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Science and Technology in São Paulo's Development

A Review and Critique of a Proposed Program
To Utilize Science and Technology for the
Economic Development of the State of São Paulo, Brazil

by an
Ad Hoc Panel of the Board on Science and Technology for International
Development of the Office of the Foreign Secretary
National Academy of Sciences—National Research Council

AID/csd-2584

Prepared for the
BRAZIL MISSION OF THE U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT
Washington, D.C. • July 1972

This report has been prepared by an ad hoc panel appointed by the Foreign Secretary of the National Academy of Sciences in response to a request from the Director of the United States Agency for International Development Mission in Brazil. The panel was asked, and has undertaken, to consider plans developed in Brazil for an integrated program to utilize science and technology to further the economic development of the State of São Paulo. Its work was supported by the U.S. AID Mission in Brazil under contract AID/csd-2584, Task Order Number 10.

In submitting this report, the panel wishes to express its appreciation to Mr. William Ellis, Director, and his associates in the USAID Mission in Brazil, and to Dr. Miguel Colasuonno, Dr. José Pastore and their associates in the State of São Paulo for the helpful and cooperative assistance they provided during the course of the panel's visit to Brazil, May 20 - June 1, 1972.

NOTICE

The study reported herein was undertaken under the aegis of the National Academy of Sciences with the express approval of the Governing Board of the National Academy of Sciences - National Research Council. Such approval indicated that the Board considered that the problem is of national significance; that elucidation and/or solution of the problem required scientific or technical competence and that the resources of NAS were particularly suitable to the conduct of the project. The institutional responsibilities of the Academy were then discharged in the following manner:

The members of the study committee were selected for their individual scholarly competence and judgment with due consideration for the balance and breadth of disciplines. Responsibility for all aspects of this report rests with the study committee, to whom sincere appreciation is expressed.

Although the reports of our study committees are not submitted for approval to the Academy membership nor to the Council, each report is reviewed by a second group of appropriately qualified individuals according to procedures established and monitored by the Academy's Report Review Committee. Such reviews are intended to determine, inter alia, whether the major questions and relevant points of view have been addressed and whether the reported findings, conclusions, and recommendations arose from the available data and information. Distribution of the report is approved by the President only after satisfactory completion of this review process.

NATIONAL ACADEMY OF SCIENCES

2101 CONSTITUTION AVENUE
WASHINGTON, D. C. 20418

OFFICE OF THE FOREIGN SECRETARY

August 2, 1972

Dr. Harrison Brown
Foreign Secretary
Office of the Foreign Secretary
National Academy of Sciences

Dear Dr. Brown:

The report of the Ad Hoc Advisory Panel To Consider Plans for an Integrated Program To Utilize Science and Technology in São Paulo's Development is submitted herewith.

In submitting this report the panel would like to emphasize the following points: first, the importance of having the São Paulo Project focus on those efforts in science and technology that can improve the capacities of Brazilian industries to compete successfully in world markets; second, the potential importance of the São Paulo Project as a model for demonstrating some of the significant ways by which science and technology can contribute to economic development; and, third, the need for a plan and program of implementation that can better assure the successful operation of the São Paulo Project as a viable model for Brazil and other developing countries.

The goal of helping Brazilian industries to compete successfully in world markets is at once the most demanding and the most worthy objective of the São Paulo Project. It is the most demanding because rigorous efforts will be required to enable Brazil to compete broadly with the most advanced economies in the world. It is the most worthy because, if the Project succeeds, it will provide needed foreign exchange for further investment in Brazil, a higher degree of efficiency within Brazilian industry, and an improved standard of living within the domestic economy. For all these reasons, it is important and right that the State of São Paulo, which has the strengths and resources, should be the setting for the Project.

The substantial resources already committed to the Project by the State of São Paulo and the Government of Brazil, as well as those that may be forthcoming from the United States Agency for International Development, give cause for the belief that this Project, if properly conceived and properly executed, could become a model for demonstrating some of the more useful ways by which science and technology can contribute to economic development. Accordingly, the Board on Science and Technology for International Development may wish to assess the c. usions

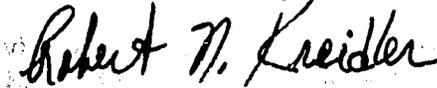
Dr. Harrison Brown

August 2, 1972

of the report not only as they relate to the particular situation in São Paulo, but more broadly as they bear upon furthering the state of the art for stimulating the development process at large.

Many of the resources are at hand in São Paulo for initiating this ambitious Project; but resources and a general plan will not be sufficient: a detailed program of implementation is urgently required. The panel recommends, therefore, that the United States Agency for International Development initiate and support efforts to create such a detailed program. Only through such a program is it likely that technical assistance from the United States will be deployed in ways that will have maximum effect.

Yours respectfully,



Robert N. Kreidler
Chairman

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AD HOC ADVISORY PANEL TO CONSIDER PLANS FOR AN INTEGRATED PROGRAM TO UTILIZE SCIENCE AND TECHNOLOGY IN SAO PAULO'S DEVELOPMENT

U.S. Panel

Robert N. Kreidler, Chairman
Alfred P. Sloan Foundation
630 Fifth Avenue
New York, New York 10020

William E. Andrus, Jr.
National Bureau of Standards
Washington, D. C. 20234

Kenneth R. Hansen
Doxiadis Associates, Inc.
1058 Thomas Jefferson Street, N. W.
Washington, D. C. 20007

George R. Herbert
Research Triangle Institute
Durham
North Carolina 27702

Bernard Kupferschmid
Technology Transfer International
P. O. Box 442 Newton
Boston, Massachusetts 02158

Richard O. Mason
Graduate School of Management
University of California
Los Angeles, California 90024

Kenneth K. Mabuchi
Greater Washington Interventure
1015 18th Street, N. W., Suite 300
Washington, D. C. 20036

Robert D. Stillman
748 Madison Avenue
New York, New York 10021

Resource Person: Jack Baranson
Consultant to the Board on Science and Technology
for International Development
Office of the Foreign Secretary
National Academy of Sciences

National Academy of Sciences Staff:

B. K. Wesley Copeiand
Professional Associate
Board on Science and Technology for International
Development
Office of the Foreign Secretary

Paul E. Irick
Assistant Director, Special Projects
Highway Research Board

OFFICE OF THE FOREIGN SECRETARY

Board on Science and Technology

for International Development

Washington, D. C.

MEMBERS

Carl Djerassi, Chairman
Department of Chemistry
Stanford University

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University of Chicago

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Agricultural Sciences
The Rockefeller Foundation

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Director
New York University Medical Center

Joseph B. Platt
President
Harvey Mudd College

D. Mark Hegsted
Professor, Department of Nutrition
Harvard University School
of Public Health

Roger Revelle
Director
Center for Population Studies
Harvard University

Lady Barbara Ward Jackson
Albert S. Schweitzer Professor of
International Economic Development
Columbia University

H. F. Robinson
Provost
Purdue University

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

Stefan H. Robock
Professor
Graduate School of Business
Columbia University

Robert N. Kreidler
Executive Vice President
Alfred P. Sloan Foundation

H. Burr Steinbach
Dean of Graduate Studies
Woods Hole Oceanographic Institution

Roy L. Lovvorn
Administrator, Cooperative
State Research Service
U.S. Department of Agriculture

Carroll L. Wilson
Professor
Sloan School of Management
Massachusetts Institute of Technology

MEMBERS EX-OFFICIO

Harrison Brown
Foreign Secretary
National Academy of Sciences

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Foreign Secretary
National Academy of Engineering

Thomas F. Malone
Deputy Foreign Secretary
National Academy of Sciences

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PART I

THE SAO PAULO PROJECT: GENERAL REVIEW

Introduction

This brief report is concerned with the large set of problems that center on the uses of science and technology for economic development in Brazil.

For the purpose of this report, and in accord with the request for our views, the panel has sharply focused its comments on the proposed project for the State of São Paulo, a project that seeks to link science and technology to the economic development of the state both as an important objective in its own right and as a model for the nation.

Since the panel had access to only the sparsest information about the planning for the São Paulo Project in Science and Technology (hereinafter called the Project) before leaving for Brazil, and since the time spent in Brazil with the architects of the Project was relatively brief, it is important to emphasize at the outset of this report certain qualifying statements concerning the comments and suggestions that follow:

- The panel fully appreciates the preliminary nature of the project proposal we were asked to review. But because operations under this joint federal-state Project are already underway, we have attempted to reach beyond the written description of the Project, even as amplified by intensive briefings and discussions, and to frame our conclusions in a way that would be anticipatory of new developments.

The panel is not profoundly familiar with the economic, social, and technological environment in São Paulo, but we do not believe such familiarity is essential in dealing with the task we undertook. Our comments relate principally to problems of planning, organization, finance, research management, information systems, and standardization; they rest upon experience gained in the study of these problems in many diverse settings. We offer these comments as contributions to the next steps in the planning of this one discrete and significant Project in relating science and technology to the needs of developing industry in São Paulo. We do not pretend to provide a detailed or complete analysis of all the ways and means to further the complex processes of industrialization taking place in that dynamic state.

