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INDUSTRIAL RESEARCH AS A FACTOR IN ECONOMIC DEVELOPMENT

Report of the Joint Study Group on Industrial Research

US—Brazil Science Cooperation Program

September 1968

**Office of the Foreign Secretary
National Academy of Sciences
In Cooperation with
National Research Council of Brazil
Conselho Nacional de Pesquisas**

**NATIONAL ACADEMY OF SCIENCES
Washington, D. C.**

This report was prepared by the Joint Study Group on Industrial Research of the US-Brazil Science Cooperation Program, a continuing collaborative activity of the US National Academy of Sciences—National Research Council and the Brazil National Research Council (CNPq), under contract AID/csd 1122, to promote the application of science and technology to economic development. The Portuguese-language edition of this report has been published by the Brazil National Research Council and is available from that agency. This English-language translation will be presented to the Board on Science and Technology for International Development of the National Academy of Sciences, and to the Agency for International Development, and will be available to interested individuals and institutions in the United States.

While this report reflects very substantially the work and viewpoint of the Brazilian component of the Joint Study Group, all of the recommendations contained herein, and the problems to which they address themselves, were discussed extensively by the Brazilian and US panels in the course of four joint meetings held in Brazil and in the United States between April 1967 and July 1968. The US members, all of whom participated in their individual capacity and not as representative of any institution, fully subscribe to the recommendations.

The National Academy of Sciences wishes to acknowledge the hospitality of the Battelle Memorial Institute, Columbus, Ohio, and Texas Instruments Incorporated, Dallas, Texas, which made their facilities available for the two joint meetings in the United States; the special seminar in research management organized by Arthur D. Little, Inc., Cambridge, Massachusetts; and also the cooperation of scores of industries, research institutions, universities, and US Government agencies which received the members of the Brazil panel during their visits of inquiry in this country.

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1 — TECHNOLOGICAL INNOVATION

. . . Economic thought within the last decade has identified technological innovation as the single most dynamic factor in the growth of modern economies.

. . . True independence for a country, in the present-day world, requires a national technological capability sufficient to allow it to exploit effectively all its available resources.

. . . To make productive use of the world's technological knowledge, a nation must equip itself with the necessary structures, institutions and policies.

. . . Fruitful change and innovation in modern society occur only to the extent that the knowledge-creating and knowledge-using sectors are systematically integrated.

. . . The technology gap, a reflection of social and economic differences and lags among nations, is currently a matter of intense preoccupation even among developed countries. This problem is no less urgent for Brazil. The purpose of this report is to outline Priority Actions which can guide Brazil in its efforts to reduce its technological lag.

2 — OBJECTIVES OF THE RECOMMENDED ACTIONS

- a) To concentrate the limited public financial resources on sectors of priority interest in the country's present state of development
- b) To channel the resources of various financial agencies to priority areas of industrial research
- c) To draw the attention of industrial management to the benefits of industrial research and to obtain their support for research
- d) To develop competent industrial and research administrators in order to increase the productivity of industrial research
- e) To mesh the activities of universities and technological institutes with industry in the field of research
- f) To raise the number and the quality of industrial researchers
- g) To provide the technological institutes with adequate conditions for the performance of industrial research
- h) To provide the country with a National Center to plan and maintain an up-to-date scientific-technical information and documentation policy, and to coordinate the implementation of this policy through decentralized services
- i) To propose a model of a research institute as a goal to be attained either by existing technological institutes, or possibly by a new institute to be created
- j) To facilitate and reduce the cost burden of using patented products and processes

3 — A WORD ON INDUSTRIAL RESEARCH

3.1 — The Road to Development. For Brazil, the wise use of industrial research could be a decisive factor in finally reaching and maintaining a high level of economic development. For this development it is important that Brazilian industry make use of the best of the world's stock of technology. In Brazil, as in other developing countries, innovation is imperative if the nation is to raise its standard of living and keep improving its relative position in a technologically advancing world. It is on industrial research that innovation in industry depends.

3.1.1 — There is a danger, however, that industrial research will be thought too sophisticated, expensive, or academic to be of widespread interest to Brazilian industry. Exactly the opposite is true; only when industry recognizes that research is within its means, and begins to use it, will industry be able to prosper, grow rapidly, and contribute effectively to national economic growth. The purpose of industrial research is to provide Brazilian industry with its own technology, responsive to local factors of production and to the peculiarities of the market.

3.1.2 — For the purposes of this report, industrial research is understood to include the discovery of new products; the exploration and use of raw materials; the development, improvement or adaptation of production methods, techniques, processes or adequate equipment; pilot scale experiments; operational research; establishment of standards; quality control; market research; feasibility, project, and productivity studies.

3.2 — Research—A Link in the Chain of Industrial Innovation. Among the factors which inhibit the aggressive development of industrial research in Brazil is the common misunderstanding that industrial research must be conducted primarily or exclusively within technological institutes or university laboratories, rather than be an integral activity of industrial enterprise. The fact is that industrial research is virtually useless if it is not tightly coupled with the manufacturing, marketing, and decision-making processes of top industrial management. Moreover, industrial research which is not itself infused by a strong entrepreneurial spirit will come to naught. Industrial research per se (as, indeed, pure research) has essentially no direct utility to society, despite the intellectual stimulation it may afford the researcher. It may, indeed, be worse than worthless, when its pursuit as an intellectual exercise diverts the scarce supply of intelligent and creative technical personnel into activity not productive of the goods and services society needs.

3.2.1 — How does industrial research justify itself? It justifies itself through the practical applications which originate from it.

3.2.2 — Thus research results must undergo pilot-scale testing, though pilot models themselves are not useful to society, either. Production engineers must study the pilot-scale experiments and develop the tooling and techniques for large-scale manufacture. Then industrial engineers must design and build the factories to produce on a commercial scale. Still later, manufacturing personnel must make the product in appropriate quantities and at appropriate cost. Even then, manufacturing alone is not sufficient. For ultimate success the product must be marketed and sold in volume to individual members of society. Only at this point has research, industrial or any other kind, come to fruition.

3.2.3 — Consequently, research will give positive results to the extent that the work of researchers is complemented by that of engineers of various specialties, manufacturing technicians and marketing personnel, all of them coordinated by an efficient and energetic management disposed to committing the funds needed—often with no assurance of success—and to pressing the transfer of the results of research throughout all the intermediate stages to final commercialization.

3.3 — Government, Technological Institutes and Universities. Industrial research justifies itself insofar as it contributes to the prosperity of industry in Brazil. But its employment depends on the wholehearted, intelligent and integrated support of Government, technological institutes, and universities. Without diminishing the importance of industry's initiative and responsibility in utilizing industrial research, it must be recognized that the policy decisions and resource allocations necessary for effective industrial research lie within the purview of Government and involve the technological institutes and the universities. For this reason, therefore, we address the observations and recommendations of this report not only to industry but to Government, the institutes and the universities. Only through a well-coordinated effort on the part of these sectors can Brazil's objectives in industrial research be attained.

