CANADA

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Science and Technology for Development

Policy Instruments for the Support of Industrial Science and Technology Activities

STPI Module 9

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STPI MODULE 9: POLICY INSTRUMENTS FOR THE SUPPORT OF INDUSTRIAL SCIENCE AND TECHNOLOGY ACTIVITIES

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FOREWORD

This module constitutes an integral part of the Main Comparative Report of the Science and Technology Policy Instruments (STPI) project, a large research effort that examines the design and implementation of science and technology policies in 10 developing countries (Appendixes 1 and 2).

The STPI project generated a large number of reports, essays, and monographs covering a great variety of themes in science and technology for development. More than 250 documents were produced by the country teams and the Field Coordinator's Office, and this proliferation posed rather difficult problems during the comparative phase of the project. It was decided that a Main Comparative Report, covering the substantive aspects of the research work of the country teams would be published, and that several monographs treating specific subjects would complement it.

The Main Comparative Report is organized in three parts. The first consists of a short essay covering the main policy and research issues identified through the research, and the second contains the most relevant results of a comparative nature that were obtained in the project. These first two parts have been published by the International Development Research Centre in a single volume in English, Spanish, and French (109e, 109s, and 109f).

The third part of the Main Comparative Report consists of 12 modules containing material selected from the many reports produced during the STPI project. They provide the supporting material for the findings described and the assertions made in the first two parts of the Main Comparative Report.

The modules were prepared by several consultants, and given the diversity of topics covered, the IDRC staff did not consider it desirable nor possible to impose a single format or structure for their preparation. The reader will find a diversity of styles and structures in the modules and will find that the selection of texts reflects the views of the consultant who compiled the module. However, the modules were prepared in close collaboration with the Field Coordinator and were also submitted to a STPI editorial committee who ensured that they provided a representative sample of STPI material. They should be read in conjunction with the first two parts of the Main Comparative Report.

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INTRODUCTION

This module contains four groups of policy instruments that provide support to the science and technology activities in industries and industry-related institutions in the STPI countries. These four groups are policy instruments in connection with:

- technical norms and standards
- information centres
- manpower development programs
- consulting and engineering activities

Since none of these groups of policy instruments was studied thoroughly as an integral part of the STPI project and there are not enough collected materials on these subjects for a comparative study among the STPI countries, brief general descriptions of major issues of these instruments are presented and some policy instruments currently operating in the STPI countries are described. It should be noted, however, that these groups of policy instruments will have a significant long-term influence on the local science and technology system. As the economy develops and the science and technology base expands, the need for policy design and implementation in these areas is expected to grow rapidly. The importance of these policy areas is fully recognized in some STPI countries and there appears to be a consensus among the STPI researchers that future S&T policy studies should be directed toward these topics.

TECHNICAL NORMS AND STANDARDS

The system of standards and measures fulfills the function of standardizing dimensions, performance characteristics, and the quality of the goods produced in an economy. Technical standards are used to make the qualities, dimensions, and other parameters of a number of products uniform and compatible, thus reducing the costs incurred by interchanging products, parts, and components. Because of uniformity and compatibility, production on larger scales is thus made possible and division of production activity can be introduced. Scarce natural resources can be saved by reducing rejects, and if the mechanism is managed adequately, it can be quite useful as a tool for the diffusion of technologies, since standards include product and process specifications. It is also expected that consumer interests are protected because quality control is part of the standards and technical norms system.

In a highly industrialized country, numerous technical standards exist, and these define the characteristics of final and intermediate products as well as of raw materials. However, these standards were determined in an ex-post-facto manner by the industrialization process itself (by state institutions as well as by private ones). In turn, in a developing economy, the technical standards are generally determined by translating and copying standards defined in other countries. Thus, costs necessary for developing standards can be avoided, but greater costs can be incurred by enforcing the more-than-necessary rigid standards system in a developing economy. Such an obligatory standards system may induce technological dependency in developing countries.

In the STPI studies undertaken, the problems of norms and standards were examined only to a limited extent, with the exception of Korea, where a detailed examination was undertaken. In Korea, the need for industrial standardization grew with the military supply requirements of the armed forces, especially after the Korean War, and with the rapid export-oriented industrial development in recent years. The Korean government took the initiative in the development of industrial standards and instituted several laws and government organizations aimed at improving the quality of products. These included the following:

- Industrial Standardization Law
- Quality Control Inspection Law
- Export Inspection Law
- Weights and Measures Law

- Industrial Advancement Administration (a government agency)
- National Industrial Standards Research Institute (a testing agency)
- Korea Standards Research Institute (a metrology research laboratory)
- Korea Standards Association (a trade association)

In contrast, the activities on technical norms and standards have been voluntary and private-oriented in Latin American STPI countries. Only recently, some government interventions were introduced to enhance the quality control of products. The norms and standards systems in Latin American countries somewhat resemble the U.S. system, which was developed by the private institutions and later approved by an official body. In these countries, the technical norms and standards system has been evolving for a long time and the related policy instruments have been haphazard and loosely organized. Since industrial development in these countries has been directed toward internal consumption (cf. Korea), there has been no pressing need for a stricter technical norms and standards system.

The process of normalization and standardization in industry is a scientific and technological activity in itself and at the same time an instrument for the promotion of other scientific and technological (engineering) activities. The standardization and mass production of interchangeable parts, the quality standards established by given product norms, and the technical and engineering specifications of a given product are themselves activities that demand considerable scientific and engineering inputs and that lead to the diffusion of knowledge. The improvements in the technological conditions of a firm that result from its efforts to meet standards are a very clear-cut case of induced technological diffusion.

On the other hand, most technology has been imported to the STPI countries from foreign countries, and there is only limited domestic engineering experience and capability. This means that when the industries need standards, they tend to turn to foreign standards and engineering services. The commercial and technical ties with foreign firms can be prolonged because of the enforcement of high-quality norms and standards. This has been a particularly worrisome concern in connection with technical norms and standards. This concern is amplified in nations where the national authorities are passive to the influence of multinational corporations and are handicapped by limited resources dedicated to the examination (and adaptation) of foreign standards in the context of the local situations.

Thus, the main issue in connection with technical norms and standards is how to achieve a balance between the local industrial and engineering capacity and the goals of quality control and standardization. Goals that are too ambitious may trigger excessive technological dependency, whereas the lack of respectable standards and norms may stagnate the quality of industrial activities.

ARGENTINA

Argentinian Institute of Materials Rationalization (IRAM)

There is no law or other legal tool that governs standardization in Argentina or specifies the generic obligations regarding standards, etc. There are only two Decrees (12,430 and 13,537), dating from 1937, that recognize the Argentinian Institute of Materials Rationalization (IRAM), a private entity, as the "centralizing body for the scientific and technical study of standards, so as to maintain the production systems and criteria uniform."

There is no single body or division within the government with the function of defining policies, creating tolls, or monitoring in relation to standardization. Individual government agencies and public companies decide their own policies on standards. In a few cases, they refer to provisions of the National Accounting Law. In private entities there is no control over the standards, but the provisions of Decree 5,720/74 make it obligatory for purchases to be made in accordance with IRAM rules in the case of state purchases.

This private, nonprofit institute (IRAM) was created in 1937 to make known and diffuse standardization and establish standards on definitions, nomenclature, trial methods, analysis, technical characteristics, specifications, etc. Its Board of Directors includes business people and professionals attached to industry. The Decrees mentioned above gave IRAM the job of setting the standards because there was no official work in this area. As no institutions were created later to define the policies, the policies IRAM chooses for its own activities have become, in effect, the Argentinian standards policies. A member of INTI sits on the IRAM Board and this is the only state participation in this field.

The agreements IRAM signs with state bodies for offering services, etc., are no more than interinstitutional agreements, and the official entities do not lay down any rules regarding activities.

IRAM carries out the following activities and provides the following services:

(1) Setting Standards. IRAM undertakes a study on a standard at the request of a company, chamber of commerce, public body, or research institute. The study is done by a committee, which makes a preproject based on foreign experiences. The study result is submitted to public discussion before it is approved by the IRAM Council of Directors.

(2) Certificate of Quality. IRAM inspects the quality control of products to test whether they meet prescribed standards. Quantitatively, this is the most important service provided by IRAM.

(3) Standards Seal. A standards seal is awarded to companies that guarantee continued production of goods that meet certain standards of quality. This service has the greatest technological infleunce. Only 47 companies have this seal on their products.

IRAM bases its standards on foreign experiences, and they are adapted according to local interests expressed during the preproject discussions. Similarly, some state bodies have established specific regulations making it compulsory to use standards when key products for their productive structure or services are acquired. One example is the Argentinian Railway Company's policy, which demands the "manufactured according to the standard" seal for products related to safety.

Two minor provisions stipulate that standards controls must be used in the case of credits to manufacture products related to public safety and in the case of special credit lines granted by the National Development Bank for developing prototypes of capital goods. There are no provisions stipulating that standards must be met by exports.

The main reasons for setting standards, among others, are to define the measurement of products to assure they are uniform and, consequently, interchangeable, and to fix quality standards to improve gradually the technological standards in industry. This is relevant to the problem of defining the standardization policy followed by IRAM.

Based on the evidence collected, it can be said that the Institute's policy is basically to orient standardization toward making the measurement and the quality of products uniform to facilitate commercial transactions, reduce the unnecessary varieties in production, and consequently reduce stocks.

These benefits derived from standardization are clearly visible in economic units that handle large quantities of different products, and because of these benefits the state has become one of the main entities that insist on standards, especially through its companies.

Even the services, other than standardization, that IRAM provides very efficiently, such as certifying the quality of lots and issuing standards seals, aim to achieve these objectives. This is in keeping with the Institute's role; it defines itself as a "service for industry," and therefore it should satisfy their manifest needs.

In short, in Argentina there is an Institute with 40 years' experience in the field of standardization, and although it has only been assigned the task of setting standards, it is the entity that really decides the policies, because there is no other adequate institutional structure. There are no formal links between technological and industrial policy and the standardization activity. Given the present state of the law, the standard is only a recommendation, which may or may not be used by the parties in commercial transactions between private groups. The state should respect the standards when making purchases, but it is not obliged to do so in the case of its own production.

COLOMBIA

National Council of Standards

The Quality Control Division is a branch office of the Industry and Trade

Superintendence dedicated to the supervision and control of the quality of industrial products. It is an institution charged with controlling the implementation of technological standards for industrial production previously set by the Colombian Institute on Technological Standards (INCONTEC).

The Quality Control Division is one of the four sections that comprise the Industry and Trade Superintendence. The Superintendence, in turn, is the organism that supervises the nation's industrial and commercial activity, and whose role is only recently becoming important. Its main functions lie in the field of authorization and control over the export of royalties, over industrial property, and over quality control. This office is composed of approximately 12 officials who have at their disposal a very reduced staff for the function of vigilance and control they have to implement.

Colombia Institute of Technological Standards (INCONTEC)

INCONTEC is a semiofficial organization under the National Development Ministry. It is in charge of studying the minimum technical requirements that a given industrial product must fulfill. These regulations apply to the entire industrial field, but specific supervision over every firm is exerted.

Colombia's level of quality control is minimal. It is practically reduced to the self-control established by companies on their own products and to a minimum of governmental control over certain export products. The Quality Control Division handles the juridical instruments necessary to carry out its functions, but it lacks real influence. Its influence on technology and its development is only potential and it depends on the technological standards elected to classify products, which is a function of INCONTEC.

The problem of standards is as important in technological terms as the one of vigilance over their implementation. The Andean Pact has shown some concern over these phenomena, which are only now beginning to have a real importance for Colombia.

INDIA

Standardization, Testing, and Evaluation Programs in Electronics

Standardization and its implementation in India encompass four basic activities, namely:

(1) Research in environmental and life testing, failure modeling, reliability prediction, etc.

(2) Preparation of standards.

(3) Testing to standards and preparation of test reports.

(4) Certification based on the test reports.

The preparation of one unified series of standards will minimize the diversity of items to be produced and optimize the scale of production. The progress of standardization is not possible without a scheme for unified inspection and testing. The testing of materials, components, and equipment requires the provision of elaborate and detailed test facilities. It may not be possible for all the production units, particularly in the small-scale sector, to own such facilities for themselves. Therefore, it was recommended that test facilities be set up in various industrial centres, such as Bangalore, Bombay, Calcutta, and Delhi, in which the electronics industry is established.

Efforts are under way to augment the facilities at the National Test House, etc., to cater to the standardization requirements of the electronics industry.

In persuance of the recommendations made, the Bhabha Atomic Research Centre was advised to set up a Reliability Evaluation Laboratory, and the National Physical Laboratory was advised to enhance its test facilities and to establish a Test and Evaluation Centre. Similarly the facilities at the Controllerate of Inspection Electronics were made available to the industry by the Ministry of Defence. The National Test House also started its electronics division with this objective.

To examine the extent of additional facilities required for calibration, testing, etc., the Chairman of the Electronics Commission has already set up a Panel, which is evolving guidelines for funding in this area.

The Panel has recommended the following fields of activity with respect to electronic equipment, components, and materials:

(1) Equipment. For assuring the quality and reliability and for improving the maintainability of all electronics equipment, standard components should be used to the maximum extent. However, with regard to the standardization of the equipment itself, the agencies concerned can examine the details to determine to what extent it can be achieved.

(2) Components. There is an urgent need for standardization in the field of components to provide guidance to the industry in the production of components and to the equipment designers in the choice of components.

(3) Materials. For indigenous development and production of electronic grade materials, it is essential to draw up specification standards for these materials on the same lines as for components.

SOUTH KOREA

Industrial Standardization Law

The Industrial Standardization Law (promulgated in 1961) established the Korean industrial standards (KS) system for products and processes in mining and manufacturing. The Industrial Advancement Administration (IAA) was given the responsibility for preparation and execution of the standards. The Council for Industrial Standardization was created to assist and advise IAA on matters related to standardization.

This Law provides the procedures for establishing and supervising the Korean industrial standards system. This function is carried out mainly by the Council for Industrial Standardization, in which industrial, academic, and research establishments are represented. When the need for the establishment of a KS system for particular procedures is recognized by IAA, drafts are prepared by the Korean Standards Association and examined by a divisional committee of the Council for Industrial Standardization. It also establishes the criteria and methods for inspection when an application for KS marking is received. The KS system is essentially voluntary by giving incentives to industries with KS markings, but IAA has the authority to make it mandatory for certain products and processes where public safety and consumer protection are deemed necessary.

This law also provides operational mechanisms for its effective implementation. The government agencies, public enterprises, and private enterprises receiving government financing are required to conform to the KS system and give priority to those items with KS markings when purchasing goods. The government can also provide grants for accelerating the quality-improvement programs aimed at conforming to KS. The products with KS markings can be made exempt from inspections required by other laws. As mentioned earlier, the government can make it mandatory for certain goods and processes to conform to KS. Since the establishment of the system, more than 5,000 standards have been implemented. As of 1973, 262 companies had been authorized to carry the KS marking, and it had been declared mandatory for 32 items to receive the KS marking.

These 262 companies that received the KS marking represent only about 1% of the enterprises in Korea and, therefore, the coverage by the KS system appears to be meager. There are many reasons for this lack of coverage. First, the number of KS established so far is still quite small and the reward for receiving the KS marking is inadequate, so the incentive for receiving it is not high. Second, most KS are mere copies of Japanese industrial standards and have been established without adequate consideration of the local technical capabilities and market needs. Third, the ability to perform the tests according to specification is inadequate. Finally, many enterprises that depend on foreign technology or are export-oriented find it necessary and adequate to use foreign standards.

Although the KS system requires further development, it is the national reference for standards and norms and establishes certain goals to be achieved in the quality of products.

Industrial Advancement Administration (IAA)

IAA was established in 1973 at the Ministry of Commerce and Industry for the management of quality control and standardization of industrial products. Its major functions are:

(1) Overall control of the national standards system, excluding certain sectors controlled by other ministries.

(2) Administration of the Industrial Standardization Law, Export Inspection Law, Quality Control of Industrial Products Law, Weights and Measures Law, Electrical Safety Control Law, High Pressure Gas Safety Law, Energy Conservation Law, etc.

(3) Supervision of the National Industrial Standards Research Institute (NISRI).

(4) Coordination of standardization and quality control activities with other ministries and departments.

(5) Extension services to industry, i.e., technical information service, consultant service, and public relations.

(6) Representation of Korea in the international organizations concerned with standardization.

National Industrial Standards Research Institute (NISRI)

NISRI is a government institute reorganized in 1973 from the former National Industrial Research Institute. Its major roles are:

(1) Acting as the central official testing laboratory.