Section A. The São Paulo Project in Science and Technology:

Description and Issues

The broad purposes of the São Paulo Project in Science and Technology are

1. To promote the application of basic and applied scientific research and technology to the problems of Brazilian industry and agriculture;
2. To develop the capabilities--in industry, government, universities and research institutes--for providing an increased proportion of this research and technology from Brazilian sources; and
3. To focus efforts for increasing capabilities in science and technology most closely on those industrial and agricultural sectors that hold promise for rapidly improving Brazil's economic growth, largely through improving the capacities of commercial firms to compete successfully in world markets.

The current proposal sets forth a strategy for achieving these objectives by having the government of the State of São Paulo provide commercial firms with financial incentives, in the form of "soft" loans, to spend additional funds on specific research and development projects of their own and by contract with São Paulo institutions, principally research institutes and universities. By these contracts, the research institutes and the universities may be expected to increase their capabilities to serve the commercial firms and thereby contribute more effectively to the economic growth of the state and the nation.

This strategy is to be implemented through a new policy- and decision-making structure, the Council of Science and Technology (CET), which is to apply the financial incentives and mobilize supporting resources of technical assistance and material procurement, financed in part by the U.S. Agency for International Development (USAID).

In our view, the attempt to make better uses of science and technology for the economic development of Brazil by harnessing these resources to the needs of commercial firms in São Paulo represents an important and timely initiative. São Paulo unquestionably has the underlying economic strength and strong leadership capacities in the public and private sectors to promote economic growth through the deliberate enhancement and increased employment of scientific and technological resources.

The issues, therefore, are not whether such an effort is needed, or whether the conditions for it to succeed are present. Rather, the principal issues now to be considered are

What are the needs--especially in the commercial firms--for science and technology, and how are these needs to be met?

Does the proposed plan make an adequate start toward meeting these needs with present and proposed resources?

Is there any mismatch between the real needs and the measures proposed in the plan to meet them, or between aspects of the proposed plan and the objectives sought?

How might the proposed plan be strengthened to increase the leverage--and make more cumulative the impact--of the new resources in science and technology that might be engendered in industry, government, financial institutions, research institutes, and universities?

These issues are of basic significance, but we do not believe that the unknowns or uncertainties they give cause to should delay the further development of a substantial federal-state project in science and technology in São Paulo. To the contrary, we believe that such an effort can go forward promptly, but only if certain fundamental concerns expressed in this report, as to approach, scope, planned organization and method of operation of the proposed Project, are resolved; and we think they can be.

In Part II we offer certain suggestions concerning the major components of the proposed Project: the role and organization of the Council of Science and Technology (CET) and the Banco de Desenvolvimento do Estado de São Paulo (BADESP); the operations of the Fund for Science and Technology (hereinafter, called the Fund); research management; education and training programs; standardization and quality assurance; information systems; industrial extension services; and technical assistance related to all of these components. But before we discuss these suggestions, and the needs they are designed to serve, we wish to set forth our fundamental concerns about the present Proposal.

Section B. Certain Fundamental Concerns

1. Orientation of the Project: A Critical Factor

In broad terms, the principal objective of the proposed Project is to increase national income through investments in technological input that are designed to improve production efficiency, and in other ways to enhance the competitiveness of Brazilian industry in world markets. According to the plan presented to the panel, this objective is to be achieved, first, by improving and expanding engineering development and research capabilities in the supporting scientific and technological infrastructure; second, by directing the research interests of applied research and academic institutions toward more industry-relevant and development-relevant projects; and, third, by offering financial inducements to industry, and financial support to government research organizations, in ways that will cause them to gravitate towards each other to satisfy industry's technological needs on the one hand, and the research aspirations of the institutes and the universities on the other.

One assumption of this strategy is that augmentation of research institute and university capabilities will ultimately lead to and engender stronger linkages and increased interaction with industry. Another assumption is that the research institutes will perceive, and become instrumental in overcoming, certain disadvantages of Brazilian firms in their attempts to gain entry into world markets--notably inadequate production technology, lack of trading knowledge and abilities, and difficulties in acquiring appropriate technologies at reasonable prices.

Explanations of the current proposal, the several detailed projects presented, and the plans of the institutes outlined to us by their

directors, however, indicate that the basic strategy fails to take adequate account of the realities of the existing industrial structure of São Paulo and its relationship to internal and world markets. Thus, in our view, a fundamental shortcoming implicit in the proposed program is a misdirected or inadequate client orientation. Rather than concentrating on the needs of Brazilian firms for technological and marketing research inputs to improve their competitive position in world markets, the project focuses on the needs of the technical infrastructure--primarily the research institutes--and is oriented toward the needs of these institutions as a first order of priority.

Concomitantly, there is an apparent gap between government development-planning theory (relating technology investments and programs to economic-sector development) and the real world of commerce in which technological inputs support market development. The lack of a client orientation--looking first to the firm, and to market-induced requirements for production processes, quality control, product development and marketing skills--thus results in certain basic flaws in the proposed program:

a. The emphasis upon research and development as a major factor in advancing industrial efficiency and competitiveness in world markets reflects an inadequate understanding of the evolutionary nature of the engineering, development, and research spectrum (EDR spectrum) and its contributions to firms at varied and different stages of industrial development and with different manufacturing and marketing capabilities. The proposed program emphasizes investments at the D and R end of the technology spectrum in an industrial economy that needs considerable improvement in the engineering standards of industrial technology already installed, as well as a substantial improvement in marketing capabilities.

b. There are at least three distinct classes of enterprises that may be involved in the Project whose differences have not been adequately considered in the design of the Project: the large multinational corporations, large Brazilian firms, and smaller firms and service organizations. Each of these classes of enterprise differs in structure and stage of development, and each requires a different approach and a different mix of economic, technical, and manpower development programs.

Firms owned and controlled by foreign multinational corporations benefit from their own highly developed technical transmission system and have built-in access to world markets. They thus would appear to need little, if any, economic or technical assistance, although they should be encouraged, in numerous ways, to apply adaptive technology further and to mobilize their local and international R & D resources toward increasing Brazil's exports of industrial products. Large and medium-sized Brazilian firms that have absorbed "first generation" licensed technologies represent another distinct level of technological absorptive capability. To enter world markets these firms may need only economic assistance, and perhaps some help in product development. The third class of medium and small firms, still in varying stages of absorbing first-generation technology, clearly needs substantial technical assistance, chiefly in the engineering portion of the EDR spectrum (quality control, upgrading of standards, technical manpower training, etc.) if they are to grow in size and competence and enter the export arena.

c. The gap between the economic planners in the public sector and the managers of enterprises in the private sector appears to be substantial. Failure of those who designed this Project fully to comprehend

the role of EDR for industrial firms at different stages of industrial development is a consequence of this gap, and leads to inadequate proposals for integrating economic development goals with technical and commercial variables. This, in turn, is reflected in misdirected efforts to use Project resources to build up the general research, instead of the market-oriented capabilities, of technical institutes and universities. There is little recognition that medium and small firms generate almost no effective demand for scientific research, yet have a great need for engineering quality control and adaptive technologies. Thus, some of these smaller firms fear they are being induced to support institute-sponsored research activities far removed from their perceived needs and opportunities, and the larger firms are particularly concerned that the use of public funds might lead to detrimental interference in their commercial operations, including the loss of proprietary rights in innovations that they may finance.

2. Science and Technology and the Marketplace

The Project recognizes science and technology as important resources for economic development, but does not acknowledge the need to develop these resources in relation to the turbulent arena of the commercial marketplace. If the commercial firm is considered the principal client of the Project, and if it is to be served through a sequential EDR spectrum then the marketplace in various ways dictates the nature of much of the supporting system.

In this context we find several important capabilities lacking or inadequately provided for:

- a. Marketing Research, which provides much of the stimulus, guidance and practical framework for decision making in agricultural and

industrial research and the application of technology is deficient or misperceived in the proposed project. Since marketing research plays a dominant role in controlling the demand side of engineering, development, and research activities, it should be a central factor in the Project not only because it prompts innovation and higher standards but because it provides a feedback system that can direct readjustment to the changing demands of the market.

Product Development, as a means of focusing technical efforts and disciplining the use of technical resources in the development of specific products or processes with market potential, is not sufficiently emphasized in the entire system. The process of trial and error, of setting specifications, and of achieving levels of cost and quality in new products is at the heart of the industrial process and consequently must dominate research and engineering efforts supporting new or improved industrial undertakings.

Research Management, as a key factor in the Science and Technology Project, is approached principally as an educational function of the universities rather than as on-the-job training in technical institutes and industrial firms.

There undoubtedly is a need for developing sound programs of instruction (both courses and seminars) in research management in the universities, but such programs alone will not fulfill the needs of the Project. Both on-the-job training in technical institutes and industrial firms and technical assistance from abroad (e.g., highly qualified applied-research managers) will be required to link effectively the research capabilities of the technical

institutes to the needs of the firms. And since effective research management is a key factor in the Science and Technology Project, it must be accorded high priority. A high degree of competence from the outset at the level of both policymaking and applied research is essential.

