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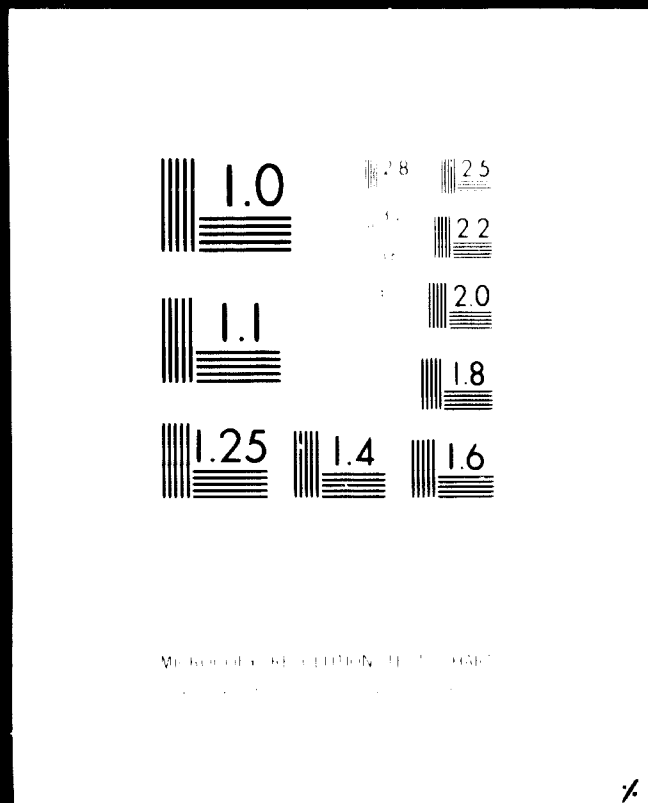
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TRANSFER AND DEVELOPMENT OF TECHNOLOGY ^{1/}

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1. INTRODUCTION

1.1 The process of industrialization has been recognized by developing countries as a vital requirement in the improvement of their economies. Since the population of most developing countries are predominantly rural in character, the basic economies of these countries have been traditionally agricultural, and national planning has tended to lay more emphasis on agricultural expansion. In recent times, however, it has been appreciated that, to achieve balanced and speedy advancement, sound industrialization should proceed concurrently with agricultural expansion. This position is now clearly reflected in the development planning programmes of developing countries, and Ghana is an example of this. Ghana has embarked on programmes of industrialization, the two main areas of emphasis being the production of import substitutes, and the manufacture of products for export.

1.2 Industrialization depends to a large measure on technology. Technology is an essential input to production, and is bought and sold on the world market. Technology can be viewed as a commodity embodied in capital and intermediate goods, in highly skilled manpower, and in blueprints, process formulae and other kinds of proprietary and non-proprietary information.

1.3 The world's store of technology is enormous. This is mainly held in the industrially advanced countries where, with the better supplies of scientific and technical manpower as well as capital, the great bulk of scientific and technological research and development has been and is still conducted.

1.4 Technological requirements for development in developing countries such as Ghana may be broadly categorized as:-

- (i) technology needed to appraise, design and construct projects
- (ii) technology needed to operate projects and to market their outputs

- (III) technology needed to keep projects from becoming obsolete because of world-wide technical progress.

2. TRANSFER OF TECHNOLOGY - OBJECTIVES

2.1 The present and probable future scale of the transfer of technology from the developed to the developing countries suggest that the latter should formulate policies to ensure that imported technology makes the maximum contribution to their technical progress and economic development. The objectives to be aimed at in the transfer of technology are:-

- (I) to improve the process of acquisition of foreign technology
- (II) to improve the national capacity for absorption and adaptation of technology at all levels and sectors
- (III) to encourage innovation
- (IV) to promote the development of indigenous technology.

2.2 It would also be beneficial to set down criteria that would be required in licensing agreements covering technology transfer; criteria such as:-

- (I) the appropriateness or suitability of the technology for utilization in the country, having regard to the socio-economic conditions prevailing in the country as well as the possible impact of the technology on the local environment
- (II) the absence or considerable reduction of restrictions on the licensee's market.

3. TRANSFER OF TECHNOLOGY - THE PROCESS

The technology transfer and development process involves the following interlinked activities:-

- (i) Identification of technological needs in the light of development objectives

- (ii) acquisition of information on alternative sources of information, including local sources
- (iii) evaluation and selection of the most appropriate technology
- (iv) unpackaging of technology packages in order to assess the suitability, costs and conditions of their components
- (v) negotiation of the best possible terms and conditions
- (vi) adaptation and absorption of imported technology
- (vii) stimulation of the development of indigenous technology
- (viii) dissemination of newly available technology to potential users.