(2) Quality control of industrial products on request from private and public sector agencies as well as mandatory testing and inspection of export goods.

(3) Production and distribution of certain Standards Reference Materials (SRM) to industry.

(4) Technical extension services on quality control, manufacturing and test methods, consulting, and information dissemination.

Korea Standards Association (KAS)

KAS is a private organization established to provide a link between the government and industry in matters related to standardization and quality control. Its major roles are the publication and sale of all Korean industrial standards (KS) and other literature on standardization and quality control, the preparation of KS drafts, the promotion of KS, the promotion of company standardization and quality control, and the training of personnel in these areas.

Quality Control Inspection Law, Export Inspection Law, Weights and Measures Law

These laws complement the Industrial Standardization Law and their objective is to ensure the quality of products.

The Quality Control Inspection Law is complex and its implementation seems to be difficult except for products that require mandatory quality requirements. It promotes voluntary observation of quality standards in general. Since no testing procedures have been adequately established, voluntary observation of quality standards has proved to be ineffective.

The Export Inspection Law, on the other hand, appears to have produced some desirable effects with regard to improving quality and resolving technical problems. There are a number of testing laboratories that perform quality inspection of export products.

The other laws regulating measurements appear to be ineffective. Because of foreign ties many industries are using nonmetric measurement systems. Also, much of the measurement apparatus is not adequately calibrated as required by the laws, but enforcement is not feasible because of the lack of service capability.

Korea Standards Research Institute (K-SRI)

In response to the need for modernizing the national standards system to stimulate and support industrial growth in Korea, the Korea Standards Research Institute (K-SRI) was created as an autonomous organization under the Weights and Measures Law and the Specialized Research Institute Promotion Law. The stated goals of K-SRI are:

(1) Modernizing the national standards system (NSS) and maintaining its traceability to the international system.

(2) Strengthening the infrastructure of NSS and establishing a foundation for promoting high-technology industries.

(3) Enhancing the productivity of Korean industry and improving the quality and reliability of industrial products.

(4) Improvement of a broad-based national precision measurement capability.

(5) A program of systematic technical assistance to small and medium industry.

(6) Immediate development of the mechanical and electrical engineering capabilities.

Thus, K-SRI is charged with the responsibility of upgrading the level of Korean measurement standards to support the growth of precision and high-technology industry. Its goal of establishing a nationwide industrial calibration network system is particularly noteworthy. K-SRI has already conducted an extensive industrial survey, which revealed a general pattern of neglect in instrument calibration and a limited understanding of the value of accurate measurement (88% of precision instruments did not receive regular calibration, and 86% of these instruments were never calibrated).

The idea of providing technical assistance to small and medium industries involves the identification of measurement problem areas, their potential solutions, the importation of appropriate technology, periodic calibration, and upgrading productivity by standardizing product qualities. K-SRI is expected to serve about 24,000 small and medium firms, of which more than 80% are individually owned.

The Metrology Division of K-SRI maintains primary standards and carries out some basic R&D projects as well as verification and calibration services. The Technology Division is responsible for disseminating technical information and carrying out industrial service projects. Both divisions will collaborate in planning, implementing, and evaluating metrology education and training programs. As the primary metrology institution in Korea, K-SRI acts as the core body of the Korean national standards system and represents Korea in various international standards organizations. K-SRI maintains close relationships with the Bureau of International Weights and Measures (BIPM), the International Organization for Standardization (ISO), the International Organization for Legal Metrology (OIML), and other national standards organizations. At present, K-SRI collaborates with the U.S. National Bureau of Standards and the German Physikalisch-Technische Bundesanstalt.

MEXICO

General Office of Standards (DGN)

The procedure for defining an industrial standard in Mexico is closest to the system in the United States, where private institutions define the nature of the standards, which are later approved by an official body. The General Office of Standards (DGN) is the institution charged with carrying out this last phase of the process and of playing the promotor's part in the first stages. Technical standards in Mexico are determined under the following procedure:

(1) Selection of the theme;

(2) Bibliographical research on foreign and international standards related to the same topic;

(3) Identification of sectors (locating manufacturers and consumers of the product to be standardized, as well as the centres of scientific and technological research and of higher education related to the topic);

(4) Industrial research consisting of visits to manufacturers and consumers, to know their problems and needs;

(5) Preparation of the preliminary proposal of the standard, which is then distributed among manufacturers, consumers, and research centres;

(6) Standardization conferences or meetings between manufacturers and consumers, with the purpose of reaching an agreement between these sectors;

(7) The proposals thus prepared are reviewed by the General Office of Standards, and if they are approved, the appropriate declaration is made and they become official

standards with the publication of their title in the "Diario Oficial."

The General Office of Standards lacks a centre for technological research that would enable it to carry out the tests necessary for the definition of a standard. Fundamentally, the process of standardization is concentrated in the companies. It is by means of consultations with manufacturers that the Office comes to prepare a proposal for a norm, which must bring together a consensus of the various sectors (manufacturers, suppliers, and consumers). Such a procedure might be appropriate to highly industrialized countries, where an extremely intense innovative process occurs. But in an economy in which 80% of the technology used comes from external sources, and where the research effort is not articulated with productive activity, such a process can consolidate technological dependence on foreign sources. Furthermore, the choice of products or sectors to standardize is itself carried out fundamentally through the Consulting Committees on Standardization, which have the function of advising DGN on the process of standardization in certain branches of industry (at present, 34 of these committees are functioning).

Mexican standards can be optional or obligatory. The first are those that indicate certain requirements, established by DGN, that must be complied with to be able to use an official seal of guarantee (administered and controlled by DGN itself). This seal is a mark that the Ministry of Industry and Commerce allows manufacturers of articles covered by an optional standard to use. The sign can be placed on the products or their containers and in commercial publicity. Manufacturers authorized to use the official seal of guarantee are subject to systematic inspection by DGN to verify compliance with the corresponding standard. However, the number of industries that use the official seal of guarantee is extremely small. The obligatory standards are those that DGN determines for products that "affect the life, security, or bodily integrity of persons," which are set for articles for export, and which are established because the economy of the country requires it.

The technical norms that predominate were prepared by various professional, public, and industrial organizations of the United States: American Society of Mechanical Engineers, American Welding Society, American Society for Testing and Materials, American National Standard Institute, American Petroleum Institute, etc. In many cases, the use of foreign standards is a determining factor in the origin of equipment to be acquired. In other cases, manufacturers of equipment for these industries have adopted foreign standards and can satisfy the demand for these goods (in particular, this seems to be the case with manufacturers of equipment involved with civil or industrial engineering firms).

In terms of standards related to petrochemical products, the picture is rather different from that of capital goods. Here, standards exist for quality or for testing to establish what will be the "normal" values of the various parameters of principal petrochemical products. Many of these standards are translations (and in some cases adaptations) of foreign standards for the same product. In relation to the food industry, DGN had defined (up to 1973) 210 technical standards. In principle, food products should be subject to the use of obligatory standards. However, a recent study in Mexico revealed that scarcely 20% of the prepared food products susceptible to standardization relied upon a DGN standard.

Another aspect of standardization is the processing to which the standards must be submitted, particularly those related to sectors with rapid technological change. In a sample of 40 standards issued in 1973 as substitutes for former standards, an average of 4.5 years lapsed between the dates of the old standard and the new one that replaced it. In principle, this is not an excessive time span. However, if these 40 standards are examined by sectors, the lowest average times will not coincide with the sectors judged most dynamic from the point of view of technical progress.

The objectives sought through the system of technical standardization differ greatly from what has actually been attained in Mexico. On the one hand, the feeble output of technical standards does not manage to cover more than a tiny proportion of national industry. On the other hand, the lack of criteria with which industrial products have been selected for the establishment of standards has provoked an enormous scattering of energies, with the result that certain sectors of great importance for future industrial development have been ignored.

PERU

Technical Standards

Articles 6 and 7 of the Constitutive Law of ITINTEC (September 1972) establish the bases for normalization in Peru. This provision acts mainly at the industrial level but is aimed at the establishment of technical standards in all other sectors of productive activity.

The basic objective that is sought with this provision is to attain an adequate capacity to establish, adapt, and promote the use of technical standards in such a way that these are in keeping with the quality requirements demanded by the market and by technological development. In particular, these objectives are:

(1) To determine the quality levels by specifying the requirements that the products and services should fulfill.

(2) To reduce the diversification of models to a number than can cover the needs of the country.

(3) To ensure interchangeability by setting and defining the product requirements.

This legal provision gives ITINTEC responsibility for drawing up and disseminating standards, granting seals of approval to them, and coordinating with the pertinent ministries in the cases in which compulsory standards should be declared.

In the preparation of standards, ITINTEC acts at the following levels:

(1) At the enterprise level, it promotes the generalized establishment of standards and their respective control systems. ITINTEC also fosters the creation of standardization departments within the industrial enterprises.

(2) At the national level, ITINTEC's action is directed mainly at the preparation of technical standards; for this purpose the participation of producers, consumers, and technicians is coordinated, so that results can be obtained that harmonize the interests of the different sectors.

(3) At the international level, ITINTEC conciliates the work of national standardization with that carried out by the most important international standardization organizations.

With regard to the specific application of standards, ITINTEC assumes responsibility for fomenting the creation of quality control departments that would guarantee the fulfillment of standards, for promoting the installation of laboratories and the appropriate training of the personnel in charge of verifying the implementation of the technical standards, and for securing the use of technical standards in export and import products.

In connection with the granting of the seal of approval for the fulfillment of standards, ITINTEC promotes the use of that seal. ITINTEC disseminates information on the objectives of the seal, its advantages, and the conditions under which it is granted. It also carries out actions to accredit the guarantee conferred by this seal in its application to specified products. To fulfill these functions, ITINTEC has a Standardization Bureau, which is made up of a supporting body (Department of Programming) and three executive organizations (the Standards Division, the Metrology Division, and the Seal and Certification Division).

In Peru, standardization has recently emerged as a systematic activity. However, its history dates back to the old Weights and Measures Law issued in 1862. Subsequently, a series of regulations and codes was published, which culminated in the Industrial Promotion Law (13270) of 1959, creating the National Institute of Technical Industrial Standards and Certification (INANTIC). In this field, INANTIC is the immediate forebearer of ITINTEC and its functions were taken over by the latter.

The main activities carried out in ITINTEC with regard to standardization constitute a whole process in which each stage involves the use of a series of mechanisms that together not only make it possible to establish a technical standard but also to promote and implement it.

The establishment of specialized committees as a mechanism used by ITINTEC to prepare the proposed technical standard is the result of an important institutional effort to achieve the active participation of consumers, producers, and technicians so as to have the proposed standard in keeping with the needs of these groups, which would guarantee a specified level of quality of the product for users in general.

In addition to their specific functions of drawing up the draft standards, these committees, which have been gradually growing, have had favourable indirect effects on the industrial sector inasmuch as they provide the opportunity for a dynamic relationship between producers and consumers and for the consequent dissemination of their products under better conditions.

The application of the technical standards approved by ITINTEC is optional, which is to say that the enterprises can choose to use them or not. They are only considered compulsory when the standards have to do with the health or safety of the population. In this regard the effort being made to achieve a greater acceptance of the standards by the productive sector is highly significant.

With regard to the results of the standardization activity of ITINTEC, it can be seen that the number of officially accepted standards has risen noticeably since 1973. However, for these approved standards to have a favourable impact on the Peruvian economy, they must be implemented and generally used at a national level. The application of standards in Peru is hindered by the fact that most of them are optional.

VENEZUELA

Normalization and Quality Control

In Venezuela, Decree 1195 of January 10, 1973, regulates all aspects related to normalization and quality control. The implementation of the Decree is the responsibility of the Venezuelan Commission on Industrial Norms (COVENIN) at the Ministry of Development. The main features of the Decree are the following:

(1) There is a clear orientation toward the promotion of national exports. The utilization of adequate technical norms guaranteeing competitiveness in terms of the quality and price of the Venezuelan products intended for export is considered indispensable.

(2) It creates technical commissions with the purpose of programing and developing projects for new norms and for the reassessment of existing norms. These commissions include representatives of public institutions, producers of the products or related professional service firms, manufacturers of parts and components of the branch, independent experts, tradespersons, consumers, and other users.

(3) It adopts the trademark NORVEN, which certifies that the manufacturer abides by the rules established by COVENIN. These rules are not obligatory even though it is also established that those who abide by the norms will be given preferential treatment by the state's industrial promotion institutions. The same could be applied to the other forms of protectionism and promotion, particularly in the case of exports of local products.

(4) When purchasing some products, the public administration institutions are obliged to demand that those products abide by the requisites established by the Venezuelan norms of COVENIN and then to give preference to those bearing the NORVEN trademark.

(5) The norms COVENIN approves can be national or foreign.

As neither normalization nor quality control are obligatory, their application is not a generalized practice in industry. Bearing in mind that to benefit from certain financial and fiscal incentives and privileges it is not necessary to comply with COVENIN norms, this tendency is reinforced. (For the approval of an industrial project, the industrialist is asked to give information about which norms and quality control systems are being used, then the approval is given without any other control.)

The use of norms and quality control systems is frequently the result of conditions imposed by the foreign supplier of the technology. National norms are frequently adopted with or without the agreement of COVENIN. As a result of this situation, foreign production norms and quality control systems are adopted, which lead to a dependence on imported supplies and machinery.

Normalization in Venezuela does not take into consideration its impact on technological development, notwithstanding the fact that Decree 1159 explicitly refers to such impacts. One of its paragraphs, for instance, reads as follows: "normalization and quality control are particularly important for the industrial development of Venezuela for they allow the rationalization of technology transfers...." As normalization is very much seen in relation to the product itself, almost in abstract terms without reference to its economic and industrial linkage (which demand a macro point of view), standardization tasks are not taken into account in concerns of technological development.

INFORMATION CENTRES

The generation, accumulation, and dissemination of technical information are important functions for performing scientific and technological activities. The original generation of scientific and technological information belongs to the R&D laboratory, but searching and recasting the needed information should be carried out at the dedicated information centres or the information branches of scientific institutions.

Technical information centres can be broadly classified into three categories:

(a) those specializing in collecting technical information;
(b) those specializing in regrouping existing information for general dissemination;
(c) those responding to individual inquiries from industry.

A typical category (a) information centre is the traditional library, which collects whatever books, journals, and reports are available. There are many category (a) information centres, but most of these centres located in developing countries do not maintain an adequate collection of available scientific and technical information. Because of the inadequacy in existing centres, a number of nations are building national information centres. For example, Brazil set up a technical information centre and India operates a national information centre. These centres are collecting technical information and provide citations to the users.

KORSTIC, the primary technical information centre in Korea, has a much broader function than merely collecting information. It classifies the collected information and distributes the information indices to the user community. It is concerned with the delivery of information as well as its collection. Although the delivery mechanism is passive and not specific (to the industrial inquiry), KORSTIC is more than a library.

The most active information centre in the STPI countries is Mexico's INFOTEC. INFOTEC provides question and answer services on the technical problems of industry, conducts field visits to industrial firms, and provides extensive technical bulletin services. An initial survey of INFOTEC's performance indicates positive reactions from the industrial users.

There are a number of issues (or problems) in S&T information centres. The first is whether a public information centre should serve a small number of large companies or a large number of small and medium-size industrial firms. Since large firms are usually concerned with high technology and are also capable of utilizing technical information, they tend to utilize information centres more frequently. On the other hand, small and medium-size firms are more isolated from the existing technical information. Small and medium-size firms need external technical assistance, whereas large firms can maintain an internal technical capability. These two conflicting interests have an influence over the customer-scope of information centres.

The demand for technical information cannot be created by the information centres. Information centres (services) can be utilized only when the capacity to learn exists. The existence of qualified engineers and trained personnel is considered to be a vital factor in the viability of information centres.

Even though well-functioning technical information centres exist, a large number of information exchanges are conducted through informal information channels. These information channels are sporadic and unorganized. Therefore, information centres often function as secondary information channels to supplement informal channels.

SOUTH KOREA

There are some 250 higher-level libraries, including 50 public libraries, 110 college libraries, and about 70 special libraries in Korea, but very few deal with scientific information to any appreciable extent. In fact no public library has shown any special concern for science information material, scientific holdings at universities are inadequate except in some 10 major universities, and only five or six of the special libraries attributed to research institutes or various other organizations seem to be functioning properly. Positive information-disseminating activities are in an early stage and a lending network between libraries has yet to be developed. Equally, national organizations corresponding to institutions such as the Referral Centre of Science and Technology, the Science Information Exchange, or the Clearing House for Science and Technology in the United States do not exist.