As a result of the insufficient attention to market factors, there is a serious likelihood that the limited loan and supporting funds that are to be available to implement the strategy of the Project will either not be applied to the most promising commercial ventures and market-oriented research projects or they will be siphoned off into general support of the technical infrastructure as a means of overcoming serious deficiencies caused by inadequate government support of institute budgets.

If either of these situations were to occur, the State of São Paulo will have irretrievably lost a promising opportunity to develop viable and creditable demonstrations of how the technical resources of the research institutes and universities might best be linked to the specific and urgent needs of industry. (Part II, Section A, of this report, which discusses the proposed Fund for Science and Technology and other banking aspects of the Project, sets forth a series of suggestions for reorienting the Project to take better account of market factors.)

3. Technical Support: The Research Institutes and Universities

Our third area of concern relates to the problem just alluded to, e.g., how best to develop and link the important but badly neglected resources in the research institutes and the universities to the needs of industry and thereby to the economic development of the State of São Paulo and the nation.

The research institutes and the universities have important, indeed critical, contributions to make in engineering and research, education and training, standardization and quality assurance, and in providing technical information for all components of the Project. We believe the Project should provide for a large role for these organizations, especially those singled out for special attention and encouragement. Reorientation of the Project should not imply abandonment of constructive and aggressive support of their growth and utility, and we strongly urge that the state and federal governments provide more direct budgetary support to strengthen their capacities to interact more fully and freely with each other and with industry.

The institutes and universities have serious problems, which certainly should be resolved if they are better to serve the objectives of the Project, and we cite here, by way of example, some of the more prominent ones:

a. The salary problems in the institutes (and to a lesser degree in the universities) are destructive in their impact on recruiting and retaining high-quality professional staff.

b. The inability of the institutes--aggravated by government policies on salaries and other matters--to develop a series of technical service specialties makes them unable effectively to assist small- and medium-sized companies by offering training in quality control and other production processes, as well as assistance in value analysis and review of specific technical problems.

c. The strict prohibitions against university professors serving as consultants to industry precludes at the outset one of the more effective means for forging strong links between the research needs of industry and the research capacities of the universities.

These problems of research institutes and universities are serious, and they require prompt resolution. But in the context of the project we have been examining, we do not think they can be resolved, or should be resolved, by using loans--whether borrowed by government or industry--from the proposed Fund for Science and Technology. On the contrary, we believe these problems are appropriately resolved directly by the government through the normal budget process and by making certain obvious changes in laws and regulations.

If these problems are not resolved in this way--without recourse to new loan funds available for this project--we foresee a scatteration and diffusion of new resources that could seriously handicap the Project in achieving its main purposes. If, on the other hand, the resources of the Fund are targeted on the needs of industry in such a way as to enlist the strong participation of industry, we can foresee an opportunity for the Project to contribute to the total needs of the institutes and the universities. A real opportunity, implicit in the Project, is to make clear and credible to industry and to government how these institutions can use their scientific and technological capabilities to advance the economy. This opportunity should be seized; but it can only be seized if the limited resources available for the Project are carefully deployed in a few rigorously selected, sharply focused target areas so as to produce the kind of demonstrations that are cumulative and reinforcing in their impact. If this is done adroitly, we predict a strong demand from both government and industry for enhancing the capabilities of the institutes and the universities.

(Part II, Section B, of this report discusses more fully the roles of the research institutes and universities in the Project and offers other

suggestions on how these institutions might better serve the needs of industry.)

Apart from their major roles in research, education, and training, the research institutes and the universities, with the Council for Science and Technology, have important responsibilities under the Project in (1) standardization and quality assurance; and (2) technical information support. As is pointed out in Part II, these two areas, which involve many participating agencies and institutions, are not the exclusive affairs of the research institutes and the universities. Nevertheless, we wish to express here our general concerns with these areas as set forth in the

Projec

In standardization and quality assurance, the Project design appears workable and consistent. There is, however, an important exception: the Project is stated in terms of the State of São Paulo and its governmental structures; except for a minor reference to the National Testing Laboratories, it ignores existing federal regulations and structures, and the organizations recognized by the Government of Brazil in matters relating to standards and certification. We believe the certification system should be an integral part of a national system so that it may be recognized by industry and government in Brazil, by the certification agencies of other countries, and by regional treaty organizations. (Part II, Section C, presents further detail about standardization and quality assurance in terms of the needs of industry and the stated purposes of the Project, and it also offers several specific comments and recommendations related to the development of materials research and testing facilities.)

In the information system outlined in the Project, there are serious deficiencies in orientation and scale. The effort required to provide a

full service capability in scientific and technological information is, of course, beyond the present capability of any country in the world, let alone a single state such as São Paulo. Consequently, to better allocate the scarce financial resources of the state, it is necessary to identify and to emphasize only those information projects that promise to facilitate specific targets for economic progress.

Information by itself has no value; it assumes value when it has careful orientation, interpreted from some point of view, and used to make decisions or to guide useful activity. We are concerned by the lack of orientation in this Project toward the users of information whose activities fit most closely with the objectives of economic development, i.e., the members of industry. We suggest, therefore, scaling down the information system from what is proposed, more "direct targeting" of the effort, and more emphasis on selection and dissemination of information capabilities, with considerably less emphasis on procurement of hardware. (Part II, Section D, further analyzes the information needs of the Project and offers other suggestions for improvement.)

4. The Council for Science and Technology: The Central Point of Decision Making

Our fourth area of concern is with assuring strong leadership, staff, and institutional back-up capabilities for the CET as the central point of decision making in the operation of the Project.

The Project proposal states that CET is currently hiring a professional staff, and that technical assistance will be provided for strengthening the capabilities of CET to provide leadership for the Project and to supervise,

evaluate, and harmonize its various components. In our review we found no decision had yet been made as to who should be the director of this Project at CET, what is to be the nature and composition of the staff, or whether the director and the staff will have ready access to various back-up capabilities.

The panel has been further advised that the CET staff will be small and that the development of a new institution or new kinds of institutional capabilities for managing the Project are not contemplated.

We do not disagree that CET should have a small staff, but we strongly believe that a small staff will require ready access to outside capabilities, both at home and abroad, and that the CET director and staff must be able to tap these other resources to manage the Project.

The key manager of the entire Project, of course, is the director. In brief, he should have these qualifications, among others:

- a. Recognized professional stature in some aspect of science and technology, preferably related to industry;
- b. Experience with industry-related research projects and institutions;
- c. Experience in managing complex projects; and
- d. Leadership ability.

The director should be granted authority to recruit his own staff from industry and research organizations. His office should be outside civil service, should be able to offer salary levels that will attract top-flight professional talent, and have budget flexibility comparable to nongovernmental operations.

The CET staff should be able to call on substantial technical assistance--provided by United States Agency for International Development

and others--and it should, if possible, have access to institutional backstopping, especially in project management; in review of scientific and technical research proposals submitted by the research institutes and universities; and in organization of special projects that may be beyond the research management capabilities available in the São Paulo scientific and technological communities.

Consideration thus should be given to the possibility of contracting for technical assistance of an institutional nature to assist in the planning, development, implementation, and control of a few major demonstration projects of wide scope, importance, and visibility. A few such projects could demonstrate the prospects for success of the entire São Paulo Project; and they could be extraordinarily useful to CET in providing on-the-job training for its managerial staff, and other managers and researchers who are to be involved in the programs.

Section C. General Conclusions and Recommendations

In this section we set forth the conclusions and recommendations that stem from our general review of the São Paulo Project as described in Part I. As noted earlier, each section of Part II sets forth specific conclusions and recommendations based on more detailed reviews of certain component aspects of the proposal.

In both cases, our conclusions and recommendations are offered as a further contribution to the planning that already has been done to develop an extraordinarily innovative Project for the State of São Paulo.

On the basis of our general review, then, we urge six principal recommendations. All of them rest on our basic conclusions that the Project should be

Reoriented from a major emphasis on strengthening capabilities of government institutes and universities to more support of industry undertakings.

- Revised, with considerably less emphasis on "research and development" and greater attention to "engineering, development, and research"

at appropriate scales and levels of sophistication to fit the mix of industries in São Paulo.

- Directed mainly toward exports, with substantial emphasis on marketing research, process and product development, and adaptive technologies; and

- supported with high-quality technical assistance, stressing professional, industry-related research skills, research management, and project execution.

We also make the following more specific recommendations:

First: The CET/BADESP Fund loans should be promoted for and directed to research projects that have a demonstrable commercial importance. Accordingly, most of the loans should go to the projects of firms susceptible to breaking into the EDR (engineering, development, and research) cycle. Correspondingly, we recommend that projects proposed and initiated by government institutes and universities should be financed from the Fund only if 20 - 30 percent of the total cost will be borne by one or more industrial or agricultural enterprises that would ultimately benefit from the work.

Second: The initial projects selected for financing from the Fund for Science and Technology should be used for a relatively few, generally large-scale, demonstration projects, which will have high visibility and thus lend credibility and impetus to the effort to promote the utilization

of research and applied technology in São Paulo industry. To ensure this result, extraordinary support--technological, managerial, and financial--for the design and execution of these demonstration projects should be mobilized in Brazil and abroad.

