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**RESEARCH INTERESTS OF FOREIGN ASSISTANCE
AGENCIES CONCERNING APPROPRIATE TECHNOLOGY**

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RESEARCH INTERESTS OF FOREIGN ASSISTANCE AGENCIES
CONCERNING APPROPRIATE TECHNOLOGY

Origins of Current Interest in Relating Technology to
Factor Endowments

During the past several years there has been a sharp increase in interest of the development community in the relationship between the types of technology that are introduced in developing countries and priority development objectives, such as increased employment opportunities, improved income distribution, and more efficient use of locally available materials. For some development practitioners the notion that borrowed technologies are often inconsistent with the factor endowments of developing countries comes as a new revelation; others welcome this revival of long-held views that instant industries, western style, can result in harmful secondary effects.

For the technologists, the World Plan of Action for the Application of Science and Technology to Development, together with the supporting documents prepared by UNIDO, represented a major breakthrough in the level of sophistication of thinking about technology transfer and the relationship between technical change and social and economic factors.^{1/} This step was reinforced by inclusion for the first time of a solid discussion of science and technology in the 1971 annual report on development assistance prepared by the Organization for Economic Cooperation and Development (OECD).^{2/}

The development economists have discovered in the phrase "science and technology" a new peg for their employment concerns and a ready source of funds within

1/ See particularly Chapters VI and X of the World Plan of Action for the Application of Science and Technology to Development, United Nations, New York, 1971, and the related document Appropriate Technology and Research for Industrial Development, Report of the Advisory Committee on the Application of Science and Technology to Development, New York, 1972.

2/ Chapter VII of Development Assistance, Organization for Economic Cooperation and Development, Paris, December 1971.

foundations and development agencies to pursue studies concerning technology transfer and technological innovation.

For many years agriculturalists have been pleading for machinery better suited to the manpower situation in rural areas. The new debate has spotlighted a number of their experimental programs in this direction.

Recently, under the stimulation of the UNCTAD conferences and concurrent pressures from Latin American countries at a number of other international forums, multinational corporations have been reassessing their approach to technology adaptation. Developments such as the Ford Fiera have begun to merge with broader conceptual approaches in the development community.

Finally, advocates of village technology are now being heard. They have long argued that the usefulness of equipment is directly related to simplicity of design and operation.

Differing Perspectives on Technology Adaptation

The economists have mobilized behind the expression "labor intensive technology" as a principal concern within development circles. They have even begun to count the number of employees in different types of plants producing the same types of goods in building their case.

The technologists are less enamored with this phrase, and many argue that "capital saving technology" represents a far better conceptual and practical approach to industrialization in developing countries.

Meanwhile, the village oriented specialist discusses "intermediate technology" which usually refers to simple and primitive techniques that may have been passed over by developed countries many years ago.

Rather than stumbling on words, the phrase "appropriate technology" seems best suited to the problem. It can be defined simply as technology which is as responsive as possible to the capital, manpower, natural resource, institutional, and social realities of a particular developing country environment.

Overview of Recent Activities

The activities of foreign assistance agencies are many and varied in this field. Most of these efforts are not deliberately designed to capitalize on factor endowments. However, in project implementation they interact very directly with the concept of appropriate technology.

This presentation is limited to highlighting some of the most interesting current approaches, of development agencies, emphasizing "what's new" in the field. The discussion will be limited to engineering technologies, and more specifically, manufacturing technologies and technologies related to construction and operation of economic infrastructure activities, such as transportation, communication, water resource development, power, roads, buildings, and housing. Analytical efforts as well as laboratory research efforts supported by assistance agencies are described, recognizing that laboratory research often includes a substantial analytical component.

A wide variety of traditional development activities, closely related to research, are not considered, even though these activities may often be the decisive determinants of the success of foreign assistance in influencing the direction of industrial growth. These omissions include such activities as training of developing country engineers and technicians,^{1/} minor adaptation of standard engineering techniques for large construction projects, and industrial supporting services, such as industrial standards and quality control, testing and measurement laboratories, and technical information.

Last year OECD began to survey the activities of the bilateral donors in selected areas of science and technology, including adaptation of industrial technologies. These efforts are currently in mid-stream and will probably continue for several years. In addition to surveying the general field of industrial research, specialized studies have been initiated in utilization

^{1/} The importance of training should not be underestimated. For example, there are more than 12,000 developing country engineers enrolled in U.S. graduate schools.

of tropical forests, building and engineering construction, and non-food uses of agricultural products including fibers, and are being considered in processing and preservation of food products and industrial uses of non-agricultural natural resources. The principal objective of this activity is to identify high priority research gaps in the kaleidoscope of foreign assistance efforts and then to stimulate action to fill these gaps.

