a specialist official who shall make studies of the requirements of both national and governmental sectors for labour and technical experts and prepare a plan for making labour and technical experts available.

XXXVI. INDUSTRIAL RESEARCH IN THE SYRIAN ARAB REPUBLIC

Prepared by A. S[illegible]*

Summary

The urgent need of Syrian industry for an industrial testing and research centre is discussed in this paper. The objectives of such a centre are to help industry to improve the quality of manufactured products and consumer goods, and to raise productivity and yields, by testing its production, by advising on testing and controlling facilities in the factories, and by the execution of research and development work, as well as feasibility studies for industry.

Details of a project for the establishment of a testing and research centre in Damascus are given. The project will be executed through the joint co-operation of the Government of Syria and the United Nations Special Fund, the United Nations Educational, Scientific and Cultural Organization (UNESCO) being the Executing Agency.

Introduction

1. The industrial development of the Syrian Arab Republic is a relatively recent event and, although considerable expansion is taking place in Syrian industry, industrial research is practically lacking. There is thus an urgent need at as early a date as possible for an industrial research and testing centre for the purposes of testing and standardization of industrial products and for industrial feasibility, and research and development investigations.

2. There are a few government laboratories existing in the Syrian Arab Republic, but none of them is considered suitable for assisting in satisfying the above-mentioned needs. In addition, it is recognized that industry has very few means at its disposal for the scientific testing of its products in order to ensure conformity with the world and the proposed Syrian standard specifications. The various larger industrial units have facilities in their own laboratories for their domestic product control and simple investigations, but these are the exception rather than the rule.

3. Syrian industry, in the main, consists of small units which are unable, for financial and traditional business reasons, to support collectively or individually their own development and feasibility investigations. It is thus in great need for testing, analysis, and research and development laboratories that would help it in improving the quality of its products and manufacturing techniques and processes, as well as educating Syrian industrialists on the importance of control analysis. This need is obvious from the fact that, although many Syrian industrial products and consumer goods conform reasonably well to standard specifications, many others are well below them. Moreover, locally manufactured products are in many instances costlier, owing in part to lower yields and lower productivity.

4. Despite the good progress made so far in developing Syrian industry, there still remain many fields where industry could expand and thus make fuller use of the

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* Ministry of India, Syria.

locally available resources. Such an expansion, however, would require a programme of systematic study and research.

5. To meet the steadily growing need for an institution that would satisfy the above needs, the Ministry of Industry in the Syrian Arab Republic has decided to establish an industrial testing and research centre.

A. Background information

6. The idea of establishing the centre dates back to 1959. The foundation of an institution that would meet the needs of the different ministries and government organizations for the testing and standardization of industrial products and consumer goods, in general, was then discussed, and a preliminary report drawn up.

7. Later, the Ministry of Industry felt that the centre should be more than a testing and standardization laboratory, and that it should meet the needs of Syrian industry.

8. Contacts were subsequently made with the United Nations Special Fund to explore the possibility of obtaining assistance from the Fund in establishing such a centre. The result was encouraging. United Nations experts were sent to the Syrian Arab Republic to collaborate with Syrian experts in the assessment of the project and the preparation of the request for assistance to be submitted to the United Nations Special Fund. In early 1964, the United Nations Special Fund agreed to participate in the project and later a plan of operation was drafted. Execution of the project will begin soon after the formal signature of the plan of operation by the parties concerned.

B. Details of the project

Objectives

9. The Industrial Testing and Research Centre will be established as an independent, non-profit institute, whose object is to serve Syrian industry by:

(a) Obtaining better quality in the items produced by industry through the establishment of suitable standards and specifications, and control of the products;

(b) Advising industry on how to obtain better-quality products and increased productivity, including assistance in installing testing facilities in the factories;

(c) Research and development work, particularly with a view to the use and utilization of local sources of materials;

(d) Training of technical personnel from universities, faculties, and from industry, in the activities of the Centre.

Location

10. The Centre will be situated in Damascus because of the amount of industry in the area and the close contact with official bureaux. The land selected is near

the airport, driving time from the centre [illegible] minutes. The buildings of the Centre are planned with [illegible] 8,000 square metres.