Korea Scientific and Technological Information Centre (KORSTIC)

The Korea Scientific and Technological Information Centre (KORSTIC) was established in 1962 and is the only organization that devotes itself solely to science and technology information activities. KORSTIC is now collecting about 1,500 different foreign periodicals (1,200 by subscription and the balance by exchange) covering a wide range of disciplines, but excluding medical science. On this information base, the Centre issues monthly a series of five volumes, together constituting a Current Bibliography on Science and Technology, and two other current bibliographies dealing with foreign patents and management science. These bibliographies, which are distributed on a subscription basis, carry translated titles of articles in foreign journals, arranged according to classification tables compiled by KORSTIC. A literature search service is available, and hard copies or microfilm copies of any material in the collection can be supplied. The growth rate of these two services is clear testimony to the widening role of KORSTIC, as shown in the Tables 1 and 2.

Besides the Centre's main function of collecting, processing, and disseminating scientific and technological information from worldwide sources to users in Korea, it also issues an English-language abstracts journal covering domestically produced scientific and technological literature for dissemination abroad.

KORSTIC is expanding and automating its facilities to meet the growing demand for its services. As an institution, it is probably not unfair to say, however, that KORSTIC meets the needs for scientific information rather than the technological information required by industry. This is admittedly a difficult field because of problems of proprietary technology and the importance of personal contacts in technology transfer, but the needs of industry are becoming urgent, even if not fully recognized by many individual firms. Worldwide, a great deal of effort has been expended in developing information systems geared to meeting the needs of scientific personnel, but the lack of adequate industrial and engineering information and the inability to use effectively the available information are common problems in many of these systems.

Korea Institute of Science and Technology (KIST)

The Korea Institute of Science and Technology (KIST) started its science and technology information activities for industry in the belief that unfiltered information without review by pertinent experts is hardly usable by industry. KIST therefore set up an Electronics Development Information Analysis Centre in its Technical Information Department, which aimed at making maximum use of both information resources and KIST research staff to analyze, review, screen, and manipulate the inflow of information for the Korean electronics industry, disseminating this information selectively to relevant firms. The Centre was thus intended as a go-between, linking world information resources, KIST expertise, and the Korean electronics industry, and rendering a form of extension service. The Centre was also regarded as a pilot model for later application in other disciplines, though subsequent developments have so far been limited.

Before the Centre was established, KIST had conducted a rather comprehensive survey of the electronics industry in Korea to obtain insights into the industry's information environment and to prepare user profiles on which to base selective dissemination. In the course of the survey, KIST staff visited 52 electronics firms during early 1969 and received 38 responses to its questionnaire. The results showed the importance attached by the industry to different sources of technical information, as shown in Table 3.

As may be seen, predominant importance was accorded to foreign companies, and relatively little to domestic sources. To some extent this is a reflection of the type of technical information required by industry. Basic requirements for technology can be met in part through access to published material, but other mechanisms are more important - movement of people, training programs, licences, patent agreements, and foreign investment. This apart, firms can make effective use of open literature services such as those KORSTIC offers only if they have a high level of technical competence and probably some in-house R&D activities. KIST's Electronics Centre aimed at overcoming this weakness, but the Centre's activities have ceased since April 1973.

KIST's information activities have not expanded to the extent anticipated at its inception, and KORSTIC may not be able to meet all industrial requirements.

MEXICO

Fund for Technical Information for Industry (INFOTEC)

Background: The immediate antecedents of INFOTEC can be found in the centres of information and documentation that offered support to the scientific and technological system. Among these centres can be mentioned the Centre of Scientific and Technical Documentation, which was created in 1954 and functioned until 1960. Between that year and 1970, no institution in charge of offering these services existed in Mexico. In 1970, the National Council on Science and Technology was founded and included among its functions the establishment of a national service of information and documentation. Moreover, the Science and Humanities Information Centre of the Autonomous University of Mexico began to function, providing services to any academic or research institution. However, the information systems available to industry have always been given secondary importance. Within CONACYT itself, the technical information service (SIT) was launched without the financial support that it needed. This service was integrated into a broader system, the National Service of Information and Documentation. This organization is composed of the following subsystems: infrastructure (libraries, document centres, archives, etc.), sectoral networks of information (SIT would form the central nucleus), and horizontal services (including the gathering of human resources in the field of information and the establishment of a research centre on information). The subsystem of sectoral networks is integrated at present with the following information services: chemical industry, metallurgical industry, nutrition industry for the processing of agricultural and livestock products, economic and commercial statistics for industry, and a technical information service for industry in general. This last service formerly functioned as part of the Office of Information and Documents of CONACYT. Inspired by the technical information service of Denmark (the DTO of the Danish Council of Scientific Information) and of Canada (the Technical Information Service of the National Research Council) the technical information service of CONACYT began to function on a trial basis in February 1972. Slowly, SIT gained experience and was able to attain the support needed for its operation. Its growth and achievements finally necessitated its separation from the Council. In June 1975, the service was decentralized, becoming a fund of the Nacional Financiera, and the Council was put in charge of carrying out these tasks.

Functions: INFOTEC offers the following services:

- Program of Industrial Communication
- Question-Answer Service
- Bulletin of Technical News

The Program of Industrial Communication is designed to identify the technical information needs of firms in the manufacturing industry in Mexico. Furthermore, it seeks to detect specific problems in these firms with the object of proving that INFOTEC can help to resolve them. The role that this instrument plays is of vital importance because, in many cases, the productive unit lacks the capacity to make explicit demands for technical information; only by means of a visit and dialogue with engineers is it possible to make these units aware of the potential contribution of the information services. Three types of visits are carried out by the INFOTEC personnel:

(1) Promotion: The first visit to a firm is aimed at diffusing information about INFOTEC, identifying the needs of the firms, and trying to satisfy them.

(2) Problem solving: This deals with visits made at the request of a firm with the goal of finding a solution to a specific technical problem.

(3) Follow-up: This occurs after the two previous visits, and the object is to observe the way in which a firm incorporates and assimilates the information that has been given to it in response to a question.

The Question-Answer Service was established with the goal of locating and delivering the technical knowledge that industry needs to improve its products and manufacturing procedures. This service seeks to increase the provision of information disseminated by INFOTEC by attending to the specific demands for information. The majority of questions come from the production units, but the service also deals with the requests of public bodies, universities, technological institutes, foreign researchers, and the personnel of CONACYT. The questions can be formulated in writing or verbally. This aid has always been given for free (as are the other services offered by INFOTEC).

The selective dissemination of technical information is carried out by means of the Bulletin of Technical News. This monthly service aims to inform firms in different branches of the manufacturing industry about technological events judged to be of interest. On the basis of a previously determined interest profile, the titles of the articles that appear in various technical magazines are distributed; the subscriber indicates the articles that he would like to read, and INFOTEC sends him a copy free of cost.

In addition to these services, INFOTEC (and its predecessor SIT) began other functions that today play a secondary role in the activities of the institute. Among these services, one finds a "bank" of technologies subject to licencing procedures. This bank maintained a voluntary registry of technologies that had been developed or adapted by Mexican firms, with the aim of offering and promoting them in countries with a level of development similar to Mexico's. Another of the services is that of "new ideas applicable in Mexico."

<u>Program of Industrial Communication</u>: Up to November 1974, 785 visits had been carried out. The visits serve two central functions: to identify needs for information (in 1975, 52.8% of all the visits originated from a specific inquiry to INFOTEC, in comparison with 43.7% in 1973), and to familiarize the personnel of INFOTEC with the characteristics of each industry. Furthermore, the visits are not limited to firms: research centres were also visited, for this service aspires to be a link between the scientific-technological system and the industrial community.

A total of 730 visits took place between 1973 and 1974, and their distribution by type of firm was as follows:

- 76.4% of the visits were to national firms;
- 10.2% were to firms with a participation of foreign capital ranging between 20% and 100% of the equity;
- 13.4% were to research and experimental development centres.

If, indeed, the visits are an ideal instrument for identifying the need for information and for linking units of production with centres of research and experimental development, it is inexplicable that this service (which is free) has been given to subsidiaries of transnational corporations. In the first place, the technical information needs of these companies are satisfied directly by their main offices and, in fact, some of these corporations invest more in research and experimental development than is channeled into these activities in all of Mexico. Two explanations of this fact have been advanced: first, Mexican technicians working in the transnational corporations that operate in Mexico must keep informed so that dependence on the sources of information from the head firm does not increase; and second, these visits are necessary so that INFOTEC remains informed of the techniques utilized by transnational corporations in Mexico. The first explanation lacks a basis, because the technical information used by subsidiaries of the transnational corporations invariably comes from the central office: in fact, the possibility that the subsidiaries might adopt technologies that take local conditions into account is very limited, because they respond to the global strategy of the corporation. Under these conditions, it is not possible to expect that the Mexican technicians who offer their services to the subsidiaries of the transnational corporations would see their dependence reduced because INFOTEC (or any other organization) helps them resolve a technical problem in their production activity. In the end, the beneficiary is the transnational corporation, which does not need this type of service. As for the second explanation, it must be emphasized that the technicians of INFOTEC would be able to inform themselves about some practical aspects of production activity that will invariably be in the public domain. No technological element that is the object of a patent or protected as an industrial secret would be revealed in the course of a visit to a transnational company. Nonetheless, as there is no lack of interest in obtaining technical information on the production activity of these firms, it is better to obtain it in a systematic, standardized manner from every one of them. To this end, the National Commission on Foreign Investments (CNIE) could work in close collaboration with INFOTEC to obtain this type of technical data.

Question-Answer Service: The Question-Answer Service received its first question in January 1972, and by November of 1974 it had already received 1,538 questions. Of the first 218 inquiries, 52.2% were related to the chemical, nutrition, and metal-mechanic industries. These same fields have continued to be the most important: of 668 questions received during 1974-1975, 25.4% dealt with the chemical industry, 10.2% with the metal-mechanic industry, and 9% with the nutrition industry. Table 4 presents a classification by the type of questions and by the type of unit that presented them. (It is necessary to note that questions are classified by their themes and not by the branch of industry to which the unit that presented the questions belongs. Thus, a manufacturer of petrochemicals might ask questions about pollution or administration, and the questions would be classified according to these headings.)

Recent data show that 9.4% of this sample of questions came from subsidiaries of transnational corporations. Leaving aside the field of industrial engineering (in which the number of questions is quite low and in which the high involvement of transnationals could distort the general average), those areas in which questions asked by these corporations appeared with greatest frequency are: suppliers and manufacturers, mechanical equipment, pharmaceuticals, chemicals, and pollution. If it is considered that the Service was also made available to foreign institutions (educational or research centres), it appears that on the average 13% of the Service was offered to foreign institutions. In turn, 16% of questions arising from private industry originated from subsidiaries of foreign businesses.

Since in the offering of the Question-Answer Service, the accuracy of the information furnished increases (and with that, the cost of retrieving it), it is appropriate to ask whether it is justifiable to offer this assistance to firms that do not need it. On the average, answering each question occupies some 10 man-hours, according to 1973 figures. Given the limited resources of INFOTEC, the opportunity cost of offering such a service to these businesses is quite high. Moreover, in this case no benefit accrues to INFOTEC because it cannot obtain any knowledge of the technology used by these foreign subsidiaries in Mexico.

Bulletin of Technical News: The Bulletin of Technical News began in August 1972 in three specialized industrial fields: nutrition, chemicals, and metal-mechanic. Also, two general bulletins were put out: one on administration and the other on pollution. Subsequently, series were begun that treated the electronics, pharmaceutical, and ceramic and glass industries, as well as industrial engineering. The bulletins include an analysis of some 35 periodicals (on the average) in each of the fields they cover. From their content, articles of greatest interest are chosen and their titles sent to subscribers, who can then request a copy of the articles that seem most relevant to them. Each subscriber may request up to 15 copies (and a firm may subscribe to four bulletins); the service is free. Table 5 shows the sectoral distribution of the Bulletin of Technical News. The three most important sectors are still the first three in which it was distributed.

Like its Danish model, INFOTEC was oriented from the beginning to offering a service to small and intermediate firms. Because data broken down according to branches of industry on the sizes of firms receiving the various services of INFOTEC are unavailable, it is only possible to attempt a general analysis based on the data on the Bulletin of Technical News.

In October 1974, the Bulletin had 1,825 users, as shown in Table 6. Some 54.8% (1,002) were businesses with less than 50 employees. These 1,002 firms represent 1.6% of the total number of companies of the same size included in the Ninth Industrial Census (1970) (1). On the other hand, some 30% of the users (568) were firms with more than 100 employees each.

This total represents 19.8% of the companies with more than 100 employees, as recorded in the 1970 Census. Moreover, if the analysis considers the number of engineers working in each firm, more than 14% employed three or more engineers (and 80 employed more than 11 engineers).

One year later, the distribution of different-sized firms using the Bulletin of Technical News showed an increase in the relative participation of larger companies. As shown in Table 7, the total number of private firms using the service was reduced to 1,778, basically because the number of user firms employing 50 persons or less declined from 1,002 in 1974 to 782 in 1975. Yet the subscriber businesses that employed more than 100 persons increased from 568 to 697 in the same period. These changes are also reflected in the classification by number of engineers working in each firm: those that employed more than 11 engineers totalled 80 (4.4% of the users) in 1974, but this increased to 313 in 1975 and represented 17.6% of the total users in that year.

Table 7 contains the distribution of the sizes of the users of the Bulletin, according to the number of employees. A comparison of Tables 6 and 7 reveals that larger businesses of greater technical capacity had increased their participation as users of the Bulletin of Technical News. Firms with 100 to 250 employees totalled 1,796 in the Ninth Industrial Census; in 1974, 14.4% of these firms were users of this service, and this percentage grew to 17.5% in 1975. The same occurred in companies with more than 250 employees: the Census registered 1,065, and of these 29% and 35.8% used the service in 1974 and 1975 respectively. Moreover, 57.7% of the firms with more than 500 employees received the Bulletin (always for free) in 1975.

The data taken from the survey confirm the results mentioned above and prove that this type of service can constitute a powerful instrument for technological policy. Of the 67 firms visited, 30 had received some of the services of INFOTEC (or its predecessor, SIT). However, more than half (17) were firms that had foreign participation in their equity of more than 20% (and in 11 of these, such participation exceeded 40%). The distribution of sizes is presented in Table 8. As can be seen, there was no case in which a firm did not employ at least one engineer. About 33% had more than 20 engineers. With regard to the number of personnel employed, more than 50% employed more than 200 persons. Since the sample is small, it should be compared with the data supplied by INFOTEC on the size of all its users.

For the present and in relation to this small sample of companies, the effects of the service on their most important technological decisions are minimal. Some of these firms carried out research and experimental development efforts, but it is not possible to determine whether these were completed as a result of receiving the services of SIT or INFOTEC (although it is feasible that this service would be considered a help in such activities). On the other hand, of the companies involved in research and experimental development activities (10 in capital goods, 12 in petrochemicals, and 8 in foods), 52% received some service from INFOTEC. Therefore, one might hope that these firms would have the capacity to understand and assimilate technical information obtained through this channel.

In only two cases (one in petrochemicals and the other in foods), those interviewed indicated that they had come into contact with suppliers of machinery and equipment through the technical information service. These two companies have, respectively, 39% and 70% foreign capital; of the machinery installed in their various plants, 25% is of national origin in the petrochemical firm, while 90% is of foreign origin in the dairy product company. Neither company claimed to have come into contact with suppliers of technology through this service. In contrast, 11 companies that had used the services of INFOTEC noted that their suppliers of machinery and equipment had taken the initiative by visiting them and offering equipment, which they subsequently acquired on at least one occasion. Of the various channels of communication between the companies and the suppliers of machinery and equipment, publications (though not necessarily those furnished by INFOTEC) were mentioned by 12 firms in the three sectors. Finally, of 30 businesses receiving the information service, 26 had looked among various suppliers of machinery on the occasions when they acquired capital goods. This shows that the majority of the 30 enterprises using the services of SIT-INFOTEC had an active attitude vis-à-vis their suppliers of capital goods. But, after all, it seems improbable that the orientation of these technological decisions would be influenced in any way by this instrument.

In general, those interviewed made it clear that the technical news service was good and useful. Yet in some cases the service had been discontinued, and in one (in the capital goods industry) it was felt that the Bulletin rarely contained good articles. This observation agreed with the report of Sectional Committee No. 14 on the durable consumer goods and capital goods industry, which functioned within the framework of the preparatory studies of the National Plan for Science and Technology. In the section on information services, the report noted that "in general, the information distributed is inadequate for the technical level of the industries of this sector."