4 — RECOMMENDED ACTIONS

4.1 — Budgetary Planning of Research Expenditures by Governmental Agencies and Criteria for Priority Classification of Industrial Research Projects.

Goal: To concentrate the limited public financial resources on sectors of priority interest in the country's present state of development.

4.1.1 — In their budgetary planning, official Federal and State agencies should include specific appropriations for the performance or contracting of research they wish to see done in their fields of activity, in accordance with the areas of priority of the Government's Strategic Development Program. Similarly, specialized governmental agencies—such as the National Research Council (CNPq), National Bank for Economic Development (BNDE), and Fund for Financing Studies of Projects and Programs of Economic Development (FINEP)—with funds available for industrial research, should give preferential consideration to requests from private sector organizations.

4.1.2 — Government agencies which support industrial research, in assigning priority classification to industrial research project proposals presented by private entities for financing, should consider the following factors—these factors to be reviewed periodically to keep them current with Brazilian conditions:

- a) importance of the sector to which the project belongs in the light of the Government's Strategic Development Program;
- b) degree of proximity between the objectives of the project and the areas of excellence or high priority defined in item 4.1.3 below;
- c) profit potential of the industrial undertaking which might result from the successful outcome of the research project;
- d) feasibility of the research project, i.e., possibility of a successful outcome within the resource limits and the projected schedule of the research project;
- e) national economic benefit from the industrialization of the results of the research (e.g., employment, inter-industry effects, foreign exchange earnings, etc.).

Related benefits:

- a) impact of the project on the promotion of industrial research in general;

- b) impact of the project on the development of areas of technological "know-how" capable of generating other important economic developments;
- c) effects of the project in increasing the number of industrial research workers;
- d) possibility of using equipment and methods developed during the proposed research work in other research applications;
- e) degree of social impact of the industrial development resulting from the proposed research;
- f) relationship of the proposed research to the possibility of utilizing unexploited or inadequately exploited resources and, especially, to the upgrading of primary export products.

4.1.3 — Areas of excellence or high priority. These will vary as development proceeds and should therefore be revised periodically through inclusion of new areas (of higher priority) and exclusion of others already sufficiently exploited. At present, the following are considered areas of potential excellence or high priority:

- a) those in which the country already has a reasonably well developed technology and in which, with an additional limited effort, it could favorably compete in the international markets, namely: treatment of ores, primary metallurgy including steel production, metal working;
- b) those which, with a successful research effort, could reduce or free the country of important foreign exchange obligations, namely: petroleum, shale;
- c) those whose development could contribute to the improvement of living conditions, namely: food and its by-products, clothing, construction materials;
- d) those in which applied research could improve the utilization and production of Brazilian mineral resources.

4.2 — Financing Agencies: Funding of Public and Private Industrial Research.

Goal: To channel the resources of various financing agencies to priority areas of industrial research.

4.2.1 — Financing agencies should set aside a significant percentage of their budgets for the exclusive purpose of financing industrial research.

4.2.2 — Special priority should be given to applied industrial research programs or projects consonant with the needs and objectives of Brazilian industrial development programs.

4.2.3 — Financial support should also be given for special training projects at universities and research institutes aiming to increase the number and upgrade the technical competence of researchers and engineers.

4.2.4 — Banking institutions should provide loans for industrial research purposes at the lowest possible interest rate.

4.2.5 — Banking institutions should study the possibility of sharing the risks of research, and the potential rewards of research, by making loans repayable contingent upon the success of the undertaking.

4.3 — Fiscal Incentives. Exemption of Controls and Duties on Import of Research Equipment and Materials Having No Domestic Equivalent.

Goal: To draw the attention of industrial management to the benefits of industrial research and obtain their support for research.

4.3.1 — An enterprise, in Brazil, which contributes to the training of research personnel by

- a) financing of scholarships for students in technical-scientific graduate courses, in Brazilian institutions so classified by the Federal Education Council; or
- b) financing of professors and graduate-level technical-scientific courses given in Brazil in accordance with Federal Education Council classification; or
- c) financing of scientific or industrial research in Brazilian institutions of higher learning

should benefit, in calculating its income tax, by consigning as operating expenses 200 percent of the amounts involved.

4.3.2 — An enterprise which performs industrial research or which contracts for research with a specialized Brazilian entity of the Federal government, the State governments, or the private sector, should benefit, in calculating its income tax, by consigning 150 percent of the expenditure involved as operating expense, including, if it wishes, investments in fixed assets other than land made for purposes specifically related to industrial research.

4.3.3 — An enterprise which industrializes processes or products whose development was effected through industrial research carried out in Brazil, should benefit by applying accelerated depreciation coefficients to the fixed investment involved in the industrialization of such processes or products.

4.3.4 — An enterprise subject to payment of taxes on industrial products, or subject to the "sole tax,"* should be allowed to use annually a sum equivalent to 5, 10, and 15 percent of the income tax due the first, second, and third year, respectively, following the enactment of a law to this effect, for purposes of industrial research performed by itself or contracted with private Brazilian entities or entities of the Federal or State governments, and shown to have been carried out in Brazil. An enterprise not investing these amounts in research will pay the equivalent each respective year as an addition to its income tax; after the third year the 15 percent value will remain in effect.

4.3.5 — An enterprise which remits funds abroad derived from profits, royalties, use of trade names or patents, or technical assistance, should be allowed to apply 10 percent of the gross value of the remittance for purposes of industrial research to be performed in Brazil by itself or contracted with private Brazilian entities or entities of the Federal or State governments; or be required to pay an equivalent amount as an addition to the tax on the transfer of exchange abroad.

4.3.6 — Existing legislation regarding import duties on research equipment and materials applies exclusively to official and non-profit institutions. These legal exemptions should be extended to all private organizations which, with proper recognition by the Brazil National Research Council (CNPq), conduct technological research.

4.3.7 — Importation of small units of equipment and materials required in the course of a research project should be allowed without the customary formalities—import license, pro-forma invoice, etc.,—in accordance with regulations to be established by the Foreign Trade Section of the Bank of Brazil.

4.4 — Development and Improvement of Industrial and Research Management Capabilities.

Goal: To develop capable industrial and research administrators in order to increase the productivity of industrial research.

*Sole Tax: A Brazilian tax on minerals and fuels.

4.4.1 — The Federations of Industry and the National Confederation of Industry should:

- a) disseminate, widely and systematically, reports of industrial research projects which have yielded positive results, as a means of motivating entrepreneurship towards the rational application of technology;
- b) organize tours of entrepreneurs to research organizations in Brazil and other countries;
- c) investigate areas in which research could produce significant economic results, within a short period, as a means of drawing the interest of management to such problems;
- d) encourage research managers from private industry, governmental institutes and university laboratories to meet regularly and exchange information and ideas on successful practices in industrial research management;
- e) encourage enterprises to have industrial research directors participate in planning and decision-making in all phases of the enterprise.