Organization

11. The Centre will be provided with suitable equipment for testing and development work in the industrial branches already established and in the [illegible] which it is expected will be established in the next few years. The Centre will include general and special laboratories. Its internal organization will be based on five sections:

(a) Information section, covering the preparation of standards and specifications, and technical information service;

(b) Chemical section, with facilities for chemical analysis and testing, and for research and development work;

(c) Mechanical-electrical section, with facilities for testing materials, prototypes of equipment and manufactured products, as well as instrumentation;

(d) Inspection section, with metrology, non-destructive inspection, inspection of production methods and safety precautions at the factories, and a workshop;

(e) Administration section, which, in addition to its normal functions, will be in charge of the hall for development work on a large laboratory scale.

Co-operation with universities and industry

12. On research, the Centre will co-operate with universities and institutes. In principle, basic research will be transferred to these institutions whenever they are equipped for the subject and able to undertake the investigation, as will applied research where it is expected to be of advantage. On the other hand, graduates and post-graduates will be given the opportunity for carrying out particular investigations at the Centre, where the Centre is better equipped than the other institutes and the ordinary work at the Centre is not thereby affected. Further, graduates from universities and faculties, as well as professional technical personnel from industry, will be invited to join the work at the Centre for a suitable period, both for their own experience and in order to establish a good contact with industry.

13. The services of the Centre will be available to everyone.

14. Duplication of equipment which is seldom in use will be avoided and agreements will be made with the other institutes on mutual utilization of such equipment.

Management

15. The management council of the Centre will be established as follows:

(a) Minister of Industry, Chairman;

(b) Secretary-General of the Ministry of Industry;

(c) Secretary-General of the Ministry of Planning;

(d) Secretary-General of the Ministry of Economics;

(e) The Rector of the University of Damascus or Aleppo, or the Dean of one of the science or engineering faculties;

(f) Four members appointed by the Chambers of Industry and Commerce.

The Director of the Centre and the project manager will attend the meetings of the management council, but with no voting right.

Financial responsibility

16. The financial responsibility for the running of the Centre will be the total responsibility of the Government, but the aims are that the Centre will eventually become a partially (at least) self-supporting, non-profit unit, through its charges to the users for its services and by the issuance of government-approved certificates.

Experts

17. The United Nations Special Fund will provide a number of experts, including the project manager. The task of these experts will be to assist in establishing testing and research activities within their individual fields of specialization.

Fellowships

18. There will be a number of fellowships, each with a duration of twelve months. Some of these fellowships will be sponsored by the United Nations Special Fund and others by the Syrian Arab Republic.

Staffing

19. The possibility of obtaining suitable staff for the Centre has been explored and found satisfactory.

Duration of the project - executing and co-operating agencies

20. The duration of the project is estimated to be five years. The executing agency will be UNESCO and the Ministry of Industry, Syrian Arab Republic, the government co-operating agency.

Participation and contribution of the United Nations Special Fund

21. This will be provided through the Executing Agency, UNESCO, and will consist of the following:

(a) A number of experts in various fields, as well as the project manager;

(b) Fellowships;

(c) Equipment and supplies;

(d) Miscellaneous services and facilities.

Participation and contribution of the Syrian Arab Republic Government

22. This will consist of:

(a) Contribution in kind:

(i) Personal services: management and professional and other staff

(ii) Fellowships;

(iii) Land and buildings;

(iv) Equipment which can be supplied by local purchase, office equipment, laboratory furniture and supplies, etc.;

(v) Cost of transportation, handling and installation of equipment;

(vi) Miscellaneous services and facilities.

(b) Contribution in cash:

(i) Contribution towards local operating costs (i.e., towards the cost of United Nations Special Fund experts);

(ii) A contribution towards the cost of foreign equipment.

C. Conclusion

23. It can be seen that the above-mentioned project is a sound one. Its execution will fill a gap in Syrian industry, by providing it with an institution which will greatly help in raising its standards and improving its productivity and, in the long run, is expected to create research consciousness among Syrian industrialists.

XXXVII. INDUSTRIAL RESEARCH IN LEBANON

Prepared by M.I. Attiyan*

1. Scientific research as an activity of national dimensions gained official attention in Lebanon only a few years ago, having formal expression in the Law of 14 September 1962, establishing the National Council for Scientific Research (NCSR).

2. Whatever research activity there was in Lebanon prior to that date had either arisen around the universities, contingent upon teaching and philosophical curiosity, or, on the national side, out of immediate needs of development in certain sectors of the economy. Thus, the establishment and organization of the latter was by definition that of an isolated activity designed to serve immediate and so-called practical ends. That is why among the most important tasks currently facing NCSR is the co-ordination of all national research activities in the country in a manner to eliminate duplication and establish complementarity.