Third: The CET and BADESP should be supported with highly competent staff to perform the key coordinating and policy and program decision making functions in the use of the Fund and in mobilizing resources to

Encourage projects in export areas of economic and technological significance;

- Assist in policy formulation, and in the review and monitoring of projects from the perspective of the adequacy of the scientific-technological preparations for the projects as well as the possibilities of successful execution;

- Bring to bear on the selection of project proposals--and in the design of project proposals--judgments of a substantial marketing and research competence; and

Assure that projects have as their objective tangible product and process development, the key purpose of the entire program.

The CET and BADESP also should undertake to assure the establishment in such institutions as the Instituto de Tecnologia de Alimentos (ITAL) and the Instituto de Pesquisas Tecnológicas (IPT), of a strong capability for market research and project evaluation so that these institutions can make a strong contribution to the purposes of the Project.

Fourth: Since the proposed Project is only one part of the state's program in science and technology, it is essential that the state give concomitant and substantial budgetary support to the research institutes

and universities. More specifically, the state should strengthen the capacities of these institutions to contribute to the Project by correcting such fundamental problems as low salaries at the institutes and the prohibition on consultation with industry by university faculty and staff.

Technical assistance, to support the roles in the Project envisaged for the research institutes and the universities, should take the following forms:

- For the research institutes: Resources should be provided for sending technical specialists from the United States to work with staff in the São Paulo research institutes to help these institutes develop and strengthen their capabilities in such fields as project evaluation and market research, product and process development, standardization and quality assurance, and information systems. In certain circumstances, it may be advantageous to send institute staff to the United States for training in these fields.

- For the universities: Resources should be provided for sending young educators from U.S. universities to the universities in São Paulo to initiate or strengthen educational programs in, for example, research and engineering fields related to the project, research management, and marketing. U.S. postdoctoral students could be most usefully engaged in this task. Correspondingly, support should be provided for Brazilian students to enroll in U.S. universities for doctoral training in similar fields so they will be able to assume these educational responsibilities in the São Paulo universities in due course.

Fifth: Technical assistance provided by USAID should be deployed so as to have a significant impact on the Project in two ways: first in the use of funds; and, second, in the administration of the use of resources by USAID itself.

Concerning the proposed use of funds, the proposal at present suggests that \$10 million be allocated for hardware, and \$15 million for other forms of technical assistance. We believe there has been insufficient justification for the hardware and that most of the equipment required by the Project can be made available from other existing sources, such as state and federal agencies

We believe, further, that some of the other forms of technical assistance described in the Project are not fully responsive to certain major needs of industry. Technical assistance should support the marketing, evaluation, and technical-service efforts that are summarized in the third and fourth recommendations, as well as the projects approved by CET. This would suggest a major emphasis on technical assistance of a practical type, except in such specialized areas as certain research and engineering fields related to the Project, information systems, standardization, and development of new university education programs. In any case, U.S. advisors in São Paulo should have ready access to institutional support in the United States.

The other major contribution of USAID will be through the activities of the staff it enlists to administer the technical assistance support for the Project. The quality of this administrative effort, especially in mobilizing other high-quality resources for the Project, will be a key factor in the entire process. Since this is an extraordinary role, it requires extraordinary talent.

To offer less than excellence in the management of USAID's contributory role could seriously handicap this promising initiative in economic development; to provide outstanding advice, counsel, and technical help through this Project could tangibly demonstrate the will and ability of the United States to mobilize its best resources to help Brazil achieve its major national objective.

Sixth: The entire Project, as revised, should have an implementation plan and program. Such a plan and program should be the principal responsibility of the CET Project director and staff; it should be coordinated with the Government of Brazil and USAID as the other major participants in the program; and it should encompass activities outside São Paulo, in the United States, and, possibly, Europe and Japan which could aid in mobilizing EDR resources, facilitating access to appropriate technologies, and in creating a network of institutional relationships that would backstop the São Paulo engineering, R & D, and information-systems efforts. A deliberate, well-coordinated, and performance-oriented implementation program, possibly involving further assistance from the National Academy of Sciences and the National Academy of Engineering, could be vital in moving the Project from an original, exciting concept to the realization of a model effort by Brazil to become an "outwardly oriented" industrial country in the shortest possible time.

The opportunity exists; the means are at hand; and Brazil and São Paulo have already demonstrated the national will and regional dynamism that can make this effort succeed.

PART II

THE SAO PAULO PROJECT: REVIEW OF CERTAIN COMPONENT ASPECTS

Section A. The Fund for Science and Technology and Other Financial Relationships

The discussion and suggestions that follow stem largely from the concerns expressed in Part I about the orientation of the Project (Section B-1) and its relationship to the marketplace (Section B-2). The ten sets of suggestions in this section fall into three categories: (1) management of the Fund for Science and Technology; (2) organization of the Council on Science and Technology (CET) and its relationship with the Development Bank of the State of São Paulo (BADESP); and (3) the Fund's relationship with industry.

1. Revolving Fund

A significant component of the proposed Project is the revolving Fund for Science and Technology. This Fund is to be financed entirely by the State of São Paulo and the Government of Brazil; the first \$15 million has already been allocated, half by the state and half by the federal government. Our comments on the Fund, then, are made in the spirit of helpful suggestion to the State of São Paulo, and in the belief that successful operation of the Fund is essential to the success of the entire Project.

It is contemplated that two types of loans will be made from the Fund: (1) to industrial or agricultural processing companies to support development work or other technological advances (which would be performed either

by the company or under contract with one of the research institutes), and (2) to the state, to be used to support projects proposed by the research institutes and judged to be important in furthering the goals and objectives of the state.

2. Rates and Terms of Loans

The Project proposal suggests that the Fund might apply a graduated interest rate, dependent on the degree of risk involved in the Project. At an earlier stage, it was also suggested that part or all of such a loan might be forgiven, should the technical work fail to produce the desired result. We believe strongly that these ideas are impractical in actual administration and that the proposed rate of 14 percent provides adequate incentive, when coupled with a favorable length of term.* The half of the current Fund provided by the Government of Brazil specifies a fixed interest rate, and has no provision for forgiveness of principal.

The proposal stipulates a repayment term of 2 - 5 years. Although we expect that this range should cover most loans from the Fund, we should like to have the Fund retain the option of granting a longer term when appropriate for certain long-term development projects.

3. Selection Criteria

The Fund is an instrument for the development activity of the state; consequently, the overriding criterion for selection among loan applicants must be the extent to which a project is judged likely to meet the goals of the state. These goals include a general drive to increase exports,

*The 14 percent rate represents an interest-free loan, since this rate merely compensates for inflation and currency revaluation.

improve product quality and consistency, and improve production efficiency in the state. Priority areas have been selected, namely food processing and metallurgy. Other goals of Brazil and the State of São Paulo should also be articulated and brought to bear in the selection process.

We do not believe that a simple weighting process for project selection, as proposed in the Project memorandum, is adequate. (See Appendix B.) To the contrary, we believe it is essential that prospective borrowers (whether industrial or state) be required to present a complete project justification, including an evaluation of economic as well as technical aspects of their proposal. Elsewhere, we propose the establishment of a techno-economic evaluation capability at one or two of the research institutes, which would be available to assist the proposer. In addition, we are also suggesting elsewhere in this report the establishment of a staff at CET that would be competent to judge all aspects of a proposed project, drawing on the full range of available technical and market data.

In addition to an evaluation of a project, there is of course the need to evaluate the ability of the borrower to repay. This part of the evaluation must be made by BADESP, which proposes to use normal commercial banking criteria. We were pleased to learn, however, that at least to some extent BADESP will consider both commercial risk and the economic value to the economy of the state in its evaluations. BADESP must work closely with CET in evaluating industry projects, since in some cases the loans may be partially or entirely guaranteed by CET as a means of providing adequate credit. Here again, a competent CET staff and adequate techno-economic data will give BADESP and CET sound bases for working out appropriate loan arrangements. Such methods as third-party guarantees by

company owners or their suppliers should provide other dimensions to the range of possible arrangements.

4. Availability of Loans from the Fund

Since the purpose of the Fund is to encourage technological improvement that would not otherwise be made, and since the Fund will offer attractive interest rates and repayment terms, we believe it is necessary to protect against dissipation of the Fund to support development projects of large companies to finance existing commitments. Another concern is the possible use of loan funds to extend the operating or capital budgets of the research institutes, rather than as a stimulus to new endeavors. CET/BADESP must be constantly alert for such perversions in the use of loan funds, and organize themselves to prevent them.

We suspect that financially strong companies will rarely undertake development work merely because money is available on favorable terms. Consequently, we believe the Fund should be available largely to small- and medium-sized companies, except in those unusual cases when larger companies can demonstrate that use of the Fund is essential to their decision to undertake significant projects.

With regard to loans to the state to support research projects initiated by the research institutes, we are concerned that despite a careful review by CET, there may be inadequate consideration of market factors. Thus, to assure that projects initiated by the institutes have true commercial interest, we strongly propose that they be financed from the Fund only if the institute can secure partial funding, for at least 20 - 30 percent of the total cost, from one or more industrial companies that would ultimately benefit from successful completion of the work.