4.4.2 — Universities and Technological Research Institutes should:

- a) determine the potential demand for industrial and research managers;
- b) introduce elective courses in engineering programs for the purpose of preparing industrial and research managers able to employ modern scientific administrative methods, to meet this established demand.

4.4.3 — Federal and State Governments should:

- a) arrange for the participation of directors of government technological institutes in the planning activities of government, at every appropriate level.

4.5 — Education. Interrelationships of Education with Other Sectors.

Goal: To mesh the activities of universities and technological institutes with industry in the field of research.

4.5.1 — The Federal Education Council should restructure the university system in accordance with a plan following this approach:

- a) estimate the potential demand for technical people, by field of specialization, to meet the growth needs in each industrial sector as projected in governmental plans;
- b) quantify the available capacity of the present university system, by field of specialization; make a complete survey of university-level establishments offering technological training, and classify according to quality of training and number of specialists produced annually for the market;
- c) compare the potential need and present supply and identify the system's deficiencies; formulate directives to eliminate these deficiencies through a readaptation of the existing units of the system to enable them to meet the established demand; avoid proliferation of university-level institutions dedicated to training personnel in careers which do not contribute to meeting the above indicated demand; promote informational programs to attract young people to technological careers.

4.5.2 — The National Census Service of the Brazilian Institute of Geography and Statistics should design the 1970 census questionnaire to allow a national and regional cross-classification of the existing sectoral distribution of the labor force, showing general levels of education and giving a detailed breakdown of professional and sub-professional skills. The economic classification should permit a reasonable disaggregation of the industrial sector at the two-digit level of census classification (e.g., mining, steel, textile, food and beverage, metal working sectors), and provide, further, a useful and economically functional disaggregation within the service sector including governmental activities. The educational classification of professional and sub-professional skills should be sufficiently detailed as to produce a data base useful in planning the expansion of university, technical, and specialized educational systems.

4.5.3 — Universities.

4.5.3.1 — Undergraduate Programs.

To improve science and engineering programs and to stimulate original technological studies designed to solve Brazilian problems, universities should:

- a) receive visiting (accreditation) committees, composed of university professors (foreign to the institution examined), personnel from industry and industrial research institutions, for the purpose of evaluating and classifying courses, schools, and universities, with respect to teaching programs, knowledge of subject matter, and level of teaching staff, verifying and indicating measures necessary for their improvement;

- b) establish summer refresher courses for upgrading professors in areas of observed deficiency;
- c) encourage the formation of summer work groups to participate in projects of a high level, preferably on a work team basis and in cooperation with research institutes and industries directly interested in the problem;
- d) invite participation, with right to vote, of an outstanding industry-connected professional of great experience and capacity, in the Council of each Department and/or in the Institutes of Basic Sciences, such individuals to be selected by the head of each Department and/or Institute;
- e) establish course content and program the various curricula rigorously in accordance with industry's needs, so that the supply of technical manpower will meet the projected demand in the various growing sectors of industry, either within the geographical or economic region directly served by the university or in the field of activity in which the university excels.

4.5.3.2 — Graduate Programs.

To establish more advanced programs related to Brazilian development, to facilitate applied research by interdisciplinary groups, both at the university and in industry, and to encourage participation in techno-economic projects much needed in Brazil, universities should:

- a) convene outstanding individuals from industry and visiting professors from other universities to assist in the formulation of new graduate courses and the reformulation of existing ones;
- b) encourage thesis advisors and students to select thesis topics that can be pursued within industry;
- c) encourage professors to give courses for industry groups, either at the university or at the plant, with full academic credit.

4.5.4 — Technological and Research Institutes should:

- a) employ university teaching staff to conduct research and as research consultants;
- b) employ students to conduct research;
- c) deal directly with industry and industrial associations to sell services which they are capable of performing.

4.5.5 — Industry should:

- a) present its problems to the universities and the research institutes, so as to influence the formulation and modification of programs of instruction, and contract for services with those institutions which can help, especially universities that have included in their Councils professionals connected with industry;
- b) familiarize industrial circles with the value of research and what is being done in appropriate fields in Brazil and abroad;
- c) develop mechanisms for intimate and permanent rapport with universities and technological research institutes, with the aim of stimulating industrial research;
- d) encourage, jointly with professional associations and industry management federations, the organization of refresher courses for high-level professionals;
- e) accelerate the adaptation of new professional graduates to their jobs, through arrangements with universities providing specialists from industry to give orientation classes at the university on specific industrial activities;
- f) promote, through centers of high standing, courses and seminars to upgrade management of industrial research organizations in modern management techniques. Experienced professors and managers of advanced research organizations should be contracted to organize and administer such intensive and practical courses, and entrepreneurs of progressive high-technology enterprises should be invited to participate.

4.5.6 — The National Research Council (CNPq) should:

- a) organize task groups (accreditation teams) to evaluate and classify courses and institutions, and indicate priorities for incentive grants to be provided to centers of excellence in scientific-technological education;
- b) establish a permanent working group within the CNPq, composed of representatives from industry, the National Bank for Economic Development (BNDE, Ministry of Planning), and the Council for Advanced Training of University-Level Personnel (CAPES, Ministry of Education), to select the technological research institutions able to administer up-grading courses, and to advise on the content of instructional programs of major interest and relevance for the development of the Nation.

4.6 — Training, Compensation and Increased Output of Researchers.

Goal: To raise the number and the quality of industrial researchers.

4.6.1 — Incentives such as fellowships should be provided for researchers pursuing graduate scientific-technical courses, as defined by the Federal Education Council.

4.6.2 — Preference should be given, in the selection of graduate science and engineering theses, to industrial research questions related to Brazilian problems.

4.6.3 — Graduate doctorate-level courses should be created in specialized technologies.

4.6.4 — Salaries of industrial researchers in institutes of technology should be related to merit, as evidenced by publications or distinguished work, attendance of extension or specialized courses, graduate studies, patents, etc.

4.6.5 — The professional category of "researcher"* (pesquisador) should be created, with a salary scale appropriate to the degree of training necessary to the exercise of the profession. The possibility of professional promotion during the career of researcher, with salaries equivalent to those of technical heads, should be established.

4.6.6 — The Federal Education Council, in order to create an institutional structure which will stimulate competition for high standards of excellence, with special emphasis on applied research, should take the following measures:

- a) establish a subcommittee for industrial research to provide incentive for this activity within the universities, to maintain contact with university Research and Graduate Councils, and to promote the adaptation of the curricula and programs to the needs of industrial research;
- b) modify recruiting procedures of teachers (docentes) to the universities;
- c) require senior-year students to work on small industrial projects, in addition to the usual requirements for graduation, such work to be published and distributed to all interested persons, especially to members of appropriate professional associations;

*Research scientists, engineers or others engaged in research at the professional level.