3. Before the Second World War, national existence under the mandate was such that the need for organizing the research activities was not felt. Beirut had then been, for some quarter of a century, a city harbouring centres of higher learning, with two universities possessing faculties of science, medicine and, later, engineering. Graduates of sciences ended in a teaching career or in some unscientific occupation; those of medicine and engineering practiced their professions.

4. The country emerged from the Second World War with a newly gained independence. The task of facing the issues of organizing all sectors of national life was thus met in its entirety. Moreover, business during the war years had given rise to "mushroom" industries and had encouraged agricultural production. Thus, among the first, indeed urgent, tasks of national authority was to ensure that such production activity, in industry and agriculture, should be encouraged to survive in the normal conditions of peace.

5. The problem as concerns industry was formidable and its almost unmanageable dimensions began to be felt during the late 1940's and early 1950's, when world industrial production attained the export threshold. It was consequently quite painfully learned that industry founded in war-time was unfit to compete in the arena of world peace-time production.

6. Equipment was old and inefficient, operation unorganized, technical skill lacking, and managerial merit absent. Thus, production costs were prohibitive. This was at a time before the Government could work out a development plan. Suggestions were made, proposals formulated and ideas put forward and examined. One of these ideas was that industry needed technical aid. Hence, during 1952, with the advent of Point Four into Lebanon, the idea of providing Lebanese

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* Director, Institute of Industrial Research, Beirut.

industry with technical aid gained ground. [illegible] was signed among the Government, the [illegible] Mission to Lebanon and the Association of [illegible] what was, in effect, a technical aid and productivity centre, [illegible] the Industry Institute.

7. The Institute was a creation of an urgently felt, but poorly expressed, need. This was naturally reflected in its initial organization and plan of action. Consequently, right from the start of its existence it became an experimentation ground to discern the needs of industry and industrial development in exact terms and to adjust its organization and services to answer them, if not entirely, at least significantly. After about only three years, it was manifest that technical aid to industry does need, to be effective, more than good intentions and the willingness to serve in the agency administering it. This implied, it was realized, a corps of fully qualified professional engineers and scientists with means at their disposal to investigate, measure and do research into problems and situations. A phase was started in the Institute's metamorphosis in 1957; it lasted five years and converted it, in effect, in 1962 into an Institute of Industrial Research.

8. This is the story of the establishment of industrial research in Lebanon. Its beginnings originated in a limited purpose and a vaguely conceived need. It grew to its present stature through trial and error. Perhaps herein lies the merit of its present organization - it is practical, being fully adjustable to fresh situations and needs.

9. It is to be remembered that all this came to pass in this peculiar manner because Lebanon has not, until very recently, thought industrially or scientifically - the fashion was, and perhaps still is, to think in terms of large economic parameters.

10. Therefore, it would be quite correct to state that the organization of industrial research in Lebanon currently hinges on one point: the Institute of Industrial Research. Perhaps this centralization of research bears more advantages than disadvantages, as it has behind it a rich experience and possesses the potential to undertake whatever expanded programme national planning might indicate or require. The Institute is designed and organized in a manner to enable it to practise six main activities:

(a) Techno-economic feasibility studies of new industry including raw materials suitability investigations;

(b) Testing, calibration and standardization;

(c) Design of industrial plants and specialized consulting engineering;

(d) Operations and management of industrial plants;

(e) Technical aid to existing industry;

(f) Applied scientific research of basic and long-term interest to industrial development.

11. In the first three of these activities, the Institute has registered quite remarkable achievements not only in Lebanon but in the Arab regions of the vicinity. Some 100 major industrial feasibility studies have been done in the last six years. A national system of standardization was designed for Lebanon and is now legally instituted and, practically, executed by the Institute. Physical, chemical materials, electrical, soils and metallurgical testing facilities are fully utilized by public and private sectors and are in a steady process of growth. Specialized large projects using consulting engineering services, like grain silos, city water systems, soil foundation studies, ceramics manufacture, liquid petroleum gas bottling and distribution, flour milling, vegetable oils and soaps, are but some examples of projects fully worked out by Institute groups of specialists.

12. In the last three of the Institute's fields of activity, achievement has been modest and sometimes, as in the case of management and operation, quite disappointing. Experience has revealed that in this sector financial conditions and size of the average industry unit, as well as the over-all technical and business atmosphere, are not conducive to the advancement of modern management ideas. After all, most of industry is small or medium-sized, and it is thought that a technical aid programme fully paid for by the State would, among other certain benefits, be an effective means of introducing modern management and operations techniques. A proposal has been put forward, framed by United Nations experts, for the establishment of a small industries institute, which would, together with a programme of technical training and marketing services, sponsor at the Institute for Industrial Research a technical aid programme to industry.