This formula would also contribute to the creation of linkages between the institutes, CET, and industry that are not likely to be established otherwise. The advantages to be derived from such linkages are considerable:

- CET would receive practical testimonial from potentially affected industry of the value of the research.
- The research institutes would be required to promote their services to industry (thereby meeting a "market test" of their proposals).
- Research institutes would be required to develop their proposals in cooperation with industry.
- Industries would be required, in their self-interest, to review results and attempt to recapture some return on their investment.
- Smaller industries would be encouraged to participate because they would be making a small share of the total investment, which they have the capability to repay.

5. Relationship of the Fund to Research Institute Budgets

Both the Government of Brazil and the State of São Paulo have supervision over the research institutes, and these authorities can increase or decrease their operating or capital budgets through normal budgetary channels. To the extent that the Fund is used to support projects developed by the research institutes, it is merely serving as a supplementary appropriation. The integrated programs for meat and fish are thus examples of programs in which the Fund could be used merely to accelerate current work rather than to encourage new endeavors. But these projects also exemplify ways in which the Fund could be used to channel work toward the state's priorities, and provide an opportunity for integrated project management.

As long as the state can borrow from the Fund, there is some possibility that the Fund may be used to replace a portion of normal budget support in some years. It is for this reason that elsewhere in this report we urge meeting the needs of the research institutes through the normal budget process, and not through the Fund. We wish to repeat this recommendation again, however, because it is particularly important that the São Paulo Project result in an incremental increase in support for the state's development effort if it is to qualify for USAID support.

Structure and Role of the CET and Its Relationship with BADESP

The CET is envisioned as the science and technology arm of the state economic planning and development effort. The selection criteria outlined in Chapter V, Section E of the Project proposal imply that the CET would be charged with the responsibility for developing a wide range of business, financial, and international marketing judgments, as well as those pertaining to science and technology. In our view the capabilities to develop business and marketing analyses could better be built within the BADESP organization, rather than in CET; and CET should largely defer to the judgment of firms willing to assume the risks inherent in R & D and undertaking the responsibility of loan repayments.

The CET's key role should be to set policies and to operate the Project for Science and Technology. Policy considerations would include, for example, criteria for loans from the BADESP Fund for Science and Technology, determining requirements for technical manpower development, and the continuing development and coupling of technical capability at the enterprise level to other elements of the technological and scientific infrastructure. In setting these policies, CET should incorporate the ideas advanced by

economic-sector planners, BADESP project-evaluation personnel, the directors of the research institutes, the university technical community, and CET's own staff.

If the philosophy, policies, and specific activities of the Project and the Fund are to be realized, it is essential that adequate leadership and staff be provided for CET. Apparently, the broad policy authority of CET has been established, with the Secretary of Planning serving as President, and with a Board heavily weighted with representatives from industry. This is a fine beginning, but the crucial need now is for an adequate executive staff to operate the Project.

The executive director of CET should be named as soon as possible, and should have an impressive reputation in the industrial community if CET is to overcome the serious prejudgment that now exists in some areas of industry that it is "probably another bureaucratic body unresponsive to the market." The director should have experience in the appraisal and direction of development projects, and a personality that will enable him to promote the Project to industry, the research institutes, and university departments.

The staff of CET should be a small group of perhaps 10 professionals, carefully selected for their ability and experience in planning, administering, and evaluating technical projects. At the outset, as proposed in the Project, CET should use consultants drawn from Brazil or abroad to assist in performing these staff functions and in selecting the permanent staff.

The CET staff should draw upon institute and university personnel for ad hoc committees to judge the potential technical-economic contribution

of a proposal. Decisions to fund a project should be based on broad judgments of sector needs and the competence of those undertaking the project rather than a contrived "weighted score."

7. Market Research and Project Evaluation

We believe there is a critical need in the State of São Paulo for a capability to perform competent studies of markets and related commercial factors. This component of the R & D infrastructure is essential to relating technology to the state's goals. The key link, after all, between technology and industry is the impact of that technology in the market-place.

Consequently, we recommend that a new department be established, probably at IPT and ITAL, to perform market and techno-economic studies. With assistance from the outside, this department would serve industry, the research institutes, and the CET staff. Locating this capability at the research institutes will be useful in creating linkages between the institutes and industry.

8. Deployment of USAID Funds

The Project memorandum from AID proposes that \$10 million be spent for laboratory equipment and other technical hardware, and \$15 million for technical assistance. This would include contracts with three U.S. research centers; the sending of postdoctoral fellows from the United States to Brazil; the sending of predoctoral students from Brazil to the United States; and contracted support to CET.

Our analysis of the needs for economic development of São Paulo, however, strongly suggests a major need for increased support in the form of marketing know-how, management skills, technical engineering skills,

technological-development skills, and the establishment of an industrial extension program. Assistance of this sort should, in our view, be given the highest priority.

The prestige associated with computers and other sophisticated equipment has tended to encourage overacquisition of hardware in São Paulo and, indeed, throughout the world. To establish a basis for future judgments and to formulate realistic policies governing the acquisitions, as well as use, of computing machinery, the market principle should also be applied. By establishing more effective linkages in São Paulo between the universities and research institutes, on the one hand, and industry, on the other, the real values of hardware can be ascertained more clearly.

Moreover, we assess existing laboratory facilities at the institutes as quite adequate overall, with much of the advanced equipment only in the incipient stages of utilization. Thus, funds available for the Project would be more effectively employed by expanding the technological know-how for increasing the use of these facilities. Furthermore, given the past willingness of the state and federal governments to finance facilities, sufficient capital funds for the expansion of laboratories are probably already available.

9. Role of Multinational Corporations

Foreign-based multinational corporations (MNCs) today hold an imposing position in the overall economy of São Paulo. These giant, worldwide economic powers bring technology and other massive benefits with them. MNCs have been gaining continuing strength all over the world because of their highly efficient utilization of a wide range of resources. Their strengths in both technological innovation and research capability strongly suggest

that these corporations would have little need for drawing on the Fund for assistance.

The main inducement to MNCs is not the availability of local debt financing incentives to sponsor research or development, but rather economic measures including export incentives and tax incentives. Generally speaking, we believe that foreign MNCs should not have access to the revolving Funds except in unusual cases where assistance to component suppliers or for product engineering would make Fund loans an especially attractive means for further economic development. The principal criteria should be whether the R & D effort will contribute to the technological capabilities of the country and new export markets for Brazil.

There is little reason to believe that the MNCs' role in São Paulo will lessen in the foreseeable future. The major voids in Brazilian experience and knowledge appear to be in areas related to international marketing and markets. São Paulo might be well served, therefore, if the Science and Technology Project launched a major effort to build experience in international, regional, and local marketing research and development. By emphasizing the marketing aspects, especially as they relate to science and technology, São Paulo would be laying the groundwork for establishing Brazilian-based MNCs of her own.

10. Proprietary Rights

The question of to whom the rights to new inventions and know-how should belong is, and always has been, a major element in private industry's participation in governmental programs. Patents, inventions, and secret processes are considered major assets of private companies and government alike. Many of the world's leading corporations drew their initial

strengths from such proprietary rights. Therefore, in this Project, where invention and specialized know-how development are highly probable, the question of ownership of proprietary rights, as well as the protection of specialized know-how, are of critical importance.

We recommend that CET make an early and firmly worded policy statement that when private industry is obligated to repay loan-funds, confidentiality of all private-industry matters will be observed. Furthermore, any patents, inventions, or specialized know-how will be the property of the party or parties obligated to repay the loan monies provided.

Such a statement should remove a major obstacle to private industry's participation in the proposed programs; and it should greatly encourage a vital and active participation.

However, when governmental bodies assume the risk of investing in engineering development and research, and assume the obligation to repay borrowed funds, all know-how, patents, and rights should belong to the governmental body supporting such efforts (and release of such rights to the general public should be determined by the public authority).

Section B: The Universities and Research Institutes

1. The Project Proposal

The principal resources available for providing scientific and technical services to the industrial sector in the State of São Paulo are the universities and research institutes, and the proposed Project contemplates multifaceted roles for both sets of institutions.

Although the wording of the Project document suggests extensive university involvement, examination of the details reveals that the primary tasks envisioned for the universities would appear to be (a) increasing

the basic capabilities of the institutes and universities themselves (by conventional educational processes and short courses and workshops); and (b) providing training for CET staff. Despite reference to the availabilities of universities, as well as institutes, to undertake contract research projects, the universities' real interaction with industry under the proposed Project would appear to be minimal and to be restricted primarily to nonacademic training (short courses, seminars, and workshops in selected subjects).

A more extensive role of direct support of industry is described for the research institutes, to include (a) conduct of research projects brought to the institutes by industry after approval and funding by CET/BADESP; (b) conduct of research projects the institutes consider valuable to the industrial sector; and (c) supporting services such as information services, standards and testing assistance, nonacademic training, and elements of an industrial extension service.

More specifically, the universities would participate in the Project by providing conventional graduate and postgraduate education, inter-institutional training assistance, and nonacademic short courses, seminars, and workshops. (The conduct of applied research projects under contract arrangements is not elaborated on further because it is felt that except in rare instances the universities would not be accorded prime responsibility for applied project research.)