- d) institute an accreditation and rating system for university-level schools, the evaluations to be published and kept current by periodic reviews. Among other purposes, the evaluations should serve to fix priorities for the channeling of funds to the best institutions;
- e) establish prizes, by field of activity, for the best research work done on problems of special interest to Brazil;
- f) institute work-study programs with supervised practical work periods and make them a requirement for undergraduate and graduate degrees.

4.7 — Improvement of the Existing Government Institutes of Technology.

Goal: To provide the technological institutes with adequate conditions for the performance of industrial research.

4.7.1 — The National Research Council (CNPq) should undertake an examination of existing Federal and State owned institutes of technology and classify them into three categories:

- a) those which have the recognized potential, within a period of two years, of adapting themselves to and maintaining, the characteristics of the Model Institute proposed by this Study Group (see Recommended Action 4.9);
- b) those which cannot be converted into institutes of the model type, but which, in view of the importance and quality of their particular activities, should be maintained with such improvements in their structure as are recommended below;
- c) those remaining institutes whose work should be transferred to more appropriate institutions, both public and private.

4.7.2 — The Federal and State governments should avoid, as much as possible, maintaining research institutions under their direct administration; this should be complemented by:

- a) granting these institutions foundation or civil society status, with financial and administrative autonomy along lines indicated for the Model Institute;
- b) supporting these institutions indirectly, if necessary, through project contracts for governmental planning and solution of technological problems.

Comment:

The Study Group recognizes that, as a consequence of the modifications proposed here, some of the institutes classified in the first and second categories of item 4.7.1 might fail. This possibility is accepted as one means of promoting standards of excellence and of ensuring the best possible utilization of personnel and facilities.

4.7.3 — Managers of institutes classified in the first and second categories of item 4.7.1 should be given the opportunity of training, for short periods, in outstanding foreign industrial research institutes, to familiarize themselves with the fundamentals and systems of their operation.

4.8 — National System of Scientific-Technological Information and Documentation.

Goal: To provide the country with a National Center to plan and maintain an up-to-date scientific-technical information and documentation policy, and to coordinate the implementation of this policy through decentralized services.

4.8.1 — Information centers, including the Brazilian Institute for Bibliography and Documentation (IBBD), should organize and orient their services to meet the needs of their users, in recognition of the fact that the mission of such centers is not simply the accumulation and cataloguing of information as such, but the promotion of its use. Consequently, such centers will require engineers and other specialists as well as librarians, and their services should be determined by the users rather than by the documentarians.

4.8.2 — In the public sector, the IBBB, while continuing to operate under the jurisdiction of the National Research Council (CNPq), should be reorganized, for example, as a foundation endowed with appropriate structure and resources allowing it to function on a national level in guiding and coordinating a Brazilian information and documentation network. Subsidiarily, IBBB should correct the deficiencies of the existing documentation services and should stimulate the creation of new services, wherever necessary. This status should provide IBBB with the dynamism and flexibility necessary for an "aggressive documentation" policy in supplying needed information to technical-scientific organizations, on a priority basis.

4.8.3 — The training of librarians and specialists in documentation should be modernized and expanded. Existing programs should be revised, and active exchange programs should be established with the more advanced documentation centers.

4.8.4 — Existing legislation (Law No. 4.084 of June 30, 1962, and Decree 56,725 of August 16, 1965) should be revised so as to abolish the exclusive privilege given to graduates of library science courses to organize and administer documentation services.

4.8.5 — Pending change in this legislation, university graduates in technical fields should be given the opportunity of training in intensive short-duration documentation courses, to allow them to perform the activities specified in the legislation and thus supplement the insufficient number of librarians and documentation specialists trained in Brazil.

4.8.6 — The publication of technical and scientific journals should be systematized to encourage collaboration among all periodicals of this type and to promote a larger circulation.

4.8.7 — An aggressive and sustained campaign should be undertaken among Brazilian entrepreneurs to alert them to the magnitude of the information problem, and to obtain their participation in the formulation and adoption of effective solutions.

4.8.8 — The central coordinating information organization (IBBD or its replacement) should attach special importance to the problem of scientific-technical documentation, creating sectoral "centers of excellence" in the fields judged of priority interest to the development of Brazil.

4.8.9 — With respect to the private sector, the National Confederation of Industry, the state federations, and other industrial associations, through their proper organizations, especially their productivity centers, should assist industrial firms in the study of the organization and administration of efficient and aggressive documentation and information centers, so that member firms may satisfy their information needs and keep themselves up-to-date on developments in their respective fields.

4.9 — Establishment of a Model of an Industrial Research Institute.

Goal: To propose a model of a research institute as a goal to be attained either by existing technological institutes, or possibly by a new institute to be created.

4.9.1 — Existing technological institutes with the potential of acquiring the characteristics described below, should do so within a period of two years.

4.9.2 — Other initiatives of a private character, both domestic and foreign, aiming to establish industrial research facilities of the type described, should be encouraged by all means, including, for Brazilian organizations, financing through the Fund for the Development of Science and Technology (FUNTEC).

4.9.3 — In the event neither of these possibilities occurs within a two-year period, the Government should take the initiative to promote the establishment of a new institution of applied research, in accordance with the recommendations below. With proper attention to the particular needs and conditions of Brazil this new institution should base itself on the several types of research organizations which have been successfully developed abroad, incorporating the experience they have acquired. It is hoped this new institution, in addition to accomplishing its primary objectives, will also assist and inspire existing institutions to promote more efficient and extensive research and development services.

4.9.3.1 — The model characteristics of the type of industrial research facility required to meet the growing industrial research needs and to further the economic and technological development of Brazil—whichever of the foregoing alternatives is ultimately adopted—should include:

- a) private institutional form, dedicated to public service, with not-for-profit civil society status;
- b) capability and organization to perform multidisciplinary and interdisciplinary research in various fields of science and technology;
- c) multipurpose services suited to the broad range of complex applied research and development problems faced by industry and government;
- d) strong capability in management and techno-economic sciences, oriented to broad economic and resource development studies, well integrated with its capability in the natural and engineering sciences;
- e) practical, user- or market-oriented attitude, continuously responsive to the needs of Brazil and of actual or potential clientele;
- f) project-oriented, problem-solving operational approach;
- g) research teamwork approach to problem solving.

4.9.3.2 — The services and capabilities of such an institution should be organized in four major sections:

- a) engineering sciences;
- b) life sciences;
- c) physical sciences;
- d) management and techno-economic sciences, including resource development.