13. With the establishment of NCSR, the applied research activity was intended to be greatly expanded and enhanced, such research being of basic character to industrial development on processes, materials and products.

14. The tentative conclusion has been reached that sponsored research in a country like Lebanon could not be an efficient means of transmitting modern industrial know-how to the main body of industry in the country. Some combination of a technical aid programme to small industry and an applied scientific research programme, both completely paid for either by the State or by the State and industry on a compulsory subscription basis, seems to be the most effective means of transmitting the benefits which a well-organized industrial research unit could give to national industry. Feasibility studies, testing and calibration, as well as specialized industrial consulting engineering, could be made to run on a sponsored basis.

15. Internally, the Institute for Industrial Research is organized into two research departments and one department of finance and administrative affairs. The heads of departments are the first assistants of the Director. The research departments are: (a) the department of technology and engineering; and (b) the department of economics and management. The first is currently by far the more important. This department is organized into divisions, and the divisions into units of research.

XXXVIII. ORGANIZATION OF INDUSTRIAL RESEARCH AND DEVELOPMENT IN NIGERIA

Prepared by C. Ezeji-Okoye*

Introduction

1. Development of applied research has followed the same decentralized pattern in Nigeria as in other countries of the British Commonwealth with an agrarian economy.

2. Since produce emanates from small holdings rather than from plantations, the primary function of the first group of Government-owned institutes is to maintain a suitable quality for export. Thus, for produce controlled by the Marketing Boards, e.g. cotton lint, palm oil and cocoa, separate institutes located near the raw materials carry out research and routine testing. 1/

3. A second group of institutes directs its activities to improvement of products for home consumption; thus, there are institutes for the production of animal and human vaccines.

4. A third group may be called that of service institutes, whose functions were only recently defined and expanded to include applied research and development. In this category may be included the Fisheries Research Service and Forest Products Research.

5. The tempo of industrial activity during the pre-independence period of internal self-rule (1952-1960) brought about the establishment of an Institute of Applied Technical Research, following the recommendation of the Mission sent by the International Bank for Reconstruction and Development (IBRD) in 1953.

6. There is currently a strong feeling for the co-ordination of research and development activities in Nigeria, and discussions are being held to this end.

A. Research policy

7. There is currently no central research policy. A Statement on Industrial Policy, published in 1964 by the federal Government, lays emphasis on the establishment of industries based on raw materials available locally. The difficulty may be appreciated by examining the political situation. Nigeria is a federation of four governments, each autonomous in all aspects except defence and foreign policy. Each of the governments, therefore, is responsible for all of its domestic research and development programmes, sometimes in competition, but nevertheless conducive to an over-all progress.

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* Ministry of Commerce and Industry, Lagos.

1/ The Institute for Stored Products Research also has branches located at ports.

8. In addition to this situation, Nigeria has been fortunate in having five autonomous universities in recent times, with facilities for both basic and applied research. Recent developments in the field of nutrition at the University of Ibadan, and in industrial engineering at the University of Nsukka are significant.

9. Development policies of the regional governments, as with the Government of the Federation, are carried out mainly by the Ministries of Trade 2/ and Industry, and of Economic Development. The federal Government is the sole authority for immigration, fiscal incentives and registration of business.

B. Regional government operations

10. Each of the regional governments has a development corporation and, in certain cases, an additional credit or finance corporation for directing entry or participation in projects previously examined by their own experts. Feasibility studies, documentation and technical information are primarily the function of the Ministry of Trade, although some of the functions may overlap. The development corporations have attracted industries to their respective regions and also financed such industries as a multipurpose leather works factory, and factories producing glass, furniture,cement and textiles.

C. The Federal Institute of Industrial Research

11. On the federal level, as stated earlier, the Ministry of Commerce and Industry carries out the functions of industrial promotion, feasibility studies, documentation, technical information, projects appraisal, industrial extension service, administration of fiscal incentives and investigation of applications for loans to indigenous entrepreneurs. In addition, the Ministry has responsibility for the Federal Institute of Industrial Research, which is a successor to the Institute of Applied Technical Research.

12. A nucleus of overseas consultants, an industrial adviser and an under-staffed indigenous unit receive overseas visitors and maintain a skeletal service. However, it is apparent that as the Institute of Industrial Research progresses, so will its share of responsibility in relieving the Ministry of some of its present functions. This is particularly the case in industrial extension and pilot-plant studies which are described below.