Yet the same report contains data on the evaluation made by users of INFOTEC of the importance of the information distributed by this service. Around 60% considered this information very necessary, 18% indicated that it was fairly necessary, and 22% judged it unnecessary. On its part, the Committee on the Intermediate Goods Industry (which includes the petrochemical field) considered that the services of the Information Centre of the Chemical Industry were still quite poor. And the Committee on the Nondurable Consumer Goods Industry decided that it was necessary to create an information centre specializing in the areas of foods, beverages, and tobacco. The consensus seems to be that existing services are insufficient and should be expanded.

An additional element in the evaluation of this instrument is that of the sources of information that it uses. As was to be expected, most of the magazines and other periodicals that the service uses for the Bulletin of Technical News are foreign. This is explained by the great scarcity of technical publications in Mexico. Out of a list of 85 magazines used in 1972 for the bulletins in the food, chemical, and metal-mechanic industries, 80 were foreign and five national. Moreover, in June 1973, 232 periodicals were received and utilized in preparing the bulletins: 79.7% were published in English; 12.6% in Spanish (but not necessarily of national origin); 4.3% in French; and 3.4% in German. This explains how, in that year, of the 1,331 articles that were included in the bulletins, 70.8% were in English, 19.2% in Spanish, and the remaining 10% in other languages. The complete figures, arranged by industrial branch, appear in Table 9.

Conclusions: SIT-INFOTEC emerged in the first phase of the existence of CONACYT. In this phase, the Council sought to initiate the so-called indicative programs in various areas, and it was hoped that the information system created by the Council would be oriented to satisfying the information needs of these programs. However, the lack of a clear vision of the functions of the support services soon led to the feeling that it was CONACYT that should lend its support to these services (2). Thus, SIT began to function experimentally without orientation toward sectoral priorities. In fact, one can say that the technical information service was directed to satisfying a latent demand for information (as INFOTEC continues to do at present) but not in any sense to direct that demand. Thus, promotional visits have been made to transnational corporations, to businesses in the area of toilet articles and cosmetics, etc.

SIT-INFOTEC was established by following the models of instruments of technological policy in two countries with characteristics quite distinct from Mexico's. The most important differences at the institutional level are that these instruments (the DTO in Denmark and the TIS in Canada) are accompanied by a battery of instruments of economic and technological policy that do not exist in Mexico. For example, the TIS of Canada depends upon the National Research Council, which conducts the Program of Assistance to Industrial Research. This program basically consists of granting subsidies to the salaries of personnel involved in these activities (the company pays the cost of equipment). Also, the Program for Promotion of Industrial Technology offers financing and subsidies of up to 50% of the total cost of a project (including the phase of advanced experimental development). Finally, the Law on Incentives to Research and Experimental Development in Industry of 1967 established various fiscal arrangements very favourable to expenses on research and development activities (3). The purpose of all these instruments is to promote the development of research activities in the companies, and TIS is no more than an added form of support. Clearly, TIS constitutes an additional instrument for general promotion.

In Mexico, none of these instruments exist (nor is it clear that they should), and therefore it is necessary to question the adoption of a similar model. In turn, the DTO of Denmark is considered an instrument that seeks to promote the best use of technical information in businesses by means of sending free information "to complement the study of information performed by the companies themselves." DTO also organizes conferences and mini-courses for industrial managers in collaboration with the Danish societies of engineers: the themes are linked to the importance of information for the development of the firms. In general, DTO has no other object than stimulating the use of technical information, but without claiming to know the latest developments: that is the function of the specialized centres of each branch. The Question-Answer Service functions as a reference centre through which requests are channeled to the source of information best suited to deal with them.

Clearly the question that presents itself in the case of Mexico is this: is the support of technological development in any type of corporation or any branch of industry an important object per se? If the response is affirmative, then an instrument like SIT-INFOTEC should guide itself by the structure of demand for technical information and attempt to satisfy it. But if the response is negative, a technical information service should seek to orient the direction of the most important technological decisions at the corporate level and ought to be available only to certain types of units in industrial branches selected according to their relevance to the efforts for development of the country. It is not risky to conclude that the answer to the question posed is and has been affirmative.

The nature of the services offered by this instrument is difficult to define on the basis of the information supplied by this organism. Apparently, most of the services are oriented to providing support for productive activities themselves. SIT-INFOTEC consists of a service that aids in the solution of specific technical problems that arise in production, maintenance, quality control, administration, and commercialization. In the branches analyzed, the service has no effect on the choice of alternative technologies, the motivation to introduce them, the decision to complete research and experimental development projects, or the choice between alternative projects. This assertion could probably be generalized and applied to the other branches covered by INFOTEC.

In the light of these observations it is possible to make a few recommendations. First, INFOTEC ought to abandon the idea of constituting an instrument that detects or receives a "demand" for technical information and ought to proceed to "satisfy" it instead. The wide dispersal of the scarce resources that are available represents an extremely elevated opportunity cost.

The choice of those sectors to which the service might be directed ought to become a function of programs more broadly defined by various agencies of the public sector. In particular, programs like the Nacional Financiera for the development of the capital goods sector require major support in the area of technical information services. If there are certain sectors judged important that lack a similar program in the public sector, INFOTEC ought to take care of them. But in these cases, certain criteria should be made explicit to avoid the errors of the past. In particular, it is necessary to consider the nature of the goods produced by firms that receive the services. It is necessary to stop offering this service to companies that produce superfluous articles such as cosmetics, toilet articles, foods elaborated for higher income levels, luxury consumer goods, etc. Characteristics of user firms such as their size or foreign participation in their equity should be evaluated as well.

Moreover, the determination of which sectors ought to be attended to by this service should be made by taking into account the following questions. How is new knowledge transmitted in the field: through publications, catalogues, licencing agreements, etc.? Are the channels of INFOTEC the most efficient for transmitting this information? Would it be more efficient to offer this service through a centre specializing in information in the field?

The report entitled "Bases for formulating scientific and technological policy in Mexico" submitted to CONACYT in 1974 has already recommended that the information services should aim to provide the maximum possible information on the problems of alternative technologies, different suppliers of technology, suppliers and prices of raw materials, intermediate products and capital goods, conditions of licencing agreements, etc. Significantly, the introduction of appropriate techniques into developing countries has been blocked by various factors, among which the lack of information about sources of appropriate technologies, about centres specializing in its development, etc., is outstanding. Generally, information services seem to show a bias against the selection of technologies suitable to the needs of these countries. Some efforts have been made to establish information centres with this goal; these include the Intermediate Technology Development Group in England (established by E.F. Schumacher, this group has developed specific technologies in many areas) and the Volunteers in Technical Assistance (VITA) Service. In 1972, the Council of Europe recommended the creation of an International Centre of Information on Intermediate Technologies (a term that created a serious controversy) (4) and UNIDO has established a service for adequate selection of equipment (ACE - Appropriate Choice of Equipment). This underscores that efforts to treat these issues have been made at the international level.

A recent study has indicated certain aspects that should characterize a technical information centre that might be interested in entering this field (5). Such an information centre should be capable of obtaining information on the suppliers of machinery in all the developing countries. Detailed economic information over scales, employment, requirements in terms of qualified human resources, characteristics of inputs, probable maintenance cost, etc., of various alternatives is needed in addition to a catalogue of existing machinery. Furthermore, the same type of information is necessary about appropriate technologies and processes.

Finally, it is necessary to consider the convenience of transforming the services that INFOTEC offers into a true industrial extension service with broader goals than those that it currently has. In particular, this new instrument could seek to orient the direction of corporate technological decisions by offering not only technical information but also by supplying economic information, technical assistance, information on research groups in Mexico and other developing countries that could solve problems, etc. These extension services could be promoted through the distribution of technical information, through industrial visits, and through the Question-Answer Service.

MANPOWER DEVELOPMENT PROGRAMS

The relationship between technological capacity and manpower requirements is a complex issue because it depends on the technological level of the industry, the educational capacity, the population distribution, and the employment pattern. The matching of manpower supply and demand is notoriously difficult and successful planning has not yet been achieved in this area. In the United Kingdom a serious attempt was made to establish a manpower planning system in the 1950s, but the effort has not been a success. In spite of this difficulty, however, all STPI teams acknowledged the importance of an adequate manpower development plan and suggested some guidelines and checklists for such a plan. A manpower development plan should incorporate:

(a) a forecast for the future industrial profile, including sectoral details;
(b) an employment policy based on (a);
(c) educational programs based on (a) and (b).

The crucial factor is timeliness. Since educational processes require considerable time and the industrial demand varies rapidly, matching these two different time scales is a very difficult task. Furthermore, educational institutions have public missions, whereas industrial employment lies in the private realm. Nevertheless, a manpower plan must be able to resolve these conflicting features.

The manpower planning in science and technology can be structured at four levels:

- craftspersons (skilled work)
- technicians (operation of technical systems)
- engineers (design and engineering analysis)
- researchers (R&D)

These groups of technical manpower constitute the central core of the national science and technology system. General labourers, clerical helpers, and management personnel provide the necessary reinforcement in operating the industrial plants and complexes.

Some of the STPI findings in connection with the manpower development programs can be summarized as follows:

(1) In most countries, no systematic planning exists. Education and employment become matters of spontaneous coincidence. Luck, prestige, and convenience control their patterns.

(2) Very few nations have firm employment policies on some understanding of a future industrial profile. Most of the market countries use, if they use a guideline at all, the present industrial structure.

(3) Governmental programs are either to upgrade skilled manpower or to improve the current educational system. Both approaches seldom used to be connected to the productive system. Lately, however, some STPI nations are trying to develop training programs in conjunction with industrial jobs. Peru, Argentina, and Korea have set up national training programs for skilled manpower. Mexico also has some private training programs.

(4) New bold attempts are being implemented to reorient the existing science and engineering educational system. These efforts are based on the general understanding of developmental goals and industrialization strategies. Venezuela is installing new technology degree programs in its university system, e.g., petroleum engineering. However, the most ambitious program is being pursued in Korea, which set up a new technological graduate school and revamped engineering curricula at universities and colleges.

INDIA

Manpower Plan for the Electronics Industry

As an example, the Indian manpower plan in the electronics industry is described in this section. Other sectors have similar plans but at a lower and less ambitious level.

The electronics industry in India is poised for major growth during the next decade. Rapid technological changes are leading to a requirement for highly skilled and more adaptable manpower. The social changes, including changes in the educational system, are altering the pattern of supply of human resources in ways that may not always be in pace with the technological requirements. To ensure that the supply of trained personnel matches the future demand, it is imperative to take up the problem of manpower planning on a priority basis.

When planning for manpower, knowledge of labour productivity is essential. Labour productivity can be considered as a set of technical coefficients, which in effect establish connections between the output of different sectors of an industry and the most important resource, labour. It is, in the most general sense, volume of income per employed person. When employment cannot be increased substantially or can be increased only in the long run, the economic development will depend on productivity increases. This is the case in many developed countries. The situation is rather different in developing countries like India, where human resources are plentiful and where the production in labour-intensive industries, like the electronics industry for example, can be increased through a substantial increase in employment.

The Bhabha Committee envisaged that the average wage bill for producing electronics equipment would be 38% of the sale value, of which the wage bill for those engaged in direct production, engineering supervision, design, and development in the plant would be about 28% while the wage bill for auxiliary staff engaged in stores, purchasing, and administration would be about 10%. The output per person employed for the manufacture of equipment in the electronics industry, including all supporting and auxiliary staff, was estimated to be Rs9,000 against Rs12,000 for a person directly employed in production. As the Committee envisaged a production of Rs300 crores worth of electronics equipment by 1975, the total manpower requirement was foreseen to be 330,000, with the skilled workers, technical staff, and engineers numbering 250,000.

For the production of Rs300 crores worth of equipment, the production of roughly Rs84 crores worth of components was envisaged. The output per person employed in the components and other process-oriented industries was assumed to be about double that for the equipment industry. On this basis, the total number of persons employed in the component production industry in 1975 was estimated to be about 40,000, with skilled workers and technical engineers numbering about 32,000.

An additional manpower requirement consisting of about 15,000 scientists and engineers and 30,000 supporting technical staff was envisaged for research and development activities in laboratories and research institutes outside the plants.

Thus, it was expected that an investment of Rs170 crores would provide employment in the electronics industry for some 400,000 scientists, engineers, skilled workers, and supporting personnel, the per capita investment being about Rs4,000. Although to a large extent the production targets set by the Bhabha Committee were met, this is not the case as far as the manpower employment in the industry is concerned. It is estimated that at present about 120,000 persons are engaged as the production and supporting staff. This is only about 30% of the projected figure. The main reason for the Bhabha Committee's estimates going astray is the increase in per capita productivity. At present the average per capita productivity for the electronics industry is about Rs30,000, while for the component industry it is about Rs15,000.

An idea of the organizational structure in the Indian electronics industry can be obtained by looking into the staffing pattern in some large-scale manufacturing units like BEL and ECIL. The former, Bharat Electronics Limited, is primarily engaged in the manufacture of communication equipment, including broadcast transmitters, radars, electronic tubes, semiconductor devices, and TV picture tubes. Its production during 1972-1973 was about Rs39 crores. The total number of personnel employed is around 14,000, with a per capita productivity of about Rs30,000. More than 75% of the staff is directly employed in production units, while the remaining 25% is engaged in activities like administration, accounts, and stores. About 65% of the employees are either scientists/engineers or skilled workers. The scientists, engineers, diploma holders, and graduates account for about 8% of the staff. The strength of unskilled and nontechnical staff is nearly 12% of the total employment.

The ECIL, with an annual turnover of about Rs6.6 crores in 1972-1973, employs about 3,300 personnel. Per capita productivity during that year was approximately Rs20,000. The Corporation is engaged in the production of passive components, semiconductor devices, television, computers, and medical electronics equipment. The administrative staff accounts for more than 15% of the employment. About 73% of workers are engaged as scientific and technical personnel, while the remaining are in the unskilled category.

At present the per capita investment in the electronics industry is estimated to be about Rs9,000.

Because the electronics industry in India is predominantly labour intensive, the occupational structure is expected to be considerably different from that in the developed countries. It has a very high employment potential for skilled and semiskilled workers because the majority of manufacturing units require manual skill. At present, the semiskilled staff accounts for more than 60% of the total manpower employed in the industry. The proportion of inplant and white collar workers differs from sector to sector because it depends on factors like the extent of industrial automation, the use of subassemblies, etc. From the 10-year profile given by the Information, Planning, and Analysis Group of the Electronics Commission on the basis of extensive data available and other numerous analyses, information, and technical panel reports, the additional manpower required by the end of the Fifth and Sixth Plan periods has been estimated.

The present per capita productivity for the electronics equipment industry is about Rs30,000, while for the components industry it is Rs15,000. During the last year of the Fifth Plan period the productivity per person is expected to increase to Rs35,000 for the equipment industry and Rs20,000 for the components industry. These ratios, however, give a detailed break-down of the manpower requirement in each sector. The numbers given for the various sectors of the industry and the occupational structure were estimated from the existing manpower employment figures in the various public and private sector enterprises. Allowance has been made for the increase in productivity per person due to technology development. The employment potential of the industry is anticipated to be 1.86 lakhs during the Fifth Plan period. The semiskilled personnel alone account for 60% of the total employment. These workers are to be engaged in jobs like assembling and machining. The demand for scientists, engineers, and diploma holders is likely to be about 14,500, while 24,500 skilled workers will be required.

The increase in employment during the Sixth Plan period is expected to be less than the corresponding increase in output, because per capita productivity is expected to increase further as a result of improvements in production techniques. The partial growth of mechanization and automation of assembly line operations, the increased use of integrated circuit technology, and the associated miniaturization will reduce the demand for semiskilled workers to some extent. The employment of engineers, scientists, skilled workers, and administrative staff is expected to increase. The industry is expected to generate an additional manpower requirement of 2.14 lakhs, and semiskilled labour will account for only 56% of the additional manpower during the Sixth Plan period as compared with 60% during the Fifth Plan period. It is anticipated that the demand for scientists/engineers/diploma holders and skilled workers will be 18,500 and 33,000, respectively.

The total wage bill by the last year of Sixth Plan period is expected to be 30% of the production during the same period.

It is expected that the production of Rs2,300 crores worth of electronics equipment and components during the Fifth Plan period will provide an additional indirect employment of about 70,000 persons. This number will reach about 100,000 by 1983-1984 provided the projected production of Rs5,560 crores worth of electronics equipment and components during the Sixth Plan period is achieved. The indirect labour will mainly consist of service and maintenance workers.

Hence, the growth of the electronics industry is expected to generate an additional employment of 2.5 lakhs and 3.1 lakhs persons during the Fifth and Sixth Plan periods respectively.