4.9.3.3 — Specific offerings under each of these headings should be developed at a later date in the light of market demand and the availability of staff and resources. For the initial period of its existence, such an institution will find it useful and profitable to perform inspection and evaluation services with respect to products and processes (testing, quality control, etc.). Where possible, it should make use of existing facilities and laboratories, on a sub-contractual basis, to enlarge the range of its services.

4.9.3.4 — Contract research, fully paid for by the client, whether governmental or private, will constitute the bulk of the institution's research activity. However, the institution will derive great value from investing a portion of its own resources in non-sponsored, "in-house" research to these ends:

- a) training and upgrading of its own staff;
- b) performing advance work potentially saleable to outside clients;
- c) rewarding and providing incentives to staff members;
- d) developing technological competence for Brazil.

4.9.3.5 — The institution should be completely committed to the progress and technological improvement of the clients it intends to serve. Accordingly, it should conduct:

- a) aggressive sales campaigns, by its own research staff as well as by special sales staff, to bring its services and resources to the attention of actual or potential clients and to educate Brazilian industry and government generally regarding the benefits to be obtained from applied research;
- b) programs of continuing contact with clients and potential clients through periodic meetings, seminars, and workshops, bringing professional staff and client representatives together for exchanges of ideas and technical information;
- c) programs of visits by staff to industry and other clients, and by industrialists and other clients to the institution, to keep all concerned fully informed of their needs and capabilities.

4.9.3.6 — Great value lies in intimate and informal relationships between the research institution and nearby university institutions. Such relationships can take several forms:

- a) part-time teaching functions for the research staff (within the limitations indicated below);

- b) part-time consulting activity by university faculty for the research institution;
- c) part-time employment of graduate students during the academic year and during summer vacation;
- d) use by university faculty and graduate students of the institution's research equipment and facilities;
- e) joint programs by university and research institution in seminars, conferences, and cooperative research projects.

4.9.3.7 — To the maximum extent feasible, the research institution should, on a sub-contractual basis, collaborate with and make use of the facilities of other research institutions. This practice accords with the established principle that it should invest the least amount required in fixed assets and equipment, and the greatest amount possible in superior quality technical staff. Furthermore, extensive mutual use of such facilities will stimulate the upgrading of other institutions.

4.9.3.8 — The two top administrative echelons of the institution will be the Board of Trustees or Directors and the Presidency; decisions regarding the other sectors are essentially within the competence of these two echelons in the light of the institution's evolving needs and capabilities. For the purpose of illustration, the recommendations below relating to composition and size of the Board rest on the assumption of a substantial government interest in the model institution, both as a source of major initial or sustaining financial support, and as a major client. It should be noted that the degree of participation by government could be less, or non-existent, if the institution established were entirely privately financed.

4.9.3.9 — The Board of Trustees or Directors should be a self-organizing, self-perpetuating body of twenty-three persons, composed as follows:

- a) the President of the institution ex officio;
- b) fifteen members from private life to serve for three-year terms, to be replaced by majority vote of the Board, at the rate of five new members each year; the duration of service by members of the first Board to be determined by lot.
- c) seven ex officio members representing the government sector, for example:

Ministry of Planning and General Coordination
Ministry of Finance
Ministry of Interior
Ministry of Industry and Commerce
Ministry of Mines and Energy
National Bank for Economic Development (BNDE)
National Research Council (CNPq)

or some other combination of government agencies consistent with the purposes of the institution.

4.9.3.9.1 — In no case, however, should representatives from the government sector exceed one-third of the members of the Board. Members sitting ex officio should be appointed by the agencies they represent for a single term of service. With the exception of those sitting in an ex officio capacity, members should be chosen by virtue of their individual qualifications and/or representational status as they relate to the institution's primary purpose, and as clearly specified in the bylaws of the institution. There should be no compensation for service on the Board. The powers and responsibilities of the Board should be defined clearly and exactly, and should be limited to these four functions:

- a) election of the President;
- b) approval of the annual budget and changes in the budget;
- c) approval of major fields of activity in which the institution will provide services;
- d) establishment of general policies governing the institution, without involvement in details.

4.9.3.10 — The President should be of the caliber of the highest level of industrial executives in Brazil, and be compensated accordingly. The President should serve at the pleasure of the board. He is to be the chief executive officer of the institution, with full complete responsibility with regard to:

- a) finances, within the limits of his budget;
- b) personnel, to hire, terminate employment, and establish salary levels for his staff;
- c) program activity for each project, study or other undertaking of the institution;
- d) representation of the institution to the public at large, as its chief spokesman.

4.9.3.11 — Experience suggests that a critical mass of at least 15 professionals will ultimately be required in each of the major fields of research cited above to give them an effective and productive working capability.

4.9.3.12 — Local working conditions suggest need for a supporting staff in the ratio of about 2 or 3 to 1 professional. Thus, for an institution ultimately to become fully operational, it is envisaged that a staff of about 175 and 200 persons will be required. This staff must devote itself full-time to the institution, to the exclusion of all other employment, the sole exception being such teaching as is consistent with the goals of the institution and is formally approved by its management. Any compensation received in this manner is to be the property of the institution.

4.9.3.13 — The institution's personnel should be hired under the provisions of Brazil's Labor Code.

4.9.3.14 — Staff salaries must be fully competitive with the best available in Brazilian industry or, as required, on the international market.

4.9.3.15 — A good part of the professional staff should have had four or five years of working experience in industry and management.

4.9.3.16 — The institution should indeed promote a continuing flow of personnel to and from industry. One of its important missions is the diffusion of high-quality personnel throughout the clientele it intends to serve, both as a means of raising the capabilities of its clientele and of establishing long-term productive links with it.

4.9.3.17 — The institution should consider the continuous training and upgrading of its own staff as one of its prime responsibilities, and as the only effective way of keeping abreast of worldwide changing technology and the "state of the art" in all the fields in which it seeks competence.

4.9.3.18 — Experience suggests that a new research institution of the type under consideration must at the outset have on hand, or fully committed, a sum of approximately five to six million dollars (18 to 22 million new cruzeiros)* to guarantee it the required financial security during the first five years of its life.