13. The Federal Institute of Industrial Research was established in 1956, and its functions are more exactly defined as follows: 3/

(a) To carry out basic research into the raw materials available in Nigeria for use in industry, and the processes which can be used most effectively to convert them;

2/ In Eastern Nigeria, the title is Ministry of Commerce. At the federal level, it is the Ministry of Commerce and Industry.

3/ Annual Report of the Federal Department of Commerce and Industries 1956/57 (Federal Government Printer, Lagos, 1958).

(b) To carry out pilot scale trials of processes found [illegible] to be technically feasible;

(c) To calculate by means of larger scale tests or otherwise the [illegible] viability of such processes if established on a commercial scale.

Financial provision and site development

14. Provision totalling £260,000 ($US728,000) was made for building and equipping the Institute. The recurrent expenditure, mainly for salaries, has since increased from £64,680 in 1956/57 to £87,640 during 1963/64. No grants have so far been made for specific projects of national importance. Revenue is small: about £722 was realized in 1963 from "fees for testing of samples and sale of furniture".

15. There are four main buildings on the 22-acre plot (an administrative block, two laboratory blocks, and one mechanical workshop); site development, as initially planned, has now been completed.

Research and development at the Federal Institute[4]

16. Successful laboratory research has been carried out in the preservation of palm wine, retting and carding of coir fibre, production of desiccated coconut, fish drying, gari processing and cashew apple wine. In the case of palm wine and coir fibre, factory-scale production has since been attained by commercial enterprises. The heat exchanger used for pilot scale trials on fish drying has been installed in another area where its economics is being studied by the Fisheries Division of Eastern Nigeria.

17. Interest has been expressed by a commercial firm in the development of the mechanized gari plant. Negotiations are in progress for a loan of this experimental plant, which has a capacity of one ton per day. During the period of the loan, scientists from the Institute will have access to study its economics and to carry out any extension work required.

18. Other studies on which some progress has been made include pulp and paper from local timber and guinea corn stalks, protein fortification of starchy foods by the utilization of soy-bean flour, production of domestic hot water by solar energy and ceramics.

19. Tests and analyses have recently been carried out on a variety of samples and products, including silt, locally made orange squash, crude salt and poultry feed. The Institute keeps a library of 3,365 volumes, and operates a photocopy service. Close liaison is maintained with such overseas establishments as the Tropical Products Institute in London, and with local scientific associations.

4/ For further information, see Annual Report of the Federal Institute of Industrial Research 1963/64, published by Federal Ministry of Commerce and Industry.

D. Timber utilization research

20. The Federal Department of Forestry Research, formally concerned with basic research and silviculture, now operates a division for timber utilization research. This is a welcome development for the furniture industry. Some of the functions of the new division are as follows:

(a) To find uses for timber species, other than the better-known varieties, which are growing to acceptable sizes and quantities, but are not being commercially exploited;

(b) To demonstrate timbers that can be successfully used for specific purposes in lieu of species that may fetch better prices when not so utilized;

(c) To carry out feasibility studies of a number of timber- and wood-using industries for the benefit of entrepreneurs who may wish to establish such industries;

(d) To encourage silviculture in the light of results of applied research and development in the field of forestry.

21. This division already has established considerable contact with the wood-using industries in Nigeria and has not only examined the possibility of an extension service in the seasoning of wood, but has also answered a number of overseas inquiries on the peeling properties of Nigerian wood. Close liaison is maintained with the Federal Ministry of Commerce and Industry on all matters dealing with the exploitation and utilization of forest products.

E. Fisheries development

22. Another aspect of independent development is in the field of fisheries, where licensing of trawlers is now undertaken and positive steps are being taken to promote the establishment of fish markets and fish-based industries. The Fisheries Research Service still carries out basic research and was associated with interests of the United States of America in a recent project.

F. Conclusion

23. In spite of a modest beginning only eight years ago and a continuous change in the directorship, combined with the lack of trained scientific personnel, the impact of the Federal Institute is being felt by Nigerian industry. There is a growing awareness to the need for establishing a national standards organization.

24. Lack of co-ordination for research and industrial development programmes may lead to duplication of efforts and the waste of both funds and specialist personnel; also, there could be a divergence of goals.

25. An answer to the Nigerian situation might be found in the establishment of a national research council. The council would be responsible for policy and direction, while an administrative body with technical personnel would effect the desired co-ordination. Discussions to this end are now progressing.

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