SOUTH KOREA

Scientific and Technical Manpower Plan

As a part of its 5-year economic development plan, the Korean government establishes a plan for scientific and technical manpower for the planning period. An example is shown in Figure 1, which illustrates the basic manpower plan for the 5-year period from 1972 to 1976. To fill the gap between the projected demand and the current capacity of manpower supply, the Korean government makes adjustments in training and education.

Some of the major features and policy actions associated with the manpower plan for the 1972-1976 period illustrate the pattern of the policy instrument as follows:

(1) There are in Korea some 70 universities and colleges, both public and private, with over 150,000 students, about 30% of whom are enrolled in the science and engineering fields. As a part of a reorganization of the educational system to meet the projected manpower demand, a selected number of science and engineering universities and colleges were converted to postgraduate training, with expanded support. It was planned that the Korea Advanced Institute of Science would provide leadership in this amelioration process. Other universities and colleges, which are relatively less qualified, have been reorganized to produce professional technicians, each institution specializing in practical technologies needed by specific industries.

(2) Vocational education and training were also far behind the rising demand from industry for qualified technicians and craftspersons. The technical high-school system was therefore refurbished and extended, together with increased training within the industry. There was considerable uncertainty as to the overall position with regard to the supply and demand for technical manpower during the 1970s. There has been a considerable oversupply of scientists and engineers but a serious shortage of technicians and craftspersons. To correct this imbalance, efforts have been made to retrain scientists and engineers into skilled technicians. It remains to be seen, however, whether the use of science graduates as technicians will prove a feasible and adequate solution to the problem. Sophisticated industry requires trained personnel, comprising many different skills able to operate at many different levels. This implies a need for people who are specifically educated and trained for the job they are going to do. This requirement is particularly important in industries where not only the subject of speciality is decisive but also the level. The manpower system in industry is tightly organized and all links must be present, otherwise production will fail. One link cannot substitute for another. Every level has its special functions to perform and its special curriculum, and the overlap is fairly small. Technicians and craftspersons have the most practical curriculum and no other group can substitute for them.

(3) Another important aspect of this topic is that although education has a high prestige in Korea, people in general show a reluctance to become scientists or technologists, who generally lack status and social recognition, and in government service are comparatively poorly paid. Salaries can be adjusted, but it is more difficult to change social attitudes. Hence, to meet future requirements, it was important to increase science teaching and practical technical work at primary and secondary school levels, and to encourage the science popularization movement. The government aims that everyone should have at least one basic technical skill, thus providing a foundation for further training and at the same time helping to break down the traditional contempt for manual work.

Statistically, Korean scientific and technical manpower amounted to 550,600 in 1972, of which 27,400 (5%) were qualified scientists and engineers, and the remainder technicians and craftspersons. Of the scientists and engineers, only 2.2% were employed in agriculture, forestry, and fisheries, 28% in mining and manufacturing, and the rest in social overhead capital and other services. Within the total there were some 15,000 researchers, of whom 2,600 were in universities, and the rest in the various research institutions. (A more detailed description of Korean scientific and technological manpower is given in the country report.)

MEXICO

Structure and Operation of Worker's Training Systems

The first centres of industrial training in Mexico were created in 1963. Until that year, the emphasis in the preparation of human resources was placed on the highest level of schooling. At that time, the Centres of Training for Industrial Work (CECATI), as well as a school for teachers of industrial training, were established. Both institutions were subordinate to the General Administration of Technological Industrial Education of the Ministry of Public Education. At present, 27 CECATI exist in Mexico and 15,452 students graduated from them in 1974-75. In the period between 1963 and 1975, the workshops and classrooms of the CECATI prepared 122,267 students (6). The specialties of this total of graduates (with rights to a diploma) are the following:

Machine tools	18%
Electricity	18%
Automotive mechanics	17%
Industrial drawing	13%
Welding	12%
Clothing industry	11%
Electronics	8%
Other specialities	3%

The Centres obtain their budgets almost entirely from the state. The budget for each unit is about $300,000 on the average (which results in a total budget of $8,100,000 for the 27 Centres. Enrollment costs 100 pesos for each student, and in some cases contributions are received from corporations when a short course is specifically oriented to satisfying their request (short courses of 12 to 20 weeks exist, offered by means of agreements with industries).

The Mexican Institute of Social Security (IMSS) also operates 10 Centres for Training and Instruction. These offer free courses whose length varies according to the speciality: from 2½ months to 10 months maximum. The number of graduates is about 5,000 each year, and these Centres are financed by IMSS. But in some of these IMSS Centres, training courses for the service sector are offered.

The National Centre of Technical Industrial Reaching (CENETI) was created in 1964 and has the objectives of preparing teachers of technical industrial education, technicians, engineers, and researchers; carrying out basic and applied research; cooperating with the public and private sectors in programs for preparing technical cadres; and contributing to the solution of national and regional problems of a technological character. However, this institution does not offer rapid training courses: the shortest course lasts 3 years. In its 10 years of existence, CENETI prepared 788 teachers of technical industrial education and 514 industrial engineers. The finances of the Centre come from the state. The atomization of the functions of this institution has been quite extensive, and the research that has been developed in its installations is not integrated with well-defined programs of action that might assure the use of resulting knowledge in the phase of technological development.

The national service of Rapid Instruction for Labour (ARMO), established in 1965 after an agreement between the Mexican government and the United Nations (through the ILO), seeks to offer courses of instruction to supervisors to train them to give technical instruction to workers. Furthermore, improvement courses are presented for supervisory personnel already working in industry. Finally, programs designed to give better qualifications to workers already hired are also offered. Between 1966 and 1970, the service trained 15,000 supervisors and workers. From 1970 to 1975, the numbers completing courses increased rapidly to 14,000 instructors and 28,000 workers.

As distinct from CECATI, CENETI, and the IMSS Centres, the ARMO service is a training service for supervisors that is given in the installations of the firms themselves. Although this may represent savings for the ARMO service in terms of utilization of equipment and facilities, the flexibility of the training is reduced, for it is necessarily adjusted to the specific needs of each unit. But these instruments of industrial training (with the exception of IMSS) have one common characteristic: they are oriented toward workers who have minimum schooling at the primary level. This can indicate a bias in favour of offering a training service (free in many cases) that fundamentally benefits industries in the so-called modern sector: large or medium industries that concentrate in great part in production and that in general adopt technologies of greater capital intensity. In fact, many of these firms are subsidiaries of transnational corporations, which have resources available to train the labour force they hire.

The data obtained in the survey do not permit a quantitative analysis of the impact of the training centres on the choice of techniques in the firm. However, illustrative examples of some of the hypotheses presented above do indeed appear. Of the 67 firms visited, only 22 hired personnel graduated from the training centres in a systematic manner. The participation of foreign capital in these companies turns out to be rather significant: in six firms, it was more than 50% of the equity (100% in two cases); in another seven, the participation was less than 50% but greater than 40%; and in one case, the participation was 25%. The other eight firms were 100% national, and only one was 100% state property. Although an exhaustive study is necessary to examine in detail the relations of the training centres to the productive units, with the data presented above one can question the rationale of a system of industrial training that benefits not merely the medium and large firms, but the transnational firms as well. Apparently, efforts at establishing the infrastructure necessary for this type of company have not been curtailed, not even the absorption of training costs by the state. Very few corporations have training programs available, in spite of evidence that it is feasible to offer accelerated training to persons without previous industrial experience (7). In several of the companies visited, it was recognized that it was feasible to train a worker to perform the tasks of a technician in a few months.

On the other hand, decisions on the choice of capital or labour-intensive techniques are not solely a function of the availability or scarcity of trained labour. Even without estimating coefficients of elasticity of substitution of factors, it is possible to realize that technical possibilities that permit greater use of labour are as available to the machine tool and industrial machinery industries as to packers and processors of fruits and vegetables. In the petrochemical, dairy products, and agricultural machinery industries, the possibilities are reduced, for very large-scale production predominates, and in the case of petrochemicals (excluding the processes of intermediate flow) and dairy products, the very nature of the process imposes limitations. But in some industries, the availability of qualified labour may have some effect on the use of techniques that are more labour-intensive: six firms in the capital goods sector indicated that this was so (moreover, seven firms in this branch indicated that they could not expand their production partly because of a scarcity of qualified personnel). In four cases in the food industry, it was indicated that technical and economic possibilities for using more labour did exist, but the difficulties of obtaining more raw material represented a greater obstacle for the development of the firm and the use of labour-intensive techniques.

Differences in labour requirements can be quite accentuated between or within branches of industry: thus, in the firms visited, the greatest proportion of qualified workers was found in the capital goods industry (63% of the employed personnel, against 31% unqualified workers); the greatest percentage of technicians (8) was found in the petrochemical industry (9.7% of the personnel employed by these firms had this classification, against 5.5% in the capital goods and 2.1% in the food industries); and the greatest percentage of unqualified workers was found in the food industry (42.5% of the total personnel, versus 31% in the capital goods industry). Moreover, marked differences are present within each branch, which have implications for the choice of technology. Still, almost all the firms that were visited are located in what could be called the modern sector.

Another interesting finding is the almost total lack of training programs for labour in the firms visited. Some had extremely brief programs (scarcely 3 weeks) designed to prepare workers for tasks of only slight complexity. In others, the programs were carried on in conjunction with the ARMO service or the local CECATI. In the case of some large-scale firms with rather well-developed technological levels, the programs of the local CECATI were designed totally to serve their needs; the courses are led ("as a contribution" to the Centre) by the supervisors of the plant themselves; on occasion, a class of trainees has been absorbed as a whole by one of these companies. In general, one can conclude that private corporations, national and foreign, bore only a marginal fraction of the cost of preparing and training the personnel who later worked in their installations.

With the information available, it can be concluded that a great deal can still be done. All together, the graduates of CECATI, ARMO, and the IMSS Centres annually do not represent more than 12.4% of the total economically active population, which it is calculated is found in "equivalent unemployment" in industry (9). The demand for short courses in preparation for work must remain almost totally unsatisfied.

The dispersion in the number of types of institutions, as well as in the types of courses offered, is evidence of the lack of a well-articulated policy for directing the action of these services. No studies exist that could define criteria for concentrating the efforts of these centres in the industrial branches considered most important (or in those that might offer more possibilities for using more labour-intensive techniques). Basically, this is a result of the fact that there is no policy of employment to rely on: and in reality, a policy of employment requires a well-defined strategy for development, for it touches all its important parameters (investment, technology, income distribution, exports, regionalization, etc.). These centres simply respond to an already-existing demand for training and do not tackle the task of reorienting it. But basically the existing demand is that from modern industry, which uses techniques with greater capital intensity (which require labour with a greater level of training and preparation). The industrial training centres can have an effect in that their graduates are hired; but this does not necessarily mean that the entrepreneur will use more labour-intensive techniques.

There is one last consideration in connection with the cost and benefits of this instrument. Workers who have passed through the workshops or classrooms of a CECATI will in some manner have incorporated technical progress in their recently acquired abilities. Taking into account that training costs are not borne by the entrepreneurs who hire the newly prepared workers, who should benefit from the fruits of this technical progress incorporated in human ability?

In relation to corporate expenses for training labour, no criterion for the fiscal treatment of such costs exists at present, and in some cases fiscal authorities can accept its deductibility from the taxable total. An interesting recommendation consists of granting favourable fiscal treatment to expenditures for training courses in the installations of the plant or in the training centres in exchange for denying deductibility for expenditures for advertising. Of course, it would be necessary to rely on the valuation of specialized institutions so that such deductions would be accepted; CONACYT and the training centres themselves (unified under a single institution) would be the most obvious institutions to determine criteria on the types of firms, training programs, and industrial sectors subject to this fiscal treatment.

CONSULTING AND ENGINEERING ACTIVITIES

The development of consulting and engineering activities is widely recognized as vital for the scientific and technological development of developing nations. Their use was recognized in the STPI study as relevant for:

- making better choices in investment decisions;
- making more efficient purchases of technology;
- improving the absorption and diffusion of technology;
- developing local industry;
- using the indigenous R&D better;
- using all local resources more intensively;
- reducing technical vulnerability;
- reducing foreign exchange components of projects;
- increasing exports of goods and services;
- developing indigenous technological capabilities.

Based on the STPI country reports, the following conclusions were drawn regarding the relative effectiveness of explicit and implicit policy instruments aimed at promoting the development of such consulting and engineering capabilities, as follows:

(1) Explicit policy instruments can be used to stimulate the demand for consulting and engineering services (for example, Peru or Argentina). If there is an element of compulsion in the instrument - as there was in Peru, which required all investment

proposals to be accompanied by a feasibility study carried out by a consultant - the positive effect on demand is direct and immediate.

There are two related issues of interest: while the demand for consulting services can be stimulated, the supply of such services can become a bottleneck in that the quality of such work may be extremely poor. This would lead to consulting services being used as subterfuge to meet the legal requirements only, as happened in both Peru and Argentina. Thus the policy instrument can create a demand for Consulting and Engineering Organizations (CEDOs), but if the objective of developing CEDOs is, for example, better investment decisions or more appropriate choices of technology, these are not attained.

The quality of consulting services to be developed also needs to be simultaneously the object of an appropriate policy instrument. This may range from a detailed preinvestment study manual that stipulates the information to be submitted in a feasibility study, to the requirement of registration of engineers and firms, whose experience and background can be examined by a professional group on a periodic basis.

(2) Where the policy instruments are of a recommendatory nature (as, for example, policy guidelines in India), the effect on the demand for CEDO services is much more limited. In these cases, the institutions and mechanisms that implement the policy have discretionary power, which is utilized in a somewhat random manner. Somewhat paradoxically, the large CEDOs do not have a problem of quality of services, perhaps because they have to sell their competence in competition with the foreign sources of supply. Another side-effect of this somewhat laissez-faire policy is that CEDO capability may not be built up in a crucial sector of the economy, leading to repetitive imports of the same technology over a period of time (for example, ports and shipyard design capability in India).

(3) The registration of contracts has little effect on the disaggregation of imported technology or on the greater utilization of local CEDOs. This may be due to the fact that the duration of CEDO services is normally in the order of 6-18 months, while the normal functioning of the administrative ministries may also be in the same order. The two factors of relevance here are: (a) if a local CEDO is involved in the purchase and negotiation of imported technology, greater disaggregation of the package is possible; and (b) if certain restrictive clauses in the contracts regarding reexport or diffusion of this know-how are removed, this will stimulate horizontal diffusion of technology in the country and also permit exports to other countries.

(4) Financial and fiscal policy instruments have a limited positive impact on the growth of CEDOs. The granting of subsidies for prefeasibility studies (as, for example, in Argentina and Brazil) has had little impact, either because the smaller CEDOs are ignorant of these laws or because the larger CEDOs are not very interested in carrying out such studies, which are of marginal profitability to them. Fiscal incentives for the export of engineering services have, however, had a more stimulating effect in the preparation of "packages" for export.

(5) Policy instruments that control the amount of foreign equity in local CEDOs can be effective instruments, although the data on their performance is scanty. In some countries (for example India) this has been used to control the increase in foreign companies that form or associate with weak local CEDOs and use this facade to import technology and break into the domestic market. In Mexico, on the other hand, this has proven to be a rather inefficient instrument. In the STPI countries, the following instruments were identified as policy instruments that have some influence on the development of engineering capabilities:

Argentina	Buy National Law. Permanent National Fund for Preinvestment Studies. National Registry of Licence Contracts and Technology Transfer.
Korea	Engineering Services Promotion Law. Technical Consultant Promotion Law.
Peru	Financing Fund for the Preparation of Investment Projects. The Industry Law. Development Finance Corporation. Induperu.
Brazil	National Institute of Industrial Property.
Mexico	National Technology Transfer Register. National Commission on Foreign Investments.

		Certificates for Indirect Tax Rebates for Exporters of Services and Technology.
India		Policy Guidelines on Foreign Collaboration. Foreign Exchange Regulation Act.
Colombia		Fiscal Treatment of Technological Services Provided by Foreign Companies or Firms.

Among these, only one instrument was found to have been created for the development of CEDOs - the Engineering Services Promotion Law of Korea, 1973. In the other STPI countries, the policy instruments did have a certain impact on the various activities of the CEDOs, but they were not specifically designed for the promotion or control of CEDO activities. The impact of these policies on CEDO activities was implicit in their operation, but their major objectives were quite different; for example, control of foreign investment, encouragement of local industry, etc.

ARGENTINA

Buy National Law

The Buy National Law (1971) is aimed at using the state's purchasing power by directing it to the domestic supply services, thus favouring domestic industry as well as domestic engineering and consulting. The Law speaks clearly about favouring "the industrial and construction sector as well as engineering and consulting services." To this end, it stipulates the obligation to hire these services domestically and states the decision to reject any credit that implies designing and projecting by any imported party.