4. RESEARCH FOR INDUSTRY IN GHANA

4.1 The general set-up of industry in Ghana consists of three categories, namely, State-owned companies, joint State and Private owned companies, and purely private companies. An analysis of that section of Ghana industry dealing with food, garments, electricals, timber, chemicals, cosmetics and plastics, shows the following figures:-

- (i) employing more than 1000 people 5
- (ii) employing between 500 and 1000 people 9
- (iii) employing between 100 and 500 people 47
- (iv) employing between 50 and 100 people 58

Although these figures do not include industries such as textile, metals and construction, they serve to illustrate the relatively small size of present Ghanaian enterprises.

4.2 The main central organization for applied scientific and technological research in Ghana is the Council for Scientific and Industrial Research.

It is a government institution responsible for the overall administration of

several Research Institutes. The Council is responsible to Government through the Ministry of Economic Planning. Four of the Research Institutes operating under the Council are involved in research and technical service to industry. Three of these are specialized institutes which concentrate on special areas, industries, or developmental needs. These are the Forest Products Research Institute, Building and Road Research Institute, and Food Research Institute. The fourth institute, the Industrial Research Institute is a multi-purpose institute, covering broad spectra of industry and national development.

4.3 Scientific and Technological research is also conducted in universities, some government technical departments and to a much lesser extent in private industry.

5. INDUSTRIAL RESEARCH INSTITUTE

5.1 This Institute was conceived as a multi-purpose institute to cater for all types of industry other than those dealt with by the three specialized institutes. Its aims include:-

- (i) the development of technologies suited to local needs and conditions
- (ii) the provision of technical services to industry.

5.2 Scope of Services of Institute. The following is a listing of the scope of services both present and planned:-

5.2.1 Feasibility studies. These are necessary for the following purposes:

- (i) sound investment decisions
- (ii) pre-requisites for applications for loans

5.2.2 Market Research. Investigation of demand for new products as well as existing products on the market; identification of projects

and markets for products

- 5.2.3 Utilization of Local Raw Materials. Advice on properties, availability and utilization of local raw materials
- 5.2.4 Consultancy to Industry. Advice on production techniques, solution of industrial problems peculiar to particular industries, trouble-shooting.
- 5.2.5 Project Evaluation and Review. Evaluation and review of technical and economic reports on industrial projects.
- 5.2.6 Design. Advice on industrial plant designs and layout
- 5.2.7 Productivity Studies. Technical assessment of factors making for increased productivity in industry.

5.3 The Institute is relatively small in size at present. Total staff is 75 of whom 20 are professional. It is planned to at least double this number in the near future. Current annual operating budget is slightly below one-half million dollars. The Institute is in the process of expansion in physical facilities. Development budget for this expansion is currently slightly above one-half million dollars. The present total budget for the Institute is therefore one million dollars.

5.4 Operational Divisions. The Institute at present has four operational divisions, namely, Industrial Chemistry, Materials, Electrical and Electronics, and Techno-Economic. The following brief notes give an indication of the type of projects and activities undertaken in these divisions:-

5.4.1 Industrial Chemistry.

- (a) Investigation of Methods and Problems in the manufacture of industrial starch and related products.

The process involves the conversion of cassava to industrial starch for use in the textile, paper, and pharmaceutical industries.

In addition techniques for production of liquid glucose for confectionery industries will be developed.

(b) Extraction of Perfumes and Essences from local plants for use in industry

In this project, perfumes and essences from various plants will be extracted and characterised. The products will then be developed for industrial use.

(a) Extraction of Iron from local ore using local raw materials

The process involves the use of local oyster shells and charcoal in substitution for imported limestone and coke for the reduction of local iron ore using a specially designed furnace.

(d) Extraction and Characterization of Medicinal Compounds from Ghana Herbs

The project involves the isolation and identification of medicinal compounds from Ghanaian plants.

5.4.2 Materials

(a) Study of local clay materials

Study of the properties of local clay materials and their potential for use in local industry, particularly refractories for the heat-using industries such as goldfields, glass works, and iron and steel works.

(b) Investigation of the use of local rocks and minerals in the production of abrasives

This involves the selection of suitable rocks, minerals and other local raw materials such as fused alumina from bauxite and the development of bonding materials and techniques.