With regard to analytical efforts of other organizations, UNIDO has clearly led the way for several years. The principal techniques have been seminars in Vienna and elsewhere on many aspects of industrial technology, and survey missions to assess specific technologies in particular country settings. Indeed it is difficult to identify a single aspect of the industrialization process that is not covered in a series of UNIDO reports. As two specific examples, a recent UNIDO seminar report "Production of Panels from Agricultural Residues" and a consultant report "The Use of Bamboo and Reeds in Building Construction" lay out a series of steps, including research priorities, which interested organizations might follow in these field. With regard to broader economic questions, the five-year old report "General Issues of Industrial Policy" was an early effort followed by a series of reports directed to far ranging policy consideration.

A.I.D. has launched its share of analytical efforts in recent years. The employment oriented program at Yale is well known. This program involves both country studies and sectoral studies on employment problems related to transfer of technology, choice of technology, capital markets, and other areas.^{1/} A new program with a somewhat broader technological base is now underway at the National Academy of Sciences, involving bilateral workshops on industrial research (India, Indonesia, Brazil), conceptual studies of the suitability of technology, and specialized technical studies (ferro-cement, solar energy, power sources). Denver Research Institute has recently completed the first phase of a wide-ranging

^{1/} Two recent studies concerning appropriate technology prepared under the Yale program are included in Technology and Economics in International Development, Report of a Seminar, Agency for International Development, Washington, D.C., May 1972.

analysis of the strengths and weaknesses of industrial research institutes in developing countries. Finally, Arthur D. Little is analyzing opportunities for reducing costs and increasing use of local materials in the public works sector in Colombia and the Philippines.

Recently the World Bank entered the research arena in a serious manner with its well publicized studies of road building techniques. The Highway Design study investigates the economic costs of East and West African highways built to a variety of design standards. The Labor-Capital Substitution study analyzes the Indian construction industry to uncover uses of labor-intensive technologies in constructing highways of a particular design standard. Other Bank research involves forecasts of markets for electronic components assembled in developing countries, markets for synthetic competitors of natural products, and alternatives to the automobile.

The International Labor Organization is of course continuing its case studies of capital/labor tradeoffs in selected countries, and is considering studies of employment effects of technological change in specific sectors. The Organization of American States is launching a major experimental effort to identify technologies particularly well suited to Latin American industrial needs. UNITAR has completed its series of technology transfer studies (UNITAR Research Reports 7, 8, 10, 11, 12, 14), while the UN Economic Commissions and associated research institutes have begun modest efforts, principally seminars. The British have also recently initiated several analytical efforts. The University of Strathclyde is examining technological choices in the shoemaking, textile, and sugar industries of Ghana and Ethiopia. At Oxford studies are underway analyzing the economic rationale for appropriate technology, and particularly the necessity to conserve management and technical skills in addition to capital.

Support of Developing Country Research Institutes

UNIDO and A.I.D., and to a far lesser extent several other donors, have for some years provided assistance to many of the several hundred industrial research institutes in developing countries, in addition to training opportunities provided by almost all donors.

At present UNIDO has 29 projects which have been approved or are under action consideration targeted on

these institutes, with 13 of the projects exceeding \$100,000 and involving equipment, advisers, and training (e.g. Colombia, Israel, Libya, Malaysia, Paraguay, the Sudan, Thailand, Trinidad and Tobago). UNIDO's stated objectives are directed to (1) reviewing national plans and organizations for streamlining existing structures for industrial research, and (2) strengthening national organizations that can assist in introducing appropriate technology, design processes that utilize local raw materials, and supply services to local industry.^{1/}

A.I.D.'s efforts initially were directed to broad financial support of selected institutes with the largest undertaking being the Korea Institute of Science and Technology, a \$25 million A.I.D. investment.^{2/} More recently A.I.D. support has been for specific projects sited at these institutes, e.g., agriculture vehicles at IRRI, milling machines at the East African Industrial Research Organization, and road construction techniques in laterite soils at the Ghana Building and Road Research Institute. Now the A.I.D. emphasis is on projects designed specifically to couple the institutes more closely with industry, e.g., strengthening the local food industry through collaborative efforts with the Central American Technological Research Institute.

Judging from the information available through the OECD survey and from recent personal visits, the British, Swiss, and Dutch also support research activities at industrial research institutes in developing countries. The British have traditionally provided advisors and training opportunities to building, road, forestry, and other types of research institutions in Ghana, Nigeria, and Kenya. The Dutch efforts are largely on a small-scale, ad hoc basis, but there are major efforts involving two food laboratories in Saudi Arabia and the fish processing station in Nyegazi, Tanzania. The Swiss support the nutrition institute in Recife, Brazil.