The Law assigns engineering and consulting services a special importance, which makes them, because of their nature, activities that require that they be upgraded into their proper context: "...the density of its intangible capital brought about by training, the knowledge, the experience and the decisions and organization capacity of its professionals and experts...this type of capital cannot be transferred instantaneously but rather must be domestically created and requires long years of cumulative efforts on the part of society." The Law then tries to guarantee a stable and permanent demand for domestic engineering services to make possible "the existence of strong, stable and independent firms."

In its operative part (Art. 1, item c), it stipulates the obligation of any public administration and state enterprise to "hire domestic professionals and consulting firms with the exceptions contemplated in this Law."

Lastly, there are two specific aspects of the Law that should be specially mentioned, given the effects they have had on the way in which domestic engineering has developed:

(1) The Law makes it mandatory for foreign consultants to associate with domestic firms to be able to participate in tenders, which led, and is leading, to temporary joint ventures with different implications and consequences: "...in case an international tender is called for, no condition which explicitly or implicitly could descriminate against domestic enterprises may be included. Furthermore, the foreign firms participating must associate with domestic enterprises..." (Art. 2).

(2) The Law differentiates between engineering and construction, which, if effectively enforced, would make possible the domestic development of true engineering firms independent of construction firms: "Domestic professionals as well as the domestic engineering and consulting firms included within the present law must be absolutely independent from equipment suppliers or manufacturers, contractors for public works or financial agencies which may compromise the objectivity of their judgement." (Art. 15)

This instrument and the one that preceded it, the Buy National Law, are the first formal attempts to use the state's purchasing power to promote industrial development as well as to develop domestic consulting capabilities. For purposes of the first objective, the mechanism used is to make it mandatory to direct purchases from the public sector to domestic enterprises, classified under several categories. In the case of consulting services, it is a question of assigning top priority to domestic consulting firms, or to demand an association between domestic and foreign consultants when the latter are indispensable.

Permanent National Fund for Preinvestment Studies

The Permanent National Fund for Preinvestment Studies (1967) is for the partial financing of different technical studies and analyses related to the identification and evaluation of investment projects both at the private and public level. The studies covered by this Fund are those related to research in general, development of natural resources, and sectoral studies capable of identifying programs or specific feasibility studies. Also included are studies of piecemeal engineering, and the task of formulating the bases for public bids. One of the aims of the Fund is to develop a permanent and interdisciplinary group of consultants of a highly professional level.

When this Fund was recommended for approval, it was stated that: "The above mentioned tasks, because of their technical complexity and specialization, should be entrusted to groups or teams of expert consultants....Considering that there exist in the country several groups of specialized consultants integrated by Argentinian professionals, it is also in the national interest to maintain and increase both the technological and the occupational level of these teams."

This has had little success in accomplishing its main objectives, mainly because of the limited administrative capacity attached to it, which led to a passive attitude toward possible users.

National Registry of Licence Contracts and Technology Transfer

The objectives of the National Registry are to select the most suitable technologies for Argentinian development, and to avoid restrictive practices, unnecessary and excessive payments for technology acquisition, and the direct or indirect intervention of foreign suppliers of technology in national affairs.

This instrument is related to engineering and consulting firms in three aspects:

(1) It tries to develop local advice as regards imported technology with a view to its rationalization, which favours at the same time the activity of the firms.

(2) It tries to impede the acquisition, without restraint, of foreign technology and engineering (even piecemeal engineering), which may also favour local firms.

(3) It tries to introduce an intermediary element - a sort of filter - in negotiations involving the transfer of technology. Local firms may act in this process and consequently may be affected favourably or not as regards their interests.

The Registry has not been able to transcend the restrictive functions and head toward a more active role of advice to firms or even of searching for alternative technologies. It must be pointed out, however, that its institutional location within the National Institute of Industrial Technology has allowed the Registry to have a positive interaction with its technical staff, resulting in a better technical evaluation of the contracts.

In an overall evaluation, it can be stated that the intended effects of the policy instruments for the growth of CEDOs have not been achieved. This failure may be ascribed to the following reasons:

(1) No instrument refers specifically to the development of CEDOs as a main objective in itself.

(2) The instruments are being operated in an environment not conducive to the growth of local CEDOs as witnessed in: the isolation of the local S&T system; the risk-avoidance attitude of the bureaucracy, which prefers to award turnkey contracts; and the existence of foreign firms that bypass these instruments by associating with local firms who provide a legal facade, but that transfer no technology.

(3) The enterprises purchasing technology are unwilling to accept local CEDOs.

(4) The structure and mechanisms for the negotiation of foreign technology imports exclude participation by CEDOs.

(5) The potential user is ignorant of these instruments.

SOUTH KOREA

Engineering Services Promotion Law

The Engineering Services Promotion Law (1973) states that registered engineers are to be granted preference in engineering services contracts in Korea. If Korean-registered engineers are certified as unavailable and foreign engineers are used, then Korean engineers must be associated with the specific activity to the maximum possible extent. The Law is expected to provide a protectionist measure against excessive competition to foster the growth of domestic engineering firms and research organizations.

It is assumed that this Law will have an impact on small and medium-sized firms. Present evidence shows that local CEDOs join the established engineering firms to enhance their credibility and marketing potential. Others use joint ventures as a device for bypassing the above Law.

Technical Consultant Promotion Law

The objective of the Technical Consultant Promotion Law (1972) is the development of national consultancy and engineering capabilities. It relies on restrictive measures: professional technical consultants should be given a licence from the government to operate. It limits the participation of foreign consultants to cases where domestic technical resources are not available.

PERU

Financing Fund for the Preparation of Investment Projects

The main objective of the Financing Fund was to channel funds, originating mainly from U.S. AID, into investment studies. It set up the first register of consulting firms in Peru and encouraged consulting activities. Enterprises and project promoters were the beneficiaries of this Fund.

This Fund did not give rise to a clear encouragement of CEDO activity in the country, basically because the need for consulting services was covered nearly exclusively by foreign firms, which, in exchange for guaranteeing credit operations, served as a facade for the sake of importing equipment and technology from the foreign enterprises with which they were connected. The users' lack of a clear awareness and understanding of the importance of preinvestment studies resulted in a significant part of the finance available not being used. Yet it created an awareness of the need to carry out pre-investment studies and gave rise to the establishment of some domestic consulting firms.

The Industry Law

The Industry Law (1970) stipulates that it is mandatory for any project to be accompanied by a feasibility study justifying the investment. This regulation is applicable to both private and public projects, either to create enterprises or to expand a program.

This Law generated a large demand for CEDO services and also a large number of CEDOs. But most of the CEDOs had very scarce technical capabilities and were interested only in profits. Enterprises still did not have a clear awareness of the importance of these studies, so their implementation was seen, in some cases, as a mere legal formality. The basic criterion used to evaluate the studies was just their cost.

Development Finance Corporation (COFIDE)

COFIDE (1971) is a state financing agency entrusted with capturing savings to be directed to promoting investments. It started participating in consulting services in the areas of preinvestment and work supervision.

Induperu

Induperu (1972) is a technical and managerial services enterprise entrusted with implementing the state's entrepreneurial policy in the industrial sector. Among its duties, it is charged with providing consulting services.

The creation of these two institutions has implied the initial development of a state consulting capability, as well as a means to channel and develop private domestic consulting services.

BRAZIL

National Institute of Industrial Property (INPI)[10]

One of the functions of INPI is to orient and regulate the contracting of services and consulting engineering abroad. The contracts must be registered before INPI, whose approval is also required in the case of state enterprises.

As most state enterprises do not realize that a systematic and planned contact with INPI would get them more reasonable clauses and financial aid, they go for the register and approval at the last minute. Thus they do not use it properly and they perceive it only as a barrier that prevents them from accomplishing their objectives within the timetable scheduled for the project.

MEXICO

The effects of industry and technological policy instruments that exist in Mexico have been analyzed on the basis of a study of 47 contracts. The effects of these instruments on engineering firms are indicated below.

National Technology Transfer Register (RNTT)

The Transfer of Technology Law indicated that agreements or settlements whose job is the rendering of engineering services in general are to be registered.

A study of 47 contracts involving engineering firms revealed that this instrument has had an indecisive effect on the development of Mexican engineering firms, because the Law that established it does not give differential treatment to the various types of contracts, and does not contain all of them. Also payments and other contractual matters are not being evaluated properly.

National Commission on Foreign Investments (CNIE)

Acquisition of more than 25% of the equity or 49% of the fixed asset of any local company has to be approved by the National Commission on Foreign Investments. This instrument would be particularly useful to control the increase in foreign companies that associate with weak local CEDOs to break into the domestic market.

It has been seen that this is a rather inefficient instrument in terms of regulating the flow of foreign capital. It has been used only once, and unsuccessfully at that.

Certificates for Indirect Tax Rebates for Exporters of Services and Technology (CEDIS)

In October 1973, a fiscal incentive consisting of a tax rebate of 11% of the total value of services rendered and a tax exemption involving machinery utilized by exporters of services and technology was established.

This instrument does not seem to be a decisive factor in promoting foreign operations of domestic engineering companies, but it does help in bids and tenders submitted abroad, particularly in the case of forms which in addition to engineering services offer also construction and assembly services.

INDIA

Policy Guidelines on Foreign Collaboration

The major policy instrument in India has been the Policy Guidelines on Foreign Collaboration (1969) of the Ministry of Industrial Development. These Guidelines state that preference is to be given to local CEDOs where they exist and are competent. In these cases, the local CEDOs should act as the prime consultants, with the foreign companies acting as their subcontractors. These Guidelines also recommended a ban on the import of turnkey projects.

These Guidelines have had only a limited impact on the creation and growth of CEDOs for the following reasons:

(1) They are only recommendatory and hence depend upon the discretion of the individuals operating the instruments.

(2) Bilateral credit-supported projects often include engineering services as a part of their condition.

(3) Equipment suppliers often provide these services at an extremely low cost, thus outbidding local CEDOs.

(4) "Risk aversion" characterizes the attitude of entrepreneurs, particularly in state enterprises, who prefer foreign technology.

(5) The Guidelines do not cover engineering services specifically but are aimed at the import of goods and equipment.

Foreign Exchange Regulation Act (FERA)

The Foreign Exchange Regulation Act (FERA) and the one on in-house R&D were only introduced in 1974-1975 and it is too early to evaluate their effectiveness. Recently, tax concessions have also been announced for consultants and CEDOs on any work they do abroad. Although this has encouraged the export of technical services in a qualitative sense, empirical data on its effects have still to be collected.

COLOMBIA

Fiscal Treatment of Technological Services Provided by Foreign Companies or Firms (Art. 14 of Decree 2053 of 1974)

Before 1974, because of the concept of nonextraterritoriality in the Colombian legislation, payments made to foreign firms for technological services (including engineering firms and services rendered by foreign enterprises) were not taxed in Colombia (presumably, the foreign country paid the taxes). Only a tax of 12% was paid on the total sum of remittances abroad. The Fiscal Reform of 1974 changed this concept and declared that an income tax of 40% over the total amount has to be paid on: (a) the performance of technological services rendered to an enterprise located in Colombia, whether they are performed abroad or in the country; and (b) the rent for equipment that is temporarily brought into the country.

This tax is withheld at the moment of payment. In addition, the 12% tax for remittances abroad is imposed on the remaining balance. This represents a total tax charge of approximately 48% of the total sum of the contract. Two additional elements tighten the mechanism:

(1) The foreign engineering firm or company cannot deduct a series of costs that a local firm can (i.e., payment of salaries, etc.).

(2) If the foreign firm pays taxes abroad for that same amount of money, a deduction of only 10% is allowed for the taxes paid abroad (even if the actual payment of taxes has been higher).

The net effect of this has been to increase considerably the costs of engineering and other technical services rendered by foreign firms. Obviously the Colombian contractor will be, in the final analysis, the one who foots the bill, because the foreign organization will simply charge more to receive the same amount that it used to receive.

This control mechanism has not been followed up or complemented by any mechanism directly promoting the development of CEDOs in Colombia. Therefore the possibility of this policy instrument promoting the development of CEDOs is highly dubious.

ADVANTAGES OF LOCAL CONSULTING AND ENGINEERING CAPABILITIES

Most studies take for granted that developing countries should have local consulting and design engineering competence. Some observers, however, feel that it is necessary to be more specific, because what is being aimed at, in most countries, is the development of technological capability and rapid industrial development rather than the growth of consulting and engineering design firms per se. The following is a brief summary of Malhotra's discussion of some of the main objectives that can be achieved by the development of engineering capabilities. In this case, the organizations that perform those services are considered as instruments.

Two factors need to be established at the very outset. First, the fact that CEDOs exist, or can be organized, is not a guarantee that these objectives will be attained. The existence of CEDOs is a necessary but not sufficient condition. Second, the term CEDO refers to any organized group that provides consulting and design engineering services. It is not restricted to independent engineering firms alone. The importance of the internal engineering capabilities of industrial firms is being increasingly recognized and cannot be excluded.

Better Choices in Investment Decisions

With knowledge of local conditions, equipment capabilities, delivery times, and environment, it should be possible for a local CEDO to help in making better choices in investment decisions. Choice of the appropriate technology should be possible and the national objectives could be more easily served by directing choices of technology toward more socially desirable purposes. Not only would appropriate choices of technology be possible, but with competent local consulting and engineering design capabilities, developing countries could avoid being burdened with inadequate or obsolete technologies.

More Efficient Purchase of Technology

With the availability of competent groups of personnel in consulting and engineering organizations, the country could count on increased skill and bargaining power in the purchase and negotiations of the foreign technology that is to be imported. Disaggregation of technology packages would be possible whenever deemed necessary. This could also lead to competitive prices because maximum local participation in goods and services could be built into the local package being developed for given projects. The terms of a contract could be made more favourable to the local party, especially in the areas of guarantees, penalties, etc.

Absorption and Diffusion of Technology

The existence of a local CEDO should make it possible to gather experience on related projects at a nodal point. Since many projects may well be based on technologies of different origin, it would be possible for the nodal group to evaluate various technologies more competently and in more detail than if the public enterprises were to import these technologies directly. The experience that is gathered could also then be made available to a number of different customers who would reap the benefit of experience gained on different technologies.

Development of Local Industry

A major contribution of local CEDOs could be to contribute to the development of local industries and ancillaries. They could contribute directly by ensuring that domestic capital goods manufacturers have a fair chance in quoting for projects being engineered for enterprises within the country at the negotiating stage of the contract. By ensuring that a significant portion of the project is built either using local goods or at least according to local standards, impetus could also be given to manufacturers of components and spare parts. In addition, the existence of a competent local organization could be utilized for providing services such as surveys, administration, transportation, etc., on projects that are being handled by foreign suppliers, and even for the substitution of foreign firms at the project management level.

Utilization of Indigenous Research and Development

Most developing countries have found that the research done in local R&D institutes tends not to be utilized in the productive sectors of the economy. If local R&D is to be utilized in these sectors, it would be necessary for an organizational structure to be developed that provides a package of services similar to that being provided by foreign companies to the entrepreneurs in a developing country. In the absence of agencies or organizations that can provide these services, utilization of indigenous R&D in developing countries would seem difficult. Thus the development of indigenous R&D could be considerably enhanced by the creation of efficient consulting and engineering organizations in developing countries.

More Intensive Use of Local Resources

CEDOs can contribute directly by employing large portions of the technical manpower in a country. Besides the direct effect on the employment potential within the country, the existence of a CEDO would also help to prevent the migration of high-level manpower from developing countries to developed countries. Indirectly, it would also create, within the economy, entrepreneurs who have the capability and competence to start new industries based on their experience gained within the CEDOs.

Reduction of Technical Vulnerability

Many developing countries have found that buying turnkey plants is easier than running them. In the absence of local competence to run, maintain, and service plants that have been obtained on a turnkey basis, and with no counterpart development within the country, the country finds itself at the time of any serious breakdown at the mercy of the foreign company that supplied the package in the first place. In some instances the foreign company may no longer manufacture the components or spares, having progressed technologically to newer and more complex plants.

The existence of a CEDO and its involvement in the importation of any technologies could ensure that adequate local competence existed to run, maintain, and service these plants. It should also be possible through them to create and develop local industry for spare parts and replaceable machinery. With their detailed knowledge of the workings of the plant and with their efforts to optimize plant efficiency, it may also be possible for them sometimes to innovate solutions using locally available components and equipment.

Reduction of Foreign Exchange Components of Projects

Many developing countries find that the foreign exchange component of projects requires them to rely on local credit by use of a local CEDO to reduce the foreign exchange component of many projects by use of appropriate local equipment, personnel, and services.