(c) Manufacture of Chalk

The aim in this project is to help existing industries to use different local raw materials in the manufacture of chalk, in substitution for imported raw materials.

5.4.3 Electrical and Electronics

(a) As a technical service, there is a regular electronics workshop which maintains and repairs electronic and electrical instruments and equipment. In the process it is assembling data on the history and nature of breakdowns of components of electronic equipment. The workshop will also undertake the design and construction of cheap but efficient incubators for local farmers.

(b) Study of Effects of Environmental Conditions on Electronic Equipment and Components

This involves a study of component and equipment breakdown in relation to local temperature and humidity.

5.4.4 Techno-Economic

(a) Earnings and Output in 67 manufacturing establishments (1971 and 1972)(b) Study of local raw material utilization in Ghanaian industry

5.5 Engineering Workshop: A full-scale engineering workshop is in course of construction, consisting of Machine Shop, Electrical workshop, Welding Shop, Blacksmith Shop, Sample Store, Equipment Store and offices for engineer and technician staff. This will provide support services for the operations of all the divisions of the Institute, and will be a useful complement for pilot plant operations.

5.6 Pilot Plant Operations. Initial steps have been taken towards the planning,

design and construction of a general-purpose pilot plant building with standard fittings for pilot plant operations.

6. PROBLEMS ASSOCIATED WITH EXECUTION OF RESEARCH

6.1 Three main problems have been encountered in the execution of research and have tended to inhibit the evolution of technology for development. These are problems of finance, manpower and equipment.

6.2 Finance is the most dominant, and has an impact on all the other problems. The usual sources of finance are government and industry. In the circumstances of developing countries, most of which are virtually at the initial stages of industrialization, industrial and technological research cannot expect much financing from industry. Governments, therefore, should accept the responsibility of providing adequate financial support on a long-term basis to their applied scientific and technological institutions so as to ensure continuity in their work and thus enable them to fulfill their objectives. Investment in technological research is a sound and wise investment for development, and indeed in the future of the nation.

6.3 With regard to manpower, technological research and development institutions need to be staffed with the most highly qualified personnel at all levels. These institutions cannot function successfully with staff inferior to those of the enterprises they are called upon to guide. Skilled manpower is in short supply. As an example, several universities in Africa are still not training Chemical Engineers. Good graduates in pure Chemistry are being produced; but, since industry is not developed to the level to provide these graduates with the required post-graduate industrial training and exposure, they remain good Chemists. In the Ghana situation, as is common in developing countries, skilled manpower is needed for both the adaptation of imported technologies and the development of local technologies. To keep the correct balance in these institutions it is also

wise to employ not only scientists and engineers to do technical development, but also social scientists to analyse costs and markets and to find appropriate means of selling the research and development outputs.

6.4 A number of steps are usually taken towards solving the problem posed by manpower shortage. These include accelerated training programmes for indigenous personnel and the importation of qualified foreign staff. In the importation of foreign staff, difficulties are sometimes experienced in obtaining experts of the type and with the qualifications and experience required, or in obtaining them within a reasonable time to meet the demands of the development programme. Direct recruitment in this regard is hampered further by reason of unattractive remuneration and other service conditions. Several schemes of bilateral and international technical assistance have been launched with varying degrees of success. In these schemes emphasis has been laid on assistance in the initial organizational stages, counterpart training, and the provision of individual specialists for specific work. The great value of external technical aid is appreciated. It should however be recognized that external technical aid can nevertheless not be a substitute for the development of local staff. Serious attention should therefore be paid to training programmes both internal and external for indigenous personnel. Such training programmes are of extreme importance and should be strengthened where necessary.

6.5 Problems of equipment are those of finance, procedural delays associated with purchase, selection of the right type of equipment, adaptation of equipment and local instrumentation and improvisation. In the equipping of laboratories and the setting-up of facilities for research and development, it is also necessary to include adequate repair and maintenance facilities, workshops and skilled technicians. These pose additional problems of

availability of spares both in quantity and in time. The experience of similar research institutions in countries with reasonably similar industrial conditions can be useful in solving some of the selection and adaptation problems connected with laboratory equipment and facilities. The proven benefits of standardizing in plant and machinery can also be brought to play on the problems of variety and availability of spares.