4.9.3.19 — Of that amount, no more (and preferably much less) than one million dollars (3.6 million new cruzeiros) should be in the

*Cruzeiro at official rate of NC\$3.60 to the dollar.

form of loans. Of the balance, the greater share should preferably originate as a contribution from the private sector (Brazilian industry and foundations), and the remainder also as a contribution from the public sector (BNDE, other Brazilian Government sources, international organizations, etc.). An alternative approach would be to obtain at least ten million dollars (36 million new cruzeiros) for investment in bonds of the National Treasury. An optimal disposition of such resources might then be as follows:

a) General grant funds for start-up expenses and operating losses

\$1,050,000 (NC\$3,800,000)

At \$300,000 (NC\$1,100,000)
for year 1

\$250,000 (NC\$ 900,000)
for year 2

\$200,000 (NC\$ 720,000)
for year 3

\$150,000 (NC\$ 540,000)
for year 4

\$100,000 (NC\$ 360,000)
for year 5

\$ 50,000 (NC\$ 180,000)
for year 6

b) Funds for support of specific research projects and training of staff

\$2,100,000 (NC\$7,000,000)

At \$100,000 (NC\$ 360,000)
for year 1

\$200,000 (NC\$ 720,000)
for year 2

\$300,000 (NC\$1,100,000)
for year 3

\$400,000 (NC\$1,440,000)
for year 4

\$500,000 (NC\$1,800,000)
for year 5

\$600,000 (NC\$2,200,000)
for year 6

c) Funds for facilities and equipment

\$1,850,000 (NC\$6,600,000)

Note: investment in fixed facilities should be kept to a minimum in favor of rental arrangements.

d) Working capital and reserves

\$1,000,000 (NC\$3,600,000)

Total \$6,000,000 (NC\$21,600,000)

4.9.3.20 — Entrepreneurial initiative in launching a new research institution of this type should be taken by a carefully selected group of Brazilian industrialists, since the initiative and required resources should come from the private sector.

4.9.3.21 — The essential elements once assembled, it will then be most desirable for the institution to contract with a reputable research organization abroad, on the best terms possible, for an affiliation involving management and other services such as back-up technical assistance. This will assure, for a predetermined period, that the new research institution has at its command the best experience available in getting itself established and functioning.

4.9.3.22 — Though this type of management contract would tie it to a particular foreign organization, with the advantages of prestige and reputability that this would bring, it need not exclude arrangements on technical matters with other qualified foreign institutions.

4.10 — Proprietorship of Patented Processes and Products.

Goal: To facilitate and reduce the cost burden of using patented products and processes.

4.10.1 — The Ministries of Planning and of Industry and Commerce should reformulate Decree-Law No. 254, "Code of Industrial Property" (Código da Propriedade Industrial), in order to facilitate and accelerate transfer of technology to Brazilian industries, within the existing international legal framework.

4.10.2 — The Ministries of Foreign Affairs, Planning and Industry and Commerce should jointly undertake a study to evaluate the effects of existing Brazilian and international patent legislation and agreements on the process of technology transfer for industrial development in Brazil.

In the event the study so indicates, the Ministry of Foreign Affairs should undertake negotiations with the other participants

in international patent agreements with the view of improving conditions for transfer of technology in general, and for transfer by "copying" in particular.

4.10.3 — Brazilian authorities should continue to participate actively in programs of the United Nations concerned with securing effective access by developing countries to appropriate technology for the support of their industrial research and economic growth.

5 — PRESENT SITUATION

5.1 — Industrial research in Brazil is demonstrably inadequate. A recent study carried out under the auspices of the Roberto Simonsen Institute on the subject, "Technical Research in the São Paulo Industry," indicates that less than one quarter of the enterprises surveyed conduct research. This refers to enterprises with a capital of more than five hundred thousand new cruzeiros or with more than one hundred employees, all located in the area that represents the highest level of technological development in Brazil.

5.2 — The number of research personnel per enterprise is extremely low; more than half of the enterprises claiming to do research maintain no more than one to three researchers with professional training. Of the total number of researchers in industry about one third devote themselves exclusively to research and are university graduates.

5.3 — The traditional industries (textiles, leather, etc), employing the bulk of the labor force, account for the smallest part of the research effort.

5.4 — Industrial enterprises which are subsidiaries of foreign firms incline to concentrate their innovative research in their home facilities abroad.

5.5 — Federal and State technological institutes dispose of insufficient funds. The majority of the institutes of technology base their technical organization on the old model of the U.S. National Bureau of Standards, with adaptations to local conditions. All are subsidized to a greater or lesser extent by the Federal or State governments. Those located in areas that are industrially, economically, and culturally more developed do show a higher level of output. This is understandable since the communities in which they are located are source of supply of the manpower they require, as well as of demand and motivation for the technical and research services they undertake.

5.6 — These institutes all suffer, however, from long-standing structural problems. Generally, they pay low salaries and are therefore unable to count on a significant number of full-time researchers. They lack specialized, properly trained and motivated personnel at different levels of experience. They also lack administrative flexibility and autonomy for they are subject to higher authorities accustomed to centralized decision-making. To these weaknesses must be added difficulties in programming the use of financial resources and operational discontinuities, which stem from unexpected budget cuts and delays in the allocation of governmental appropriations.

5.7 — As a consequence, the institutes devote themselves very largely to quality control testing activities, and generally do not undertake applied research projects requested by industry.

5.8 — Brazilian universities are still predominantly academic-theoretical in their orientation and do little applied research work; requests for applied research are rarely addressed to the universities.

5.9 — Brazilian industry faces various difficulties, some of which are well known, e.g., high interest rates, high utility costs, (electricity, gas), high taxes and duties, high-cost transportation and insufficiency of secondary industries, to name a few of the more important.

5.10 — The situation is further aggravated by the bureaucratic interference of both Federal and State government agencies in the affairs of industry.

5.11 — For the most part, Brazilian industry manufactures goods which are similar to those imported at much lower prices, given the larger scale production in countries of origin. The profit margin on such goods is evidently low.

5.12 — With increasing frequency, also, Brazilian industry is forced to compete with foreign enterprises that resort to "dumping," which is made possible by the adequacy of profits on their sales at home and the low marginal production cost of additional quantities for export.

5.14 — Brazilian industry thus runs the risk of being wiped out by efficient foreign enterprises in search of new markets. These enterprises seek through exports to gain control of incipient markets in underdeveloped areas, often by "dumping" prices, with the view of installing production facilities when the size of the market will make it profitable.

5.15 — In the face of immediate problems of survival, Brazilian industrial management considers technological innovation, however sparsely and unsystematically performed, as a low priority activity.

5.16 — By and large, industry prefers the easy policy of purchasing "know-how" as required, without any effort, from the base of the "know-how" thus acquired, to progress to higher levels of technology. Such effort might ensure adequate competitiveness and might prevent the "know-how" becoming obsolete in little time, necessitating after a few years the purchase of further "know-how" for the same purpose.

6 — COMMENTS ON THE TEN RECOMMENDED ACTIONS

6.1 — Application of Resources.

The industrial research effort in Brazil is highly fragmented. There are, indeed, no guidelines which would permit a careful examination of research projects and plans in relation to the human and financial resources of the country.

6.1.1 — On the other hand, little benefit is being drawn from available raw materials, and in particular those peculiar to Brazil. Brazil's research effort could be much more fruitful were it concentrated on specific areas in which the country has high potential for commercial success.

6.2 — Actions of Official Credit Agencies.