Export of Goods and Services

In recent years the more advanced of the developing countries have started exporting goods and services. In many instances they have found that it is necessary to provide a total turnkey engineering package for the particular environment of the recipient country.

Development of Technological Capabilities (Self-reliance)

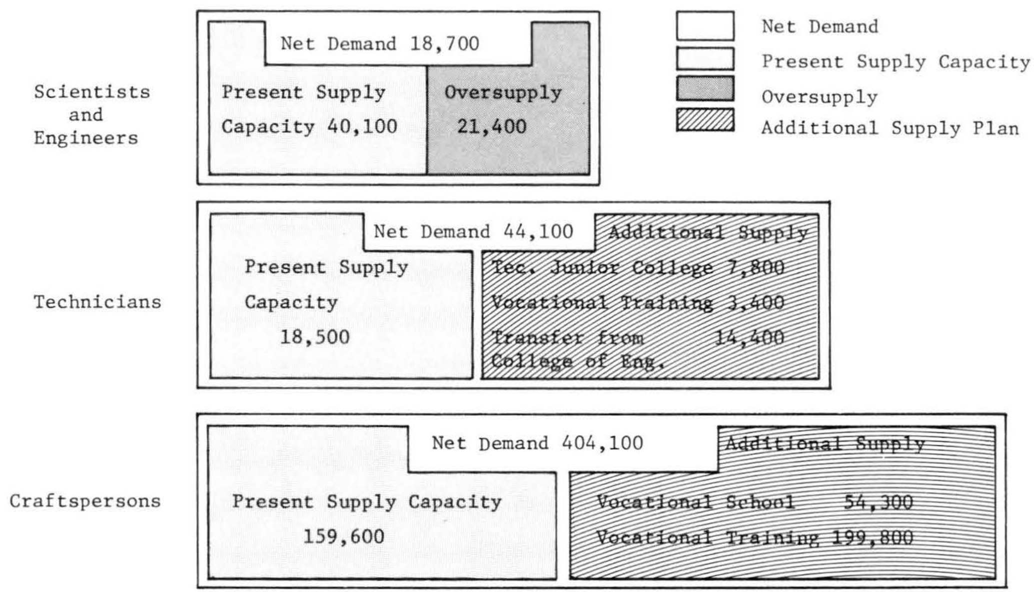
An inherent technological strength is needed in any country for its growth and development as well as a long-term equilibrium in the balance of payments, including payments for technology in all its aspects.

In the economy as a whole the basic thrust of the scientific and technological strategy should be the achievement of a certain degree of independence. This would mean the utilization of a mix of imported and indigenous scientific and technological resources: a mix in which the proportion of the indigenous components will steadily increase both in quantity and, more importantly, in the number of critical national projects that are based upon this indigenous technology, until a satisfactory equilibrium of balanced interdependence is achieved at all levels. The CEDO could be a key link in developing these technological capabilities and in reducing technological dependence.

It should be noted that not all the above objectives will be of relevance to all the developing countries. The relative importance that a country attaches to many of these objectives will depend, among other things, on its internal environment, its level of industrial development, and its national policies.

Not only will these objectives be specific for a country, they may also vary from sector to sector. Thus in certain sectors of the economy of a country, the development of consulting engineering design capabilities may not be feasible or may not contribute to any significant development. The essential points are that (a) the objective of developing a CEDO in a developing country may vary from sector to sector; (b) the more optimum strategies for science and technology development may require focussed attention on a particular sector where the necessary infrastructure exists; and (c) the policy instruments need to be refined so that varying objectives can be attained within a developing country in different sectors rather than attempting to develop consulting engineering design capabilities simultaneously in all sectors of the economy.

Figure 1. Scientific and Technical Manpower Supply and Demand (1972-76).



Source: The Third 5-Year Manpower Development Plan (1972-76), MOST, Government of Republic of Korea, 1971.

Table 1: Breakdown of Users of Reproduction Services.

Users of Reproduction Services	1971 (%)	1972 (%)
Industrial firms	43.0	41.5
Research institutes	21.8	25.2
Universities	18.8	18.6
Individuals	7.2	8.0
Government administration	5.5	4.9
Others	3.7	1.8

Table 2: Growth of Reproduction and Search Services at KORSTIC.

Year	Number of Articles Reproduced	Number of literature Search Services Provided
1963	720	
1964	4,800	
1965	5,700	
1966	6,617	
1967	6,408	17
1968	6,596	27
1969	10,458	74
1970	17,170	97
1971	26,472	179
1972	42,294	231
1973 (estimated)	55,000	350

Table 3: Industrial Dependence on Technical Information Source.

Source	Weight
Foreign technical affiliate	69
Raw material supplier	46 (domestic 3)
Machine supplier	31 (domestic 6)
Books	30
Periodicals	29
Industrial association (domestic)	8
KORSTIC	3
Academic societies	3
Others	12

Table 4: Analysis of 668 Questions Presented to INFOTEC.

Key	Sector	Government		Foreign Institutions		National Corporations		Corporations with Foreign Participation*		Researchers		Total	
			%		%		%		%		%		%
AD	Administration	5	2.9	2	8.3	6	1.8	0		0		13	1.9
AL	Foods	26	14.9	4	16.7	23	7.1	3	4.8	4	5.0	60	9.0
AR	Graphic arts	0		0		2	0.6	0		0		2	0.3
AG	Farming and livestock	2	1.1	1	4.2	1	0.3	0		6	7.5	10	1.5
CC	Clothing and shoes	1	0.6	0		1	0.3	0		0		2	0.3
CO	Pollution	3	1.7	0		8	2.5	2	3.2	1	1.3	14	2.1
CP	Cellulose-paper	5	2.9	0		6	1.8	2	3.2	2	2.5	15	2.2
CV	Ceramics and glass	4	2.3	0		9	2.8	1	1.6	1	1.3	15	2.2
DO	Documents	9	5.1	0		11	3.4	4	6.3	6	7.5	30	4.5
EX	Experts	5	2.9	1	4.2	6	1.8	1	1.6	1	1.3	14	2.1
EE	Electric	6	3.4	1	4.2	20	6.1	0		4	5.0	31	4.6
ES	Data and statistics	0		0		0		0		1	1.3	1	0.1
FA	Pharmaceuticals	4	2.3	1	4.2	38	11.7	8	12.7	1	1.3	52	7.8
PF	Suppliers and manufactures	3	1.7	0		12	3.7	4	6.3	3	3.8	22	3.3
II	Industrial engineers	0		0		4	1.2	3	4.8	0		7	1.0
MC	Construction material	3	1.7	0		9	2.8	0		4	5.0	16	2.4
MI	Mines	4	2.3	0		2	0.6	0		0		6	0.9
MM	Metal-mechanic	14	8.0	3	12.5	35	10.7	4	6.3	12	15.0	68	10.2
EM	Mechanical equipment	3	1.7	0		10	3.1	3	4.8	2	2.5	18	2.7
PN	Industry of natural products	21	12.0	1	4.2	6	1.8	1	1.6	8	10.0	37	5.5
QU	Chemical	40	22.8	7	29.2	84	25.8	24	38.1	15	18.8	170	25.4
TX	Textiles	0		0		4	1.2	0		0		4	0.6
NC	Unclassified	17	9.7	3	12.5	29	8.9	3	4.8	9	11.3	61	9.1
	Total	175	100.0	24	100.0	326	100.0	63	100.0	80	100.0	668	100.0

*The definition of corporations with foreign participation was drawn from the sample used in the study by Fernando Fajnzylber and Trinidad Martinez Tarragó, Las empresas transnacionales en la industria de México, CIDE-CONACYT, México, 1975.

Source: Prepared on the basis of a sample of 668 questions supplied by INFOTEC. These 668 questions represent 43% of all the questions received up to November 1974.

Table 5: Sectoral Distribution of the Bulletin of Technical News.

	1973 (July) (%)	1974 (July) (%)	1975 (Novemeber) (%)
Foods	14.4	12.8	14.0
Textiles	-	-	1.1
Graphic arts	-	-	1.7
Chemistry	25.3	21.8	21.1
Pharmaceuticals	8.1	10.2	7.0
Ceramics-glass	6.1	5.1	4.2
Metal-mechanic	21.9	26.9	29.8
Electric	10.0	7.7	8.3
General	14.2	15.5	12.8

Source: Based on data supplied by INFOTEC.

Table 6: Size of Firms Using the Bulletin of Technical News (October 1974)
(By numbers of engineers and of employees).

Number of Engineers	Number of Firms	%	Number of Employees	Number of Firms	%
1	152	30.7	Less than 5	375	20.5
2	83	16.8	6 - 10	106	5.8
3 - 5	115	23.2	11 - 50	521	28.5
6 - 10	65	13.1	51 - 100	255	14.0
11 - 20	36	7.3	101 - 250	259	14.2
20 or more	44	8.9	250 or more	309	16.9
Total	495	100.0		1,825	99.9

Source: Based on data supplied by INFOTEC.

Table 7: Size of Firms Using the Bulletin of Technical News (End of 1975).

Number of Employees	0	1-5	6-10	11+	Total	%
1-25	113	334	24	5	476	26.8
26-50	61	206	31	8	306	17.2
51-100	48	181	51	19	299	16.8
101-150	23	76	26	26	151	8.5
151-200	14	32	17	27	90	5.1
201-500	24	68	38	88	218	12.2
501+	24	41	33	140	238	13.4
Total	307	938	220	313	1,778	100.0
%	17.3	52.7	12.4	17.6	100.0	

Table 8: Size of 30 Users of the Bulletin of Technical News in Three Branches of Industry (1975).

Sector	Engineers						Total Employees						
	1-3	4-7	8-10	11-19	20-49	50+	Up to 24	25-49	50-99	100-199	200-349	350-499	500
Capital goods	2	3	2		3		1	2		1	2	2	2
Petro-chemicals	1	3	1	2	3	2	1		2	6	1		2
Foods	1	3	1	2	1					1	1	2	4
Total	4	9	4	4	7	2	2	2	2	8	4	4	8

Table 9: Origin of Periodicals Used by SIT for its News Bulletin.

Bulletin of Technical News	Total Periodicals	Spanish	National
Foods	47	7	2
Chemicals	43	4	2
Metal-mechanic	42	6	0
Pharmaceuticals	40	6	0
Ceramics and glass	36	2	0
Electric and electronics	33	3	2
Administration	28	8	8
Pollution	19	1	1
Industrial engineering	33	7	5
Total	321	44	20

NOTES

(1) This calculation and those that follow exclude the 57,568 establishments without salaried personnel.

(2) This misconception was present in the Working Plan Budget of the Centre of Information and Documentation Services of CONACYT in 1973.

(3) See OECD, Reviews of national science policy: Canada, Paris, 1969, pp. 278-288.

(4) See Note sur la recommendation du Conseil de L'Europe concernant la creation d'un Centre International d'Information sur la Technologie Intermediaire, document presented at a meeting on Selection and Application of Technologies held under the auspices of the OECD in Paris, November 1972.

(5) Frances Stewart, Technology and employment in LDC's, in Employment in developing nations, Report on a Ford Foundation Study, ed. E. Edwards, Columbia University Press, 1974, p. 113.

(6) CECATI, Bulletin of Information, Ministry of Public Education, May 1975.

(7) See G.K. Boon, Factores físicos y humanos en la producción, Mexico, Fondo de Cultura Económica, 1970. In particular, see the analysis of costs of various training methods in chap. III.

(8) Technicians are defined as persons with university degrees but with supervisory functions or graduates from the Regional Technological Institutes or from the CENETI.

(9) If it is considered that the CECATI trainees totaled 15,452 in 1974-75, that those going through the ARMO Service included 2,300 supervisors and 4,600 workers a year in the 1970-75 period, and that those from the IMSS totaled around 5,000 workers a year, then it can be estimated that the annual capacity of the Centres at present is about 27,352. On the other hand, the rate of equivalent unemployment in the manufacturing industry is about 10.1% (or 219,069 persons). However, the information on the unemployment rate corresponds to 1969.

(10) There are a number of other instruments in Brazil, but in the absence of data, no analysis has been possible. Special reference was made in the section relating to the purchasing power of the state as an instrument for the development of CEDOs in Brazil.

Appendix 1
INSTITUTES AND COUNTRIES PARTICIPATING IN THE STPI PROJECT

Argentina	Secretaria Ejecutiva del Consejo Latinoamericano de Ciencias Sociales (CLACSO) Country Coordinator: Eduardo Amadeo
Brazil	Financiadora de Estudos e Projetos (FINEP) Country Coordinator: Fabio Erber (until September 1974) and José Tavares
Colombia	Fondo Colombiano de Investigaciones Cientificas y Proyectos Especiales "Francisco José de Caldas" (COLCIENCIAS) Country Coordinator: Fernando Chaparro
Egypt	Academy of Scientific Research and Technology Country Coordinator: Adel Sabet (until July 1975) and Ahmed Gamal Abdel Samie
India	National Committee on Science and Technology Country Coordinator: Anil Malhotra (until June 1975) and S.K. Subramanian (until March 1976)
South Korea	The Korea Advanced Institute of Science (KAIS) Country Coordinator: KunMo Chung
Mexico	El Colegio de Mexico Country Coordinator: Alejandro Nadal
Peru	Instituto Nacional de Planificacion (INP) Country Coordinator: Enrique Estremadoyro (until February 1975) and Fernando Otero Technical Directors: Fernando Gonzales Vigil (until February 1975) and Roberto Wangeman
Venezuela	Consejo Nacional de Investigaciones Cientificas y Tecnologicas (CONICIT) Country Coordinator: Dulce de Uzcategui (until July 1974) and Ignacio Avalos
Yugoslavia (Macedonia)	Faculty of Economics, University of Skopje Country Coordinator: Nikola Kljusev

Appendix 2
SURVEY OF THE COUNTRY TEAM'S WORK

The organization, composition, and orientation of each of the country teams reflected the own interests and those of the institutions that hosted them, always within the framework of the STPI project concerns. A brief review of the approach and the work of each team may help to place the STPI project and the comparative reports in perspective. To complete the survey, a description of the field coordinator's office work is given.

ARGENTINA: The initial location for the Argentine team was the Department of Economics of the Catholic University. However, after some months, the university decided to withdraw its application and the country coordinator moved to the Argentine branch of the executive secretariat of the Latin American Social Science Council (CLACSO). The team was headed by Eduardo Amadeo, an economist, and two other members were appointed to work full time on the project. An advisory committee of several researchers and policymakers active in science and technology policy was formed. To carry out the research, the team relied on consultants who wrote reports on specific subjects that were integrated into a final report.

A significant change took place when the country coordinator was named president of the Instituto Nacional de Tecnologia Industrial (INTI), the national industrial technology institute, which is the largest and most important industrial research organization in Argentina. Mr Amadeo never relinquished his formal role as coordinator; after 6 months, he left his new post and resumed his position as country coordinator. Because most of the work was well under way, his absence did not substantially alter the team's pace, although the preparation of the Argentine synthesis report was postponed. Part of the team's work was reoriented to be most useful to the coordinator in his new position.

The Argentines focused on two branches of industry - machine tools and petrochemicals - but studied many broader issues. For instance, the reports include a document on the technological content of the 3-year development plan (1974-77), a study of the Argentine industrial structure, a description and brief analysis of technology policy instruments in Argentina, a study of the system for regulating technology imports, and several short reports on international technical assistance as an instrument of technology policy.

The structure of the Argentine scientific and technological system was studied in detail, as were the conditions under which it could be made more responsive to industry's needs. The Argentines covered the public sector, examining the possible role of the public sector as promoter of scientific and technological development. Detailed studies were carried out at two enterprises: one in charge of generating electricity in Buenos Aires (SEGBA) and the other in charge of generating and distributing gas for household and industrial consumption. Other contributions of the Argentine team were a study of the emergence and development of engineering and consulting firms in the chemical process industries, a detailed analysis of two research centres within the national industrial technology institute (INTI), and two short papers on capital accumulation and on the crisis of capitalism.

The Argentine team followed the methods guidelines; however, they produced a series of thematic reports on issues of actual and potential interest to policymakers in the country, coinciding with the themes selected for study in STPI.

BRAZIL: The Brazilian team was hosted at the research group of the Financiadora de Estudos e Projetos (FINEP), the state agency in charge of financing studies for investment projects and also the executive arm of the national fund for scientific and technological development. The first coordinator was the director of the research group, Fabio Erber. When he took a leave of absence from FINEP in September 1974, he was replaced by José Tavares, the new head of the research group. The group at FINEP had been carrying out research on science and technology policy for some time, and the STPI assignment was one of its tasks for 1973-76. Practically all of the work was done by members of the FINEP research group, although two or three reports were contracted to professionals outside FINEP.