6.6 A real problem however exists in various laboratories with regard to the maintenance, repair and replacement of scientific equipment. This is due to two main reasons: the difficulty of obtaining spare parts quickly due to shortage of foreign exchange and the paucity of instrument technicians. Serious attention is therefore invited to the need for local improvisation. The habit of pursuing the "line of least-resistance" by studying all available manufacturers' brochures or shopping all round the manufacturing world in order to select and purchase even the simplest requirement in laboratory equipment needs to be drastically modified.

6.7 There is indeed an urgent need for the strengthening of the technological capabilities of most developing countries. It is difficult for a country that does not itself possess a national technological capability in terms of trained personnel and equipment, to know what usable technology exists elsewhere, to understand it, to adapt it to the country's special needs and peculiar conditions, or even to operate, maintain and repair the necessary equipment.

6.8 There is also the need for international assistance to developing countries in recruiting leading scientists and technologists to train men and women in their own home environment, and so contribute to the production of trained people capable of handling their own problems.

7. COOPERATION AMONG RESEARCH INSTITUTIONS

7.1 Many problems requiring solution through the application of technology are of common interest to several developing countries with ecological homogeneity, and therefore lend themselves to solution on inter-country basis. Developing countries will therefore find that it is very much in their interest to make determined efforts to institute inter-country cooperative measures and programmes in the application of science and technology to development.

7.2 Closely linked with this is the need for cooperation in the provision of facilities for training scientific and technological personnel. Developing countries generally have limited resources, particularly with regard to training facilities. Among themselves, some countries are in a relatively better position as far as training possibilities in certain fields are concerned. It is therefore suggested that countries which possess training experience and facilities in certain fields, be these at professional or sub-professional level, make their facilities available to other countries wishing to make use of them. This would also strengthen the programmes of linkages among technological institutions in developing countries.

7.3 The World Association of Industrial and Technological Research Organizations (WAITRO), of which many institutions in developing countries and several in advanced countries which conduct or promote industrial research and technical services are members, has the following aims:

- (i) to facilitate the exchange of ideas, information and experience among members
- (ii) to advance the technical and managerial capabilities of members

- (iii) to encourage and support cooperation and coordination at regional and international levels in technological research and its industrial application.

WAITRO has an active programme by which it promotes linkages between research institutions in developing countries and similar ones in advanced countries. Such cooperation and linkages assist in upgrading the technological capability of the institution in the developing country.

8. NEED FOR EFFECTIVE TRANSFER BETWEEN DEVELOPING COUNTRIES

8.1 The developing nations of the world are at different stages of industrial development. As a result of differences in levels of finance, national development priorities, and the effects of the policies of former colonial powers, there is quite a variety in the form and status of science and technology in the developing countries and in its application to development in these countries. Some countries have achieved quite a respectable situation in institutionalized science and technology in the form of universities, indigenous research organizations and technical training centres, while others are in the process of establishing such institutions. Some have fairly well-defined science policies, while others are considering the formulation of such policies. The existence of Councils of Scientific and Industrial Research and similar bodies is a reflection of this situation.

8.2 In view of this there are differences in the stages of R and D activity leading to different levels of accumulation of research results and technology both local and imported. Furthermore, some have developed useful techniques of scientific appreciation, while others have limited experience in the acquisition and diffusion of foreign technology.

8.3 When this situation is viewed in relation to the general similarities in

climatic conditions, raw material characteristics, labour supply, and capital availability which exist in the developing countries, it becomes clear that an effective system of inter-change of technological experiences between developing countries would be most beneficial for economic development in these countries.

The results of technological research and activity in one country would be of direct pertinence to the needs of another country.

9. AREAS OF JOINTRESEARCH

The following are areas in which joint research can be fruitfully conducted:-

- (i) non-conventional sources of energy for farms - e.g. Biogas
- (ii) solar energy
- (iii) uses of wind power
- (iv) improved exploitation methods for low-grade ores
- (v) use of local plants in pharmaceuticals
- (vi) use of local materials in building
- (vii) small self-contained power sources.

10. CONCLUSIONS

10.1 The vital basic requirement for success in the development and transfer of technology is the existence of an effective national technological capability. The greatest need, therefore, is for all efforts to be made both by national governments as well as international organizations to strengthen the technological capabilities of developing countries.

10.2 A technological base is made up of men and machines. Action towards strengthening this base, therefore, has to be taken in two directions, namely, training of technical manpower and the provision of laboratory and workshop facilities including equipment.

10.3 Developing countries should establish links between the science and technology bodies in their countries where such links do not already exist, or strengthen such links where they exist. This will facilitate the transfer of technology among themselves, and thus reduce their dependence on the developed countries for technology.