1/ Program of Work for 1973, Part Two, Addendum 1, Industrial Development Board, May 23 - Jan 2, 1972, UNIDO.

2/ Report on Battelle's Assistance to the Korea Institute of Science and Technology, 1966-1971. Battelle Memorial Institute, Columbus, Ohio, June 30, 1971.

The most recent entrant into the field is the Inter-American Development Bank which is in the process of providing major financial assistance to technological research institutions in Brazil, with possible follow-on efforts in other parts of Latin America.

Support of Technological Research at Developing Country Universities

Foreign assistance agencies have supported many research activities at developing country universities, but unfortunately far too little of this effort has been reflected in the economic activity of the country. At long last, OECD, the Banks, and some of the donors -- with generally enthusiastic support from the developing countries themselves -- are beginning to stress the relevance of university research.

One of the best known examples of a university seeking to contribute directly to development activities is the Asian Institute of Technology (AIT). Originally an A.I.D. undertaking justified on educational grounds in the field of civil engineering, AIT now has broad multi-donor support with a sharp emphasis on partial self-sufficiency through contract research. While AIT has yet to earn its spurs in producing truly meaningful research products on a significant scale, a modest start has been made in carrying out water resource and port and harbor research efforts.

Another recent example, supported by A.I.D., is the establishment of an applied research institute at the Middle East Technical University. The concept is to provide within the University an administrative focal point to facilitate the matching of the University's professional talent with local industrial research needs, leading to contract research in various University departments. Other examples of recent donor support of potentially important research activities at universities include Swiss support for the Faculty of Mines in Medellin, Colombia (metallurgical machinery), Dutch support of the Hydraulics Institute at the University of the South in Puerto Alegre, Brazil (modelling of reservoirs) and of the Bandung Institute of Technology in Indonesia (radio transmission devices), Swedish support of the Building Technology College in Addis Ababa (school construction techniques), and British support of the Engineering Faculty of the University of Nairobi (mechanical devices for village use).

Support of Research Centers in Developed Countries

Linkages between developed country and developing country research institutions are now being stressed both in UN circles and among bilateral donors. However, such linkages have difficulty surviving in the absence of subsidies to the developed country participants.

The British have for some years led the pack in this area, largely as the result of ties established during the days of its colonial empire. Among the better known British research organizations which receive subsidies from foreign assistance agencies to maintain linkages in the industrial sector are the Tropical Products Institute (e.g., cashew nut processing machine), Road Research Laboratory (e.g., highway design studies), Building Research Establishment (e.g., on-site concrete panel casting), and National Institute of Agricultural Engineering (e.g., thresher, cotton picker, rope way for banana extraction). Many French institutions have been involved in West Africa for some years, but with minimal orientation to industrial research, largely due to the state of development of the area.

Other developed countries are now also beginning to subsidize selected institutions. The Dutch support the Central Organization for Applied Scientific Research (TNO) which is concerned with such problems as an instant coffee plant in Uganda and the anti-rodent agents in Surinam. The Japanese Consulting Institute in Tokyo carries out research in manufacturing rayon pulp from bamboo, obtaining newspaper material from bagasse, and spinning using tropical plants. The Institute of Agricultural Technology of the Norwegian Agricultural University is developing a combined spreading machine for seed grains and fertilizers in developing countries.

In the field of techno-economic analyses, the Norwegians support activities at the Christian Michelsen Institute at Bergen, the Germans at the University of Aachen, and the British at the University of Sussex.

A.I.D. recently gave a five-year grant to MIT for strengthening its capabilities in "Adaptation of Industrial and Public Works Technology to the Conditions of the Developing Countries." Its initial spread of research activities includes:

- Application of Highway Cost Models to Venezuela Road Transportation

- Application of Modern Water Resources Planning Techniques to a River in a Developing Country
- Adaptation of Urban Transportation Systems Analysis Techniques to Developing Country Problems
- Analysis of Patterns of Air Transportation Systems Development in Developing Countries
- Systems Analysis in the Nutrition Field as an Aid to Latin American Development
- Substitution of Indigenous Materials for Mechanical Engineering Functions
- Adaptation of Housing Technologies in Kenya
- Development of Basic Performance Standards for Urbanization and Housing Technologies through Testing of Models in Kenya
- Studies of the Role of Indigenous Organizations in Brazilian Development
- The Nature of R and D by Industrial Firms in India

Other Types of Technology Efforts

Several other types of activities should be mentioned in rounding out the picture of activities and interests of foreign assistance agencies.

On a few occasions research has been conducted in developed countries on specific devices which seem particularly important to developing countries. For example, in the United States an inexpensive, durable hand pump and a plastic roof were developed under A.I.D. financing. Unfortunately, neither has yet found its way into use in developing countries although efforts to introduce the pump are still underway. While the technical aspects of these projects were sound, the economic realities of developing country manufacturing interests were less well understood.