One objective of the São Paulo Project is to improve the capacities of the universities and institutes to train scientists and technicians. In the case of the universities, the Project proposal gives dominant attention to this objective, which is to be accomplished by (a) using 25

man-years per year of U.S. postdoctoral fellows in the universities (institutes are also mentioned, but not emphasized), and (b) awarding graduate (presumably predoctoral) fellowships to Brazilians for foreign study, with the Brazilian fellows committed to return to the university for teaching and research.

The principal mechanism through which the University of São Paulo would provide interinstitutional training assistance would be the proposed Research Management and Science Policy Program to be located in the School of Economics and Administration. The program would include short courses and training for CET staff; short courses and seminars for management personnel in the research institutes; "gaming seminars" for industry, institutes, banks, universities, and government agencies; and a new one-semester postgraduate course for scientists and engineers on the management of research programs. In addition, the university would provide support activities, such as some type of extension service related to management systems; assistance to industry in acquiring market information; and a library on research management and science policy.

The planned participation of the research institutes incorporates nonacademic training, interinstitutional assistance, conduct of sponsored and internally initiated projects, and direct technical extension services.

In the Materials Research and Testing (Standards) Program (described in Section C of the Project proposal), the institutes would provide training in quality-control techniques and assist in establishing company testing laboratories and quality-control procedures. The three larger institutes that are proposed to serve as "Reference Laboratories" would help train the staffs of "Testing Laboratories" located at smaller institutes.

The Project proposal further contemplates a mechanism to enable university faculty and students to conduct research within the research institutes.

As described in the Project document, the central role of the research institutes would be to conduct R & D projects concerned with the development of new products or processes. These projects would be initiated by either an industrial organization which, after approval and funding by CET/BADESP, would purchase contract services from an institute or an institute itself under support received directly from CET/BADESP.

For the universities, the Project proposal suggests USAID funding to support both U.S. postdoctoral fellows and predoctoral Brazilian fellows, to increase the technical capacities of the universities (and institutes) by providing both foreign exchange for purchase of laboratory equipment and short- and long-term foreign technical assistance in specific technologies.

The Research Management and Science Policy Program would receive initial financing from the Secretary of Planning (it is not clear whether regular budget allocations or use of the CET/BADESP revolving Fund would be used) with the expectation that its costs, beginning in the second year, would be shared by the university and by contracted research and training. USAID support for this program would be limited to U.S. experts and acquisitions for the research-management and science-policy library.

Funds for projects conducted at the institutes would be derived from loans from the CET/BADESP revolving Fund. (Repayment would be provided when a company borrows and then purchases research services.) Institute-initiated research, however, would leave the state as guarantor with the

obligation to replenish the Fund. This would be a continuing obligation for the state if this kind of project should remain as a regular part of the process.

USAID funds are proposed for laboratory equipment and for U.S. technical experts in specific areas.

2. Comments and Recommendations

a. Needs of Industry

Industry needs that might be met appropriately by the universities and research institutes are as follows:

- Training of management and supervisory personnel in specific subject areas, i.e., quality control and market analysis;
- Flow of new graduates with formal training in quality control concepts and techniques and in marketing (in its broadest sense-- market research, distribution channels, pricing strategies, packaging, standards, etc.);
- Access to information on available (nonproprietary and published) technologies, production methods, markets, etc.;
- Adaptive engineering assistance;
- Assistance in establishing and monitoring quality control procedures;
- Process "troubleshooting" assistance; and
- Research projects related to products and processes.

b. Serving the Industrial Needs

(1) Universities

Formal undergraduate and graduate courses on quality control and marketing (of the broad and comprehensive nature described

earlier) should be incorporated in university curricula, to present the most modern state-of-the-art concepts; thus, their planning and introduction probably will require foreign technical assistance. Nonformal training in these subjects also should be offered to industry and institute staffs through the preparation and presentation of seminars and workshops.

In our view, a program of U.S. postdoctoral fellows could be useful for these university services, but the supporting requirements to make the most effective use of them should be appreciated and fully provided. If the fellowship program is implemented, we recommend that a substantial number of fellows be selected on the basis of education and experience in such areas as engineering, including quality control; marketing; and research management.

We believe that foreign-study fellowships at the predoctoral level for Brazilians would also be useful, but the education programs pursued in the United States should be designed to enable Brazilians to take over, in due course, the educational responsibilities of the U.S. postdoctoral fellows being sent to Brazil.

In addition to the specific educational programs recommended for the Project, the universities could also be usefully involved by means of faculty consultation arrangements with both industry and the institutes. Such an involvement would require relaxation of the government prohibition on compensated consulting, but we believe it would be important to the full utilization of the capacities of the universities in the Project.

As stated earlier, we believe that only in rare circumstances will the universities have prime responsibility for the conduct of R & D

projects under the proposed Project. They are a key asset, however, with significant resources in faculty, graduate students, and facilities such as libraries and computers. Interaction among the universities, CET, and the institutes would be strengthened by the type of university involvement described, thus increasing the effectiveness of the total Project.

(2) Research Institutes

If the research institutes are better to serve the needs of São Paulo industry, primary emphasis should be placed on helping them to develop adaptive industrial extension services. These services should be developed primarily in the three institutes selected to be "Reference Laboratories" (IPT, ITAL, and one other still to be designated).

The development of adaptive extension services will require new, more outreaching attitudes and programs on the part of the institutes, and the addition of staff specifically assigned to extension and field services. Because extension services can be of great importance to the effective operation of the Project, they should not be left as adjunct responsibilities of project researchers. The extension specialist, who provides the services, becomes in a major sense the agent of industry: he links the needs of industrial firms to the technical services and sources of technical information that the institutes can provide, and he adapts these technical resources to the needs of particular companies.

An effective program of "adaptive extension services" should fulfill the following functions:

- On-site visits to industrial concerns to introduce the extension services program and to develop individual company profiles;

- Provision to industry of a continuing series of technical bulletins and abstracts, and searches of technical literature;

Technical assistance by field engineers who would explain new developments matching the interest profiles of individual companies and who would assist in adapting new techniques to their particular requirements; and

Provision of specialized workshops and seminars for particular companies or groups of companies.

Mechanisms also should be developed to enable university faculties and graduate students to participate in institute research and to initiate and conduct research within the institutes. (Conversely, the best institute researchers are a potential resource for the universities, and opportunities for them to teach in the universities might be increased.)

Although the percentage of companies with the capacity to receive and utilize the output of developmental research projects is probably not large, the network of research institutes envisaged for the Project is probably well equipped with adequate staff capabilities to perform such projects in targeted priority industrial sectors. Nevertheless, the panel concludes that the participating institutes should develop stronger capabilities for relating technological to economic factors, as well as stronger capabilities in market research, if technical projects are to be subjected to the rigorous economic examination needed to relate them effectively to the goals of the São Paulo Project. In addition, the institutes might well conduct workshops and seminars in these subjects for industry. We emphasize, too, that the institutes need to reach out to industry, to make known and, indeed, to sell the range of capabilities and

services they can offer. Similarly and as we have stated previously, the institutes should seek to obtain industrial participation in funding to the extent of 20 - 30 percent in institute-initiated projects, thus assuring that these projects are directed toward viable market needs and opportunities.

As we also noted previously, it is essential that the salary structures of the institutes be changed to enable them to recruit and retain able personnel in competition with industry and universities. It is certainly unrealistic to expect the institutes to be major elements of a science and technology infrastructure without making it possible for them to retain staff of the highest quality who can look upon service with the institutes as attractive career opportunities. At present, the turnover rates in the institutes are intolerable, and able, young, researchers leave, usually for careers in private industry as soon as they acquire some advanced technical education or experience in a specialty.*

(3) Other Comments

(a) The possibilities for research institutes to engage further in technician training also should be carefully examined. New programs for strengthening the capacities for the research institutes to produce more technicians in needed fields could be significant.

(b) USAID support should generally be directed toward the formation and strengthening (training) of human resources and services.**

*The "premium" system initiated at IPT in 1971, which is dependent on outside contract income, has reduced turnover, but it can only be considered a stop-gap measure.

**Examples: adaptive industrial extension services, information services, workshops and seminars.

In view of the facilities now available and their apparent underutilization, we recommend that USAID funds not be used for purchase of general laboratory equipment.

(c) When foreign experts are used for technical assistance, their primary role should be to train Brazilian personnel and strengthen organizational structures and operational modes; they should not supplant Brazilians through the direct provision of services.

Section C. Standardization and Quality Assurance

1. Needs of Industry

Product quality appears to be one of the most serious problems inhibiting the further expansion of industrialization in the State of São Paulo. Establishing the required level of quality and duplicating, maintaining, and controlling that level are nonexistent in many product areas. In some instances restrictive government regulations protect some industries from a competitive market environment, which results in a lack of incentive for improving and maintaining required quality levels. In other instances the functional and quality requirements of the market place are not understood, and in still others industries are unable to obtain materials, subcomponents, or parts of acceptable and consistent quality.