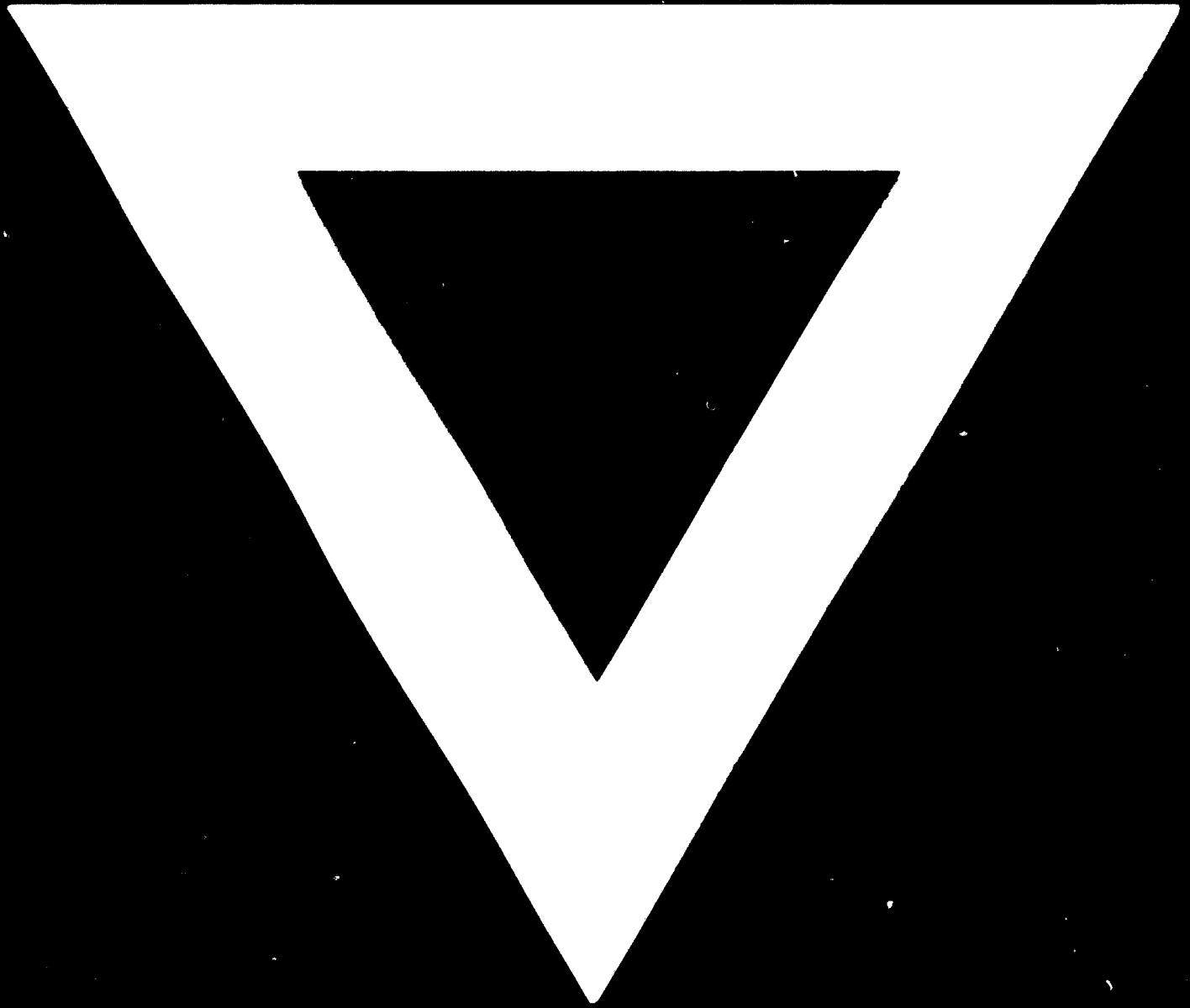
10.4 In programmes of international assistance to developing countries, due attention should be paid to:

- (i) recruitment of leading scientists and technologists to train men and women in their own home environment
- (ii) promotion of linkages between technological institutions in developing countries and similar ones in advanced countries.

10.5 Patent system is an effective instrument in the transfer of technology. Support should therefore be given to the efforts of the United Nations Conference on Trade and Development (UNCTAD) and the World Intellectual Property Organization (WIPO) to revise and improve on the international industrial property system.



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