Clearly, the development of small industry in developing countries is very significant in the diffusion

of appropriate technology. A variety of institutions in developing countries that are concerned with small industry (e.g., intermediate credit institutions, productivity centers, small industry extension services) have and will continue to receive assistance from multi-lateral and bilateral assistance agencies.

A final aspect relates to the activities of the Intermediate Technology Development Group (ITDG) in London and the Volunteers for International Technical Assistance (VITA) in Schenectady. ITDG is interested in a number of village level developmental activities ranging from a hand operated medical centrifuge in Nigeria to catchment basins in Botswana. VITA provides technical information hand-tailored to specific developing country inquiries in many fields. This information, which includes original design of machinery, is provided by interested experts throughout the United States. Some of the innovative ideas are summarized in VITA's Village Technology Handbook.

An Experimental Approach to Clarifying Technology Transfer

In early 1970, an experimental project was undertaken by A.I.D. in collaboration with NASA to determine to what extent selected types of technology developed under NASA auspices during the past 15 years are relevant to specific industrial problems of a developing country and whether a structured program could facilitate the transfer to developing country industry of the technologies of most relevance. The Korea Institute of Science and Technology (KIST) and the Illinois Institute of Technology were selected as the transfer agents. The U.S. specialists assisted the Koreans in searching the NASA technology data banks and in developing a methodology for relating the data to specific industrial problems. The Korean specialists were responsible for adapting the most promising technologies to specific Korean needs, with particular emphasis on industrial opportunities for generating employment, developing export opportunities, and utilizing indigenous raw materials and local skills. Several significant lessons were learned from the experiment which is considered to have been successful, both in clarifying many aspects of the technology transfer process and in upgrading Korean technological capabilities.

The lessons learned include:

(1) An A.I.D. input -- in terms of program design and modest financial support -- can serve as an important catalyst in facilitating the transfer of technology by stimulating an improved coupling between potential U.S. and developing country transfer agents and between the developing country agents and manufacturers.

(2) A developing country transfer agent can serve a crucial role in the selection and adaptation of U.S. technology which individual developing country firms usually cannot duplicate in dealing directly with U.S. industry or U.S. transfer agents.

(3) The developing country transfer agent must supplement its scientific and technological capabilities with an extension capability that will assist manufacturers incorporate the technologies into their production processes.

(4) While the NASA technology data bank contains information of interest to developing countries, the U.S. transfer agent should have access to a far broader data base which would be more responsive to many of the highest priority problems of urban-industrial growth.

Some specific results of the experimental project are:

(1) Several "hard transfers" to Korean commercial manufacturers are in various stages of completion. The innovations directed to reducing costs, improving performance, and enhancing acceptability of radios, TVs, calculators, and related electronic products include: miniature transceivers, high sensitivity communications circuits, tantalum capacitors, and improved electronic circuitry.

(2) Steps have been initiated toward other possible "hard transfers" in the fields of food technology (e.g., all-purpose survival rations, retortable food packaging); instrumentation and testing (monitoring battery charges, microwave non-destructive testing, measurement of flow variables); metallurgy and materials (explosive metal working, thermal insulators); and chemicals (carbon monoxide reduction, high alkali detergents, magnetic ink).

(3) The overall competence of the KIST laboratories involved in the project has been upgraded significantly.

(4) The project has heightened awareness of Korean industry of the value and limitations of technological innovation and adaptation and the importance of KIST as a transfer agent.

(5) KIST has begun to establish the capability to advise the Government and industry on a more discriminating selection of imported technologies and alternative development of indigenous technologies.

(6) The project has sharply oriented KIST towards U.S. technology sources and has significantly increased the probability that KIST will recommend to Korean industry U.S. sources for products, processes, and technologies rather than comparable Japanese suppliers.

(7) The capability of KIST to tap U.S. technical information sources has been greatly improved.

(8) A long-term linkage between KIST and the Illinois Institute of Technology has been stimulated by the project.

(9) The project has already generated \$100,000 worth of KIST contract work for the Korean Government and industry.

What Difference Does It Make?

The success of foreign assistance agencies in stimulating the introduction of appropriate technology is difficult to assess. To date the short-term results have not been particularly impressive. However, a wealth of experience has been accumulated by both the developing countries and the donors, and there now seems to be a determined effort to increase the effectiveness of industrial research activities.

In the years ahead the concept of appropriate technology will increase in importance. The prospects seem promising that intervention by assistance agencies can reinforce the efforts of developing country to influence the orientation of the technology that flows within both

the public and private sectors toward a greater responsiveness to developing country development needs and priorities.