Although the panel has made no assessment of the technical adequacy of existing Brazilian standards, the fact that there are only something more than 1,500 accepted standards today strongly indicates the need for greater standardization effort within the State of São Paulo and the country of Brazil, and for more active involvement in the development of international standards. An industrial economy of the size of the United States operates on a base of some 20,000 industrial standards. This suggests that

an industrial economy of the size of Brazil, particularly in view of its expanding nature, should be operating on a base of some 10,000 industrial standards. Because of timing, most of these standards should be adaptations of standards of other industrialized countries and consistent with existing, and growing, international standards agreements.

If there is an adequate base of industrial standards, product quality can be established and maintained on a local or plant level by product-testing programs and application of effective quality-control techniques. It can be established on a state or national scale by the introduction of a product test-and-certification system which would be in addition to quality-control programs at the local level. Such a certification system implies, first, adequate standards and test methods against which products can be evaluated; and, second, a formal procedure whereby products are tested and certified as meeting required performance and quality levels. Apparently, both are inadequate in the State of São Paulo at present.

Some smaller- and medium-size industries have neither the necessary resources nor the laboratory facilities to maintain a quality-control program on their products. Nor do they have workers and management trained to apply quality-control techniques. Therefore, a serious need exists for

- a. A quality-control training program for industrial personnel;
- b. Supplemental facilities necessary for the performance of product tests; and

Assistance in the methodology of improving and maintaining product quality and productivity.

2. Science and Technology Project

The Science and Technology Project assigns to the CET the responsibility for interpreting national policy and providing policy planning

and guidance to the Secretary of Economy and Planning (SEP). CET determines R & D priorities for the State of São Paulo and establishes criteria for allocating resources. In general, it facilitates technical and financial assistance in support of contracts for technical assistance between industry, the research institutes, and universities. Part of this support is to be directed towards the development of standards and the establishment of testing and quality-control programs and facilities.

The development of materials research and testing facilities is under the technical direction of the research institutes which are to provide the broad technical support, outlined in the Project, and, specifically, to support the proposed standardization-and-certification system. In this capacity the three large state research institutes are to function as reference laboratories and are to coordinate a network of testing laboratories created from the existing structures of state-supported research institutes and centers of technology. These reference laboratories are to maintain the capacity for testing complex systems and materials and are to provide CET with guidance on the development and promulgation of state standards for materials and products.

The reference laboratories are to (a) assist CET in developing and implementing a product certification system; (b) encourage industry participation in that system by providing, in conjunction with the testing laboratories, contract research and assistance in establishing quality-control procedures and testing facilities; and (c) assist the smaller research institutions that are selected to function as testing laboratories by training personnel and counseling on acquisition of laboratory equipment and the general methodology of testing methods and product tests.

The smaller research institutions selected to develop testing facilities will function as testing laboratories in the planned certification system. They are to counsel and assist industry in the implementation of quality-control systems and to provide independent tests of industrial and consumer products. The results of these tests are to be submitted to the reference laboratories (and, it is assumed, to the manufacturers submitting the products for testing).

The Science and Technology Project does not specify to what extent funds are to be made available to support the development of materials research and testing facilities, nor specifically what funds are to be used to purchase capital equipment for testing facilities.

3. Comments and Recommendations

As stated earlier, we believe that except for some small but nevertheless fundamental exceptions, the Science and Technology Project treats the development of materials research and testing facilities in a way that recognizes the needs of industry and proposes solutions that are workable and consistent with current and proposed national and international harmonization and certification schemes. Our primary exception is that the Project is stated in terms of only the State of São Paulo and its governmental structure and, except for a minor reference to the national testing laboratories, it ignores existing federal regulations and structures, and those organizations recognized by the Government of Brazil, in matters relating to standards and certification.

The Project does not relate its standardization plan to the standards program and certification system of the Brazilian Association of Technical Standards (ABNT). This organization, formed in 1940, was recognized as a

public service agency through Public Law 4150 on November 21, 1962. It functions as a voluntary standardization effort, operating under consensus procedures, and provides the Brazilian membership a channel of participation in the nontreaty international standards programs. Since 1962, all purchases by the federal government have been required to meet the standards of ABNT. More recently, ABNT has initiated a certification system which is recognized by the Government of Brazil in its transactions, and is gaining recognition in the private sector, (e.g., insurance rates are lower when products used are tested and certified, and exhibit the ABNT "mark" of conformance).

The panel's specific comments and recommendations on the development in the Project of materials research and testing facilities are as follows:

a. For the Project to be fully effective, a much more precise statement of objectives and policy must be made by the Government of the State of São Paulo. This statement, of course, must be consistent with federal objectives and policies and it will undoubtedly require the modification of certain present regulations that conflict with the improvement and maintenance of product quality. One of the most effective quality-control devices is a competitive market, and state policy and regulations should strive to strengthen this type of environment.

b. The standards developed and promulgated in the Project should be under structure and procedures like that of ABNT and should not be developed separately nor promulgated as state standards as is now specified in the Project. Although there is active participation in the ABNT standards programs by industry of the State of São Paulo, there is also criticism of the ABNT mechanism and procedures. Since an organization is only

as good as its members and participants, strengthening ABNT by more active, effective industrial and governmental support and participation will not only generate standards necessary for the State of São Paulo, but will also strengthen the national standards program and the involvement in regulations for international standards.

c. The certification system detailed in the project is workable, with the exceptions noted below, provided it is, or becomes, an integral part of a national certification system. It could be implemented as an adjunct to the ABNT system, or as a modification of the ABNT system, whichever is necessary to achieve a truly national system. The resulting system must be recognized by industry, government, and the certification systems of other countries and regional treaty organizations.

One exception to the standardization plan concerns the reporting of test results. The reference laboratories establish criteria and methodology for product testing; industry submits products for testing; and the testing laboratories perform tests and provide reports on the results. The test results may then be submitted to the manufacturers and the reference laboratories for information purposes. We believe they also should be submitted to an independent third party for formal certification and authorization for the product to exhibit a "mark" of conformance. This third party could be a subcouncil of CET, a Certification Council; but responsibility for the legal function of "licensing" and authorization should be separate from the technical criteria and methodology. The reason for this separation involves both product liability considerations and the need to build into the system the kind of integrity and reliance on the system that will be credible to consumer and user. Creditability is crucial to the success of any certification system.

The Project proposal also omits the follow-on effort and audit mechanism and responsibilities necessary to maintain quality levels once they have been established. Product qualification based upon product tests is only the initial phase, and the implementation of a quality-control system is necessary, but not sufficient, to maintain product qualification. The testing laboratories should have the responsibility, therefore, for auditing the continuing level of quality by systematic review of quality-control records, periodic retest of products, or spot checks of the manufacturing process.

d. The Project proposal does not indicate which funds are to be used to purchase capital equipment necessary to develop and support the materials research and testing facilities effort. Since there are other feasible ways of funding these types of purchases, outside the Project, we recommend that the funds available to the Project not be used for these purposes.

Section D. The Information System

1. Needs of Industry

An effective technical information system can facilitate economic development in São Paulo and Brazil. Information on existing technology and techniques can help to stimulate new applications and avoid redundant research and development, and thereby raise the performance level of ongoing engineering, development, and research. Information on market specifications and restrictions can suggest opportunities for new or improved products and for new points of distribution. Information on existing research can assist the scientist or engineer attempting to discover a new process or develop a new theory, and it can facilitate communication with others

doing related work. Accordingly, a well-conceived information system is potentially important in a project to promote economic progress through science and technology. An information system will be effective, however, only if it is oriented toward industry's needs.

The prospects for "overkill" in information collection, processing, and dissemination should be recognized and avoided. The amount of information that might be accumulated by such a project is virtually limitless and is prohibitively expensive. Consequently, it is necessary to identify and to implement just those information projects that show the most promise for facilitating economic progress. Information projects should serve primarily the users whose activities fit most closely with the goals for economic development that the project is designed to facilitate--members of industry.

Information assumes value only when it has a careful orientation, when it is interpreted from some point of view, and when it is used to make decisions or to guide useful activity. Thus, the basic design principle is that an information system should support the state's high-priority project plans or policies--in this case, the Science and Technology Project for São Paulo. The objectives of that Project, therefore, should be used to evaluate the information system and to provide priority guidance for its implementation.

Based on this premise, we list our criteria for evaluating proposed information projects (in priority order);

a. Does the information project directly promote economic progress of the state, as developed under the São Paulo Project? (For example, will an information project directly support the development,

improvement, or sale of a new Brazilian industrial product, especially an export product? Extend the market for an existing one? Result: (in reduced costs for production?)

b. Does the information project improve the level of cooperation, coordination, and integration among all participating organizations? (An information system project should improve the linkages among elements of industry, the financial community, the research centers, and the university.)

c. Does the information project add to the basic understanding of science and technology? (Information system projects that support basic research, provide background information for possible future developments, etc., are to be considered less important.)

Information projects that score well on all three counts should be given the strongest support.

Within the framework of these criteria, two general classes of service can be defined:

(1) A general-purpose scientific and technical information service.

A modest range of services should be developed as a long-term effort to provide industry, institute, and university users with access to relevant journal articles, documents, and data bases that may have been acquired in any part of the world. Such services will require information storage and retrieval, selective dissemination, and document distribution. However, to reduce the overall cost of an expensive, comprehensive service of this kind, information systems should provide only the most generally useful services and should encourage maximum cooperation among existing services.