There is no proper coordination between the policies of financial agencies for the support of industrial research and the strategic development policy of the Federal Government.

To prevent the dispersion of financial resources, the measures indicated in Item 2 of the "Recommended Actions" are suggested.

6.3 — Government Incentives to Industrial Research.

6.3.1 — Until a few years ago the use of fiscal policy was considered an inefficient tool to influence those responsible for economic activity.

6.3.2 — It should be noted that even in the more highly developed industrial countries the income tax did not become an important source of government revenue until after World War I, and was not used to influence economic activity until World War II. Not surprisingly, therefore, Brazilian income tax legislation offers no direct incentives to industrial research.

6.3.3 — The present Income Tax Law contains a special section (Section IX, Chapter III, Book III) bearing on "expenses for scientific or technological research." This section allows "as operating expenses, the expenses for scientific or technological research, including experimentation to create or improve products, processes, formulas and techniques of production, administration or sales."

6.3.4 — Paragraph 2, however, declares that "investments of capital in land, fixed installations, or equipment purchased for research will not be included as operating expenses"; and paragraph 3 adds that "...may be deducted as an expense: annual depreciation

or the residual value of the equipment or industrial installations in the year that the research is abandoned for lack of success, the salvage value of the property being computed as income."

6.3.5 — The legislation of other nations is much more favorable to research. Some countries already possessing a well-developed industry (Canada, for example) offer incentives especially attractive to technological innovation, e.g., deductions of one and a half times the expense of research from the total amount of income computed for income tax purposes, and, in addition, provision for financing research through government agencies offering long-term, low interest loans. Such types of incentive do not exist in Brazil, with the exception of the recent and timid efforts of the National Bank for Economic Development (BNDE) to grant loans at 6 percent per annum, increased by 20 percent of the value of monetary correction made within the period, for the account of FUNTEC and FUNDEPRO (Fund for the Development of Productivity). FUNTEC, administered by BNDE, has been the principal stimulator of university graduate programs through grants and gifts of equipment to public institutions.

6.3.6 — The purchase of a foreign process or product represents the buyer's indirect contribution to the technological development of the country of origin. In the same way that nations try to substitute for imports of goods, there is a counterpart tendency emerging to substitute for imports of "know-how." Existing legislation, which taxes remittances of profits and royalty and technical assistance payments abroad, does not provide, however, for the use of such tax income to benefit research in Brazil.

6.3.7 — Finally, the government does nothing to facilitate the import of materials needed for industrial research but subjects them to normal bureaucratic procedures.

6.4 — Industrial and Research Management Capability.

6.4.1 — The conditions under which industrialization occurred in Brazil, based on a system of import substitution, are well known. Less so, however, are its implications for industrial and research management. The import substitution policy presented the Brazilian entrepreneur with a guaranteed market, protected by a favorable exchange rate and a high tariff structure. In this manner the entrepreneur acquired and held his market through administrative or political favors granted by the Government. He did not, as a consequence, feel need for such activities as market studies, cost and quality controls, and industrial research, nor did he develop the capable, efficient management that would be attentive to costs, quality, and technological innovation. This protected market, at the present technological level, has become saturated, however; its further expansion will have to come principally from cost reduction, energetic and efficient management, modern marketing techniques and an increasing

effort to produce new processes and products through industrial research. If Brazil's economic growth is to be sustained, increased demand for researchers and managers, now in such short supply, will have to be met.

6.4.2 — It is obvious that increased productivity is necessary for successful competition by Brazilian industry in the export markets, just as it is for its continued expansion in the protected internal market now that its original market position has been fully exploited. It would be a mistake, however, to hold the Brazilian entrepreneur wholly responsible for his deficiencies and unenlightened ways toward research, since he was led to this situation in part by the Government's aggressive industrialization policy.

6.4.3 — Of even greater importance, in recent years, has been the Government's anti-inflationary policies which have created serious disincentives to entrepreneurial initiative by significantly increasing costs with higher tax rates on industrial products, high cost of money in the capital markets, and increased rates for such infra-structural services as transport, electricity, etc.

6.4.4 — Fortunately, the present Government has begun studies to reconsider and reshape the rate structure for public services along more reasonable lines.

6.4.5 — The recent tariff reduction, however, should not have been undertaken before a proper restructuring of the price system, so that the entrepreneur could prepare himself to face international competition. A more realistic and equitable policy would have been to offset a gradual and selective lowering of tariffs with measures to alleviate the cost burden and to increase the productivity of the country's industry.

6.4.6 — To assure a future supply of management and technological expertise to support a sustained increase in industrial productivity, it is recommended that Government undertake the measures indicated to increase and improve the training of the specialized manpower resources, and adopt aggressive programs for the expansion of industrial research activity.

6.5 — Industry, Universities and Industrial Research Facilities.

6.5.1 — There is no effective meshing of education, research, and industry. University courses are not planned to satisfy the demand for technicians, researchers and engineers generated by industrial growth.

6.5.2 — Furthermore, with few exceptions, existing research organizations do not direct their activities to the needs of industry.

6.5.3 — Finally, industry lacks a modern management aware of the multiple problems caused by continuous technological development, and capable of orienting industry toward rational application of technology for higher efficiency and better use of available raw materials and manpower.

6.6 — Availability of Human Resources.

6.6.1 — An adequate supply of technical graduates of good quality is a basic condition for the development of industrial research. The current training of technical graduates is insufficient. Graduate programs are few, and seldom in accordance with the real needs of Brazilian industry.

At present, the majority of Brazilian universities do not have the means to offer graduate programs to accelerate the training of researchers for industry. Available graduate courses are designed mainly to provide academic titles and to offset the deficiencies of the undergraduate courses. The majority of these courses emphasize fundamental research in biology, physics, chemistry, mathematics, and the humanities and social sciences.

6.6.2 — On the other hand, the sending of scientists and engineers abroad for additional training often leads to the loss of these talents, given the absence of conditions that would attract them back to Brazil.

6.6.3 — Since there are few Brazilian industries which perform industrial research, there is little opportunity for the systematic training of engineers and applied researchers in the country as a necessary supplement to their formal graduate training program.

6.7 — Structure of Industrial Research Institutions.

6.7.1 — The efficiency of institutions devoted to industrial research depends on their organizational structure and their administrative practices.

6.7.2 — The performance of industrial research requires managers familiar with modern techniques of planning and administration.

6.7.3 — Brazilian industrial research organizations, in general, lack operational flexibility and modern management structures.

6.7.4 — These deficiencies derive, in part, from low level of demand by industry for research services, which reflects the absence of an adequate policy of technical assistance by the research institutions to industry.

6.8 — Scientific-Technological Information and Documentation.

6.8.1 — The systematic training of librarians in Brazil began in 1911, in Rio de Janeiro. The librarians so trained were simply

handlers of books and periodicals, their cultural background was geared to the then prevailing demands, which were predominantly those of public libraries. Thus, the training was encyclopedic in character, with emphasis on knowledge of the humanities.