From the beginning, the Brazilians decided to concentrate on the role of state enterprises in technology policy. They chose branches of industry that were dominated by state enterprises (oil and petrochemicals, steel, and electricity), conducting detailed interviews, analyzing existing data, and testing hypotheses systematically to cover issues such as the selection of equipment and processes, the purchase of engineering services, the performance of research and development, and the planning activities at these state enterprises.

In addition to the new material generated by the Brazilian team during STPI, several reports based on past research carried out by FINEP were made available to the STPI network. These included background reports on the organization and structure of the Brazilian science and technology system, a study on the machine tool industry, a report on the demand for services of 12 research institutes, and a background report on industrial policies in Brazil during the last 2 decades.

In parallel with the work for STPI, the FINEP team was also engaged in a research project on the diffusion of technical innovations in three industrial branches (pulp and paper, cement, and textiles) and they agreed to put their results at the disposal of the STPI network as an additional contribution.

The Brazilian team used the guidelines only as a general reference, given that most of their work went along different lines from those originally envisaged for the project. Nevertheless, the richness and variety of their material effectively upgraded the comparative reports.

COLOMBIA: No Colombian participant was present at the initial organizing meeting, and the Colombian application to join the STPI network was received later and formally accepted at the Rio meeting of the coordinating committee. The team was hosted by the Colombian Council for Science and Technology, COLCIENCIAS, and was headed by a sociologist, Fernando Chaparro. In spite of joining the STPI network late, the Colombian team caught up with the pace of work and finished all its work by the deadline.

COLCIENCIAS organized a special team with five members who devoted practically all their time to research in STPI. Several other consultants were also asked to prepare reports on issues of specific interest such as selected policy instruments. For example, a study was commissioned on the impact of tariff mechanisms; a report was prepared on the influence of price controls; and a preliminary analysis of the possible use of the state's purchasing power as an instrument of technology policy was also prepared. The branches chosen for study were all linked to agriculture: fertilizers and pesticides, agricultural machinery, and food processing, taking into consideration the interests of Colombian policymakers as perceived by the team. In these branch studies, the methods guidelines were closely followed.

Other reports prepared by the Colombian team include a study of science and technology planning, an analysis of implicit industrial technology policies, a conceptual framework for the study of consulting and engineering organizations, a series of reports on industrial branches based on discussions with panels of experts, a study of science and technology policies in the agricultural sector (to complement the analysis done for industry), and two essays on the process of industrialization in Colombia and its technological implications.

Five groups of policy instruments were studied in detail, and their impact on each branch was examined through interviews at various enterprises. All of the findings were integrated into the final report of the Colombian team.

EGYPT: Although an Egyptian representative participated in the initial deliberations leading to the STPI project, it was not possible to organize the team to carry out research and prepare inputs for the international comparison. There were several administrative difficulties and staffing problems that prevented the organization of a working team. The host institution was the Academy of Scientific Research and Technology and the first coordinator was Adel Sabet, who was replaced by Gamal A. Samie in July 1975. The Egyptian team presented papers that were personal contributions based on past experience rather than the result of research carried out by a team; and research was not begun at the academy until the second half of 1976.

INDIA: The host organization in India was the National Committee on Science and Technology, and the first coordinator was Anil Malhotra, who was replaced in June 1975 by S.K. Subramanian. Mr Subramanian resigned in March 1976, and no one replaced him. No funds were requested to set up a country team in India, and the Indians provided background material that had already been collected as background for a new science and technology plan.

Three background documents were distributed along with the final S & T plan to all the teams in STPI. In addition, a report on foreign collaboration, a note on science and technology planning in India, a survey of engineering consultancy services, a report on the development of the electronics industry, and two papers on small-scale industries and technology transfer were distributed by the Indian coordinator. No empirical research was done following the methods guidelines, and the Indian contribution to the comparative reports reflects this.

SOUTH KOREA: The South Korean team was one of the first to be organized and was estalished at the Korean Advanced Institute of Science, KAIS, as part of the activities of its science, technology, and society program. KunMo Chung was named country coordinator and the team consisted of five other members. All but one of them had other academic duties and could allocate only a portion of their time to STPI research. Then, Graham Jones was hired to advise in the preparation of the report for phase 1.

The South Korean team advanced rapidly and completed its work in time for the Sussex workshop, following the methods guidelines and introducing modifications only where necessary. Two reports were produced corresponding to the requirements for phases 1 and 2 of the project.

The branches chosen for study were electronics, petrochemicals, and powder metallurgy, and a report was prepared for each one. In addition, the team prepared documents on engineering services and industrialization in South Korea, on the Korean Institute of Science and Technology, on transfer of technology in the electronics industry, on the interface between the science and technology plan and the economic development plan, and on state enterprises in technical development.

Although most of the work was done by the team located at KAIS, consultants were asked to deal with specifics. The team predominantly represented engineering and physical sciences, but an economist who was a senior government official, helped to relate the results to South Korean policymakers and to balance the other team members' biases.

MEXICO: The Mexican team was among the first to start working in STPI and was located at El Colegio de Mexico, an academic and social research and graduate training organization. Alejandro Nadal was country coordinator and there were four other members of the team who worked full time on STPI. The Mexican team initially followed the guidelines rather closely and was one of the first in suggesting modifications and changes as a result of contrasting concepts with preliminary research findings. In particular, the team found it difficult to interpret the results of interviews in enterprises using the schema proposed to study technological behaviour. The branches chosen for detailed study were capital goods, food processing, and petrochemicals.

A background report on the structure and evolution of the Mexican scientific and technological system was prepared, together with a description of the industrialization process and of agricultural development. Documents on particular subjects included a report on engineering firms, a study of the technology policy of PEMEX (the state oil monopoly), and progress reports dealing with hypotheses on the impact of policy instruments on technical behaviour at the enterprise level, a description of policy instruments in Mexico, etc.

Most of the findings of the Mexican team were integrated into the main final report, part of which was delivered at the coordinating committee in New Delhi (January 1976) and the rest at the Sussex workshop (June 1976). The work of the Mexican team covered practically all the research topics considered in STPI, and its contribution to the comparative report reflects this. The Mexican report was published in Spanish in 1977 and was awarded second prize in a contest for the best works in economics.

For various reasons, the Mexican team chose to limit its direct interaction with policymakers and followed its own research program. Results were made available to policymakers in the form of draft reports, and through the participation of the coordinator in one of the committees established to prepare the Mexican plan for science and technology.

PERU: The Peruvian team was established within the research group of the National Planning Institute. A series of administrative difficulties affected the progress of the team, including a change of technical director, when Fernando Gonzales Vigil was replaced by Roberto Wangeman in February 1975. Approximately two-thirds of the research was completed in time for the Sussex workshop.

From the beginning, the team decided to adopt a sectorial approach to the research. Efforts were focused on the study of industrial branches connected with the extraction and processing of minerals and with the provision of machinery for the mining industry. The steel industry was also studied, with emphasis on the state enterprise in charge of the largest steelworks. This meant that the guidelines were used primarily in sectorial studies and in the analysis of policy instruments.

Background reports on the situation of the scientific and technological system and on the evolution of Peruvian industry were prepared following the general framework put forward in the guidelines. In addition to these and the sectorial reports, the team prepared other documents, dealing with issues such as explicit and implicit science and technology policies, consulting and engineering capabilities, the possible use of state enterprises as instruments of technology policy, and the government administrative machinery for science and technology policy.

The Peruvian team was located within an official government organization, but its direct impact on policymaking is difficult to assess because it took the form of daily contact with government officials. On the basis of the sectorial reports on mining, a committee has been set up to review the findings of the STPI team.

VENEZUELA: The Venezuelan team was hosted by the national council of science and technology (CONICIT) and was among the first to start working. The team was initially dominated by sociologists, although economists increased their participation at later stages. The first coordinator, Dulce de Uzcategui, was replaced by Luis Matos, who was soon followed by Ignacio Avalos. Three other members worked full time, and the team was biased toward sociology and economics.

They progressed through two stages punctuated by a change in government. In the first stage, most of the background reports corresponding to phases 1 and 2 of the STPI methods were prepared, covering the science and technology, the political, the educational, and the economic systems. These reports were made obsolete by the change in government. In the second stage, the team tried to adjust to the new situation, repeating some of the earlier studies and continuing the research. However, the organization of a national congress on science and technology, which mobilized all the staff working at CONICIT, affected the team's progress.

The branches chosen for study were capital goods, electronics, and petrochemicals. In addition, reports were written on specific issues such as the governement organizational structure for science and technology policy, instruments for industrial science and technology policy, economic and financial policy instruments and their impact on technology, the purchase of capital goods in two industrial branches, and the relations between the financial system and technology policy. The Venezuelan team concluded its research shortly after the Sussex workshop.

The fact that the Venezuelan team was located in a government agency that took a very active role in science and technology policy after the change in government created both opportunities and problems. As a result of the new tasks undertaken by CONICIT, the pace and continuity of the STPI work was frequently altered. On the other hand, there was more possibility for actively contributing to policymaking. The Venezuelan contribution to the comparative reports reflects this situation.

YUGOSLAVIA (MACEDONIA): The Macedonian team was organized at the faculty of economics of the University of Skopje. A senior faculty member, Nikola Kljusev, was appointed coordinator. The team was composed of a very large number of faculty members and researchers who devoted part of their time to STPI. The tasks were subdivided and individual reports requested from various members of the team, although at a later stage two team members were asked to work full time on STPI.

The Macedonian team did not follow the guidelines, except in the preparation of a background report for phase 1. Individual reports were submitted on issues of interest to the STPI network, covering topics such as the problems of research and development in industrial enterprises, aspects of science and technology policy in Yugoslavia, the metallurgical industry in Macedonia, and the growth of engineering firms in Yugoslavia.

The Macedonian team's specificity is reflected in their relatively limited contribution to the comparative reports. At any rate, given the high degree of participation of professionals at all levels in policymaking in the Yugoslav self-managed economy, it is rather difficult to assess their contribution toward policymaking in conventional terms.

THE FIELD COORDINATOR'S OFFICE: In August 1973, at the first meeting of the coordinating committee, Francisco Sagasti was appointed field coordinator of the project and his office was established shortly thereafter and began operating in a limited way. Staffing was completed in April 1974 with the addition of two members.

The field coordinator's office was independent from the teams and was not engaged directly in empirical research. It offered organizational and technical support and contracted consultants to prepare reports on topics defined by the coordinating committee.

The field coordinator, first, drew up methods guidelines for phases 1 and 2 of the project. Background reports on technology policy in China, on technological dependence/self-reliance, on science and technology planning, on technology policies in Japan, and on technology transfer were also prepared, either by staff members of the field coordinator's office or by consultants. The guidelines for phases 3 and 4 of the project were prepared jointly by the field coordinator and a consultant. The office also organized the Sussex workshop and drafted the comparative reports. The field coordinator was also active in the board of the Peruvian Industrial Technology Institute (ITINTEC).

With the exception of the teams that were engaged in science and technology policy research as part of the activities of their institutions (the Brazilian and South Korean teams, for example), the teams were dismantled after the STPI project was completed. The field coordinator's office was closed in December 1976, and the comparative reports were prepared during 1977-1978, although some teams had not finished their work by April 1978. Even though most teams had concluded their STPI activities by the end of 1977, this does not mean that the team members left the field of S & T policy research and that their effort in STPI was not followed up. What was dismantled, as planned from the beginning, was the formal structure of the STPI project. The network of personal contacts remains in operation and most of the former team members are active in the field of science and technology policy, carrying the experience accumulated in STPI to their new positions.

Key to STPI Publications

STPI

Primary

(1) The STPI Project
(2) Methodological Guidelines
(3) Main Comparative Report
(4) Planning
(5) Chinese Technology Policy/ Industrialization

Modules

(6) S&T: Differing Schools of Thought
(7) Evolution of Industry
(8) Evolution of S&T
(9) S&T - Present Status
(10) Policy & Generation of Technology
(11) Policy for Imports
(12) Policy for Technology Demand
(13) Policy to Promote Industrial S&T
(14) Policy for Industrial S&T Support
(15) Industrial Technical Changes
(16) Industrial Technology Behaviour
(17) Technical Change Studies

Selections

(18) S&T Policy & Development
(19) Engineering Consulting & Design in LDCs
(20) Technology Transfer in LDCs
(21) State Enterprises & Technological Development

Background Papers

(22) El INTI en la Industria Argentina
(23) El Sector Maquinas Herramientas en la Argentina
(24) Los Instrumentos de Politica Cientifica y Tecnologica en Argentina
(25) Brazilian Machine-Tool Industry
(26) Los Bancos y Comercializacion de Tecnologia
(27) La Industria Petroquimica
(28) La Variable Tecnologica y las Variables Horizontales
(29) Indian Electronics Industry

Country Papers

(30) Mexico
(31) Korea
(32) Peru
(33) Colombia

A GUIDE TO THE SCIENCE AND TECHNOLOGY POLICY INSTRUMENTS (STPI) PUBLICATIONS

A. Primary Publications

(1) The Science and Technology Policy Instruments (STPI) Project (IDRC-050e) (out of print)

(2) Science and Technology Policy Implementation in Less-Developed Countries: Methodological Guidelines for the STPI Project (IDRC-067e) (out of print)

(3) Science and Technology for Development: Main Comparative Report of the STPI Project (IDRC-109e). (Also available in French (IDRC-109f) and Spanish (IDRC-109s).)

(4) Science and Technology for Development: Planning in STPI Countries (IDRC-133e)

(5) Science and Technology for Development: Technology Policy and Industrialization in the People's Republic of China (IDRC-130e)

B. Modules

These constitute the third part of (3) above and provide supporting material for the findings described and the assertions made in (3).

(6) STPI Module 1: A Review of Schools of Thought on Science, Technology, Development, and Technical Change (IDRC-TS18e)

(7) STPI Module 2: The Evolution of Industry in STPI Countries (IDRC-TS19e)

(8) STPI Module 3: The Evolution of Science and Technology in STPI Countries (IDRC-TS20e)

(9) STPI Module 4: The Present Situation of Science and Technology in the STPI Countries (IDRC-TS22e)

(10) STPI Module 5: Policy Instruments to Build up an Infrastructure for the Generation of Technology (IDRC-TS26e)

(11) STPI Module 6: Policy Instruments for the Regulation of Technology Imports (IDRC-TS33e)

(12) STPI Module 7: Policy Instruments to Define the Pattern of Demand for Technology (IDRC-TS27e)

(13) STPI Module 8: Policy Instruments to Promote the Performance of S and T Activities in Industrial Enterprises (IDRC-TS28e)

(14) STPI Module 9: Policy Instruments for the Support of Industrial Science and Technology Activities (IDRC-TS29e)

(15) STPI Module 10: Technical Changes in Industrial Branches (IDRC-TS31e)

(16) STPI Module 11: Technology Behaviour of Industrial Enterprises (IDRC-TS32e)

(17) STPI Module 12: Case Studies on Technical Change (IDRC-TS34e)

C. Selections

These are a selection of the numerous reports prepared for the STPI Project chosen as a representative sample of the various topics covered by the STPI Project in the course of the main research effort on policy design and implementation.

Science and Technology for Development: A Selection of Background Papers for the Main Comparative Report.

(18) Part A: Science and Technology Policy and Development (IDRC-MR21)

(19) Part B: Consulting and Design Engineering Capabilities in Developing Countries (IDRC-MR22)

(20) Part C: Technology Transfer in Developing Countries (IDRC-MR23)

(21) Part D: State Enterprises and Technological Development (IDRC-MR24)

D. Background Papers

(22) El INTI y el Desarrollo Tecnologico en la Industria Argentina (In press)

(23) El Sector Maquinas Herramientas en la Argentina (In press)

(24) Los Instrumentos de Politica Cientifica y Tecnologica en Argentina (In press)

(25) The Brazilian Machine-Tool Industry: Patterns of Technological Transfer and the Role of the Government (In press)

(26) Rol de los Bancos en la Comercializacion de Tecnologia (In press)

(27) Comportamiento Tecnologico de las Empresas Mixtas en la Industria Petroquimica (In press)

(28) Interrelacion Entre la Variable Tecnologica y las Variables Horizontales: Comercio Exterior, Financiamiento e Inversion (In press)

(29) A Planned Approach for the Growth of the Electronics Industry — A Case Study for India (In press)

E. Country Reports

(30) Instruments of Science and Technology Policy in Mexico (In press)

(31) Technology and Industrial Development in Korea (In press)

(32) Los Instrumentos de Politica Cientifica y Tecnologica en el Peru: Sintesis Final (In press)

(33) STPI Country Report for Colombia (In press)