6.8.2 — Brazil has less than 6,000 graduate librarians and more than 13,000 libraries in operation. Law No. 4084 of June 30, 1962, and Decree No. 56,725 of August 16, 1965, define the area of activity of librarians and documentarians, reserving to them exclusive rights to their functions.

6.8.3 — The number of librarians is insufficient for the existing libraries. The librarians are not prepared to meet the requirements of an "aggressive" documentation system that will supply materials to users with the required dispatch and precision. The present law does not permit other professionals to work in the area of documentation.

6.8.4 — Lack of coordination further aggravates the failures resulting from lack of personnel trained in technical documentation. The absence of a dynamic central coordinating organization, despite the efforts of the Brazilian Institute of Bibliography and Documentation, compounds the inefficiency of the present system.

6.8.5 — The libraries lack complete collections of the most essential periodicals.

6.8.6 — Private enterprise is not yet conscious of the importance of a sound documentation program. Rare are the private Brazilian firms that maintain such a facility, supply it with means of information processing and retrieval, and keep it up-to-date and accessible to the users.

6.8.7 — Brazilian scientific-technical periodicals are few in number, and their circulation is very limited. Only very recently did the CNPq decide to resume the publication of a journal on technology. In May, 1968, the National Confederation of Industry began publication of Industry and Productivity, an indication of its awakening to the problem.

6.8.8 — Some private publishing houses have initiated publication of technical periodicals, which are distributed gratis to professional and management cadres in the relevant sectors. These periodicals are subsidized by advertising.

6.9 — Existing Research Institutes.

The existing institutions of industrial research are, with few exceptions, incapable of satisfying the increasing demands of the country's industrial development.

Item 4.9 of this report proposes minimum requirements for the restructuring of the existing institutes of technology, and identifies the essential characteristics of an industrial research institution capable of satisfying the needs of Brazilian industrial development.

6.10 — Technology Transfer within the Existing International Patent System.

6.10.1 — The process of transfer of technology from more advanced to less advanced nations, properly understood and handled, is one of the most important means of rapid improvement of the technological capability of developing areas and is, therefore, of fundamental importance to their economic development.

6.10.2 — The international patent system is not being used as effectively as possible to enhance this transfer process, nor does it take into account the international consensus that economic and social development of industrially backward areas of the world is of interest to all nations.

6.10.3 — In particular the present system has a deterrent effect on "copying," in Brazil, of products and processes previously developed in more advanced countries, despite the fact that this activity is one of the most efficient mechanisms for transfer to and absorption of technology by a developing country.

6.10.4 — Were there to be a removal or diminution of this deterrent effect of the international patent system, "copying" activity could become an important component in the early phases of Brazilian industrial research.

6.10.5 — Closely related to "copying" is the transfer of "know-how" through purchase and use of patents. In many instances this is the quickest method to introduce a new industry. However, this approach does not necessarily produce a strengthening of the technological capability of the purchasing country. The reason lies in the fact that there must also be understanding of the scientific-technical basis of the imported technology, as well as its adaptation to the conditions of the recipient country, before that country's own technological capability can be said to be enhanced. It is important, therefore, that measures be taken, in purchasing industrial "know-how," to ensure that means for transfer of technical understanding accompany the transfer of "know-how."

6.10.6 — Further improvements could also be made in the Brazilian patent law itself, which was recently changed, but which is still not fully satisfactory for facilitating and assuring the technology transfer process under the existing international patent system.

7 — BACKGROUND OF THE STUDY

7.1 — An exchange of ideas between Dr. Antonio Moreira Couceiro, President of the Brazil National Research Council (CNPq), and Dr. Harrison Brown, Foreign Secretary of the U.S. National Academy of Sciences, led to a conference under the joint auspices of these two institutions at Itatiaia, Brazil, April 11-16, 1966, on the subject of science and economic development.

7.2 — One of the recommendations of this gathering called for the creation of a study group on industrial research. To compose this group, the CNPq requested the participation of representatives from other branches of Government, universities and industry who are directly concerned with industrial research or with problems related to economic development, as follows:

Persio de Souza Santos (Chairman)
Institute of Technological Research and
Polytechnic School, University of São Paulo

Abraham Iachan (Coordinator)
National Institute of Technology
National Research Council

Andre Toselo
Tropical Food Research and
Technology Center

Antonio Seabra Moggi
Petrobras

Fred W. Lacerda
Brazilian Institute of Metallurgy

George S. de Moraes
SINVAL A/A
Governador Valadares

Joaquim Francisco de Carvalho
Ministry of Planning and General
Coordination

Juvenal Osorio Gomes
National Bank of Economic
Development

Kurt Politzer
School of Chemistry, Federal
University of Rio de Janeiro

Nelson C. Gutheil
Institute of Technology
Rio Grande do Sul

Remolo Ciola
Refinaria e Exploração de
Petróleo União

7.3 — This group had the benefit of advice from a group of distinguished individuals drawn from the field of industrial research in the United States, designated by the National Academy of Sciences:

Richard C. Jordan (Chairman)
University of Minnesota

Julien Engel (Coordinator)
National Academy of Sciences

Anthony Leeds
University of Texas

Arthur W. Weber
Corning Glass Works

Bertram D. Thomas
Battelle Memorial Institute

Douglas H. Graham
Vanderbilt University

Eugene P. Pfleider
University of Minnesota

Jesse Hobson
Heald, Hobson and Associates

Robert W. Olson
Texas Instruments Incorporated

William A. W. Krebs
Arthur D. Little, Inc.

William Bollay
Stanford University

7.4 — In the course of fifteen months, the Study Group held 34 meetings, most of them in Rio de Janeiro, others in Belo Horizonte and Campinas, and also in Columbus, Ohio, and Dallas, Texas.

7.5 — They visited the principal Brazilian and North American research institutions. They studied the programs, reports and legislation concerning industrial research activity in several other countries.

7.6 — The Study Group does not pretend to present an exhaustive study of all the aspects under consideration. They limited their examination to those aspects which seem to combine fundamental importance with feasibility of implementation within the context of Brazilian realities.

7.7 — The objective of this report is to identify measures to be taken by public and private sectors to strengthen industry in Brazil with structures appropriate to local factors of production and the peculiarities of the market.

7.8 — In accordance with this approach, the Group believes that the objectives of the study will have been fully attained if some of the recommendations obtain acceptance and implementation by the appropriate authorities, while others stimulate further discussion and more detailed and thorough inquiry for later action.

7.9 — With the presentation of this report in September 1968, the Study Group considers its activities as a continuing body to have come to a close, although each member of the Group remains at the disposal of the CNPq to assist, within the sphere of his work, with the implementation of the recommended actions.