(2) A special-purpose, problem-oriented information service,

Another type of information-analysis and system-implementation service, geared to handle specific problem-oriented information needs, should be closely linked to R & D projects approved by CET. These two services are not independent. The special service will draw from the general service and, in turn, will generate information to be fed back into the general services.

2. The Plan*

The overall purpose of the information system components is described in the Science and Technology Project statement (referred to in IV A of that statement as "data resource operation"). Clearly, the total Project requires scientific and technological research information, patent and trademark information, and planning information, if it is to be effective. However, only general guidelines for meeting these information needs are given in the document. These guidelines thus should be reviewed and made consistent with the general conclusions and recommendations contained in Part I of this report.

*This part of our report is based on information from the following sources:

- "Science and Technology Project." Statement prepared by CET, received 21 May 1972 (especially section IV). (Appendix B of this report.)
- "Technology Information System." Statement prepared by IPT, received 23 May 1972.
- Resumé of "A Study of the Feasibility of Implantation of a System of Specialized Information in the State of São Paulo (SEIE)." Prepared by Escola de Comunicações e Artes, received in February, 1972.
- Interviews with relevant parties in São Paulo 21 May - 26 May, 1972.

Two more specific project proposals have been received in support of the general proposal: the Technological Information System Project and the School of Communications and Arts proposal. The Technological Information System Project calls for a three-fold program of information services, training, and development of know-how. Synoptic in scope, it requires both focusing and ordering of priorities before it can be operational. Of the several items of specific orientation given in the "end state" conditions outlined in the proposal, we believe the most promising are:

direct information support for research projects (Items 1d, 1e, and 1a-c);

development of data banks and corps of experts to aid users on specific problems (Items 2a-b); and

analysis of patent office data for planning purposes (Item 5a). These information projects, if they support specific economic and industrial development programs, are within the framework of the total project. The Instituto de Pesquisas Tecnológicas personnel, who prepared the report, appear to have the background and experience to operate these projects successfully.

The School of Communications and Arts proposal has a different orientation, is based on that organization's 2 - 3 years of experience in running a 500-node selective dissemination network and in providing document storage-and-retrieval services. The project calls for linkages among all major science and technology information centers in São Paulo, and selected centers elsewhere. Their proposal is based on principles set forth in UNISIST,

a program for the establishment of a world science information system.* This proposal needs to be coordinated with the Science and Technology Project and focused, especially during its early development, on providing general scientific and technical information to those industries most likely to improve their exports through its use.

3. Comments and Recommendations

In general, the total budgetary commitment to information systems appears to be too large. As a rule of thumb, perhaps CET should devote no more than 5 percent of its EDR budget to the systematic handling of technical information. Moreover, our investigations reveal that there is ample unused computer capacity available on the Campus of the University of São Paulo. Accordingly, it is not recommended that USAID or CET funds be used at this time to buy or lease new computers. As stated earlier, the state should acquire little new hardware unless it will lead to direct or rather immediate support of approved projects or of well-documented user needs.

a. Organization Designs

It is recommended that three operating units be set up under the policy direction of the CET: (1) Special Information Services, (2) General Information Services, and (3) Computer Operations Services. The services would relate to each other as shown in Figure 1.

*UNESCO. "Final Report, Intergovernmental Conference for the Establishment of a World Science Information System, Paris, 4 - 8, October, 1971." Paris: UNESCO, December, 1971. 60 pp.

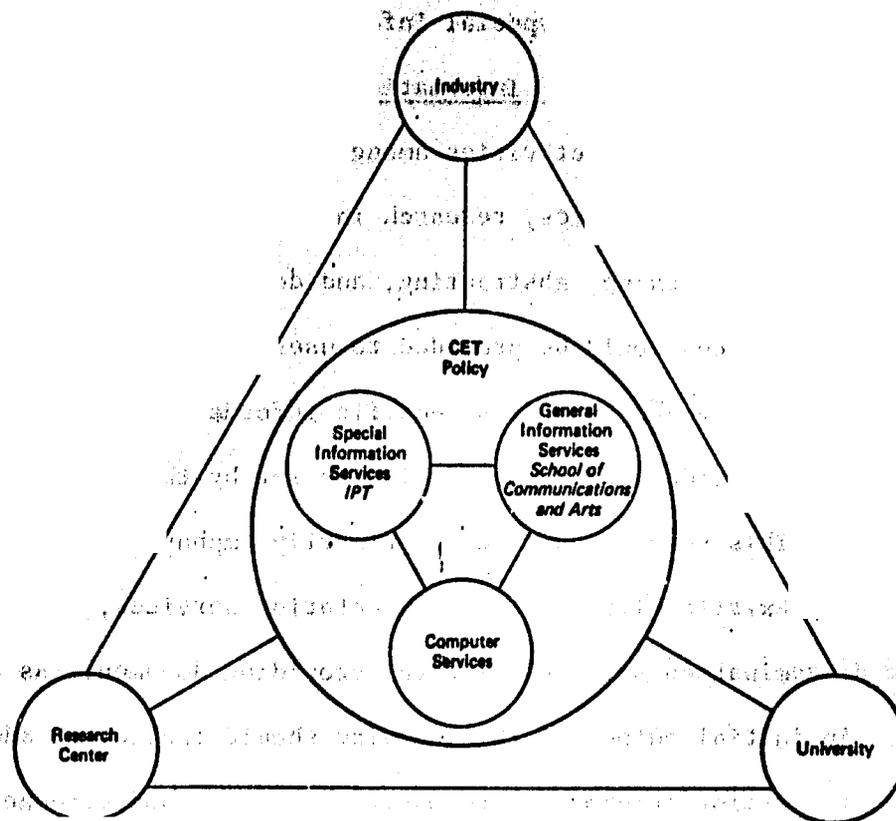


Figure 1.

A CET staff member should be appointed coordinator for these operating units, with the responsibility for formulating and implementing policies.

(1) The Special Information Services Unit would identify, design, implement, and maintain specific information systems to support CET-approved research and development projects, especially those serving industry, and would provide CET and the Secretary of Planning with resource information for planning and policy-making. The technical-information systems project at IPT, because of its experience and composition, is

qualified to provide this service; and we therefore suggest that IPT be responsible for operating the special information services unit.

(2) The General Information Services Unit would be responsible for coordinating activities among the research libraries, documentation centers, universities, research institutes, and industrial organizations with indexing, abstracting, and document-retrieval services. Dissemination services would be provided to users in the network. A mechanism for integrating São Paulo's scientific information system with other Brazilian and worldwide systems would also be set by this group.

This service unit would primarily emphasize (a) maintaining linkages among existing library and documentation services, (b) providing selective dissemination services, and (c) providing documents as requested by users. An initial output of this service should include an adequate inventory of existing information resources in Brazil and elsewhere. Early emphasis should be placed on securing and providing information to those industries supported by the total São Paulo Project.

Because of its background and experience, the group at the School of Communications and Arts appears to be qualified to carry out this service. We suggest that this university group be assigned the role under CET policy control.

(3) A separate Computer Operations Services Unit should be established to support the information services. It would oversee hardware usage and provide input and output services (keypunching, distribution of forms, and so forth). This unit would fulfill that requirement for a special administrative structure, which the history of most data-processing installations has shown is needed to manage the day-to-day operations of computers

and other equipment. Each approved information systems project should have a budget for information processing, and this unit would be responsible for contracting and managing computer time and other facilities. Like the other service units, however, it would receive policy guidance from CET.

b. Advisory Board

To succeed in a technical project, users, producers, and other interested parties must be able to exchange information about wants, needs, problems, and capacities. They should be able to reach and maintain a mutual understanding about the project. To assure user participation in the information system, we suggest an advisory board for the project, to include representatives from industry and other users as well as the persons responsible for providing the information services. The board should meet regularly, should probably have a revolving membership, and should reflect the nature of the information-analysis work current at the time.

c. Industrial Extension Information Service

Earlier, it was stated that information assumes value only through knowledgeable interpretation, analysis, and use, the achievement of which depends on an active, aggressive program to acquaint actual and potential users with available services. For this purpose, we recommend an "industrial extension" program patterned after the agricultural extension programs. There are two basic approaches for providing information-services advice via industrial extension. One is by means of a "general" extension agent who covers the entire range of services that CET offers, including information services. The other is through a special "information-services

agent" who provides the information services of the CET subgroups. In either case, it is highly important that the extension agent be able to talk with users on their own terms, that he understands the nature of the user's problems and can assist in the resolution of these problems. The industrial extension agent should also train users and maintain troubleshooting contact with them throughout the duration of their projects.

d. Demonstration Projects

Information services must quickly demonstrate their usefulness to all concerned. Equally important, however, is actual experience in providing services. We recommend, therefore, that each service begin to develop and execute a demonstration project as soon as possible. Two kinds of projects should be considered:

(1) One principal demonstration project would be an information project in direct support of an approved or proposed EDR project sponsored by CET. This demonstration project might be concentrated in one of the two general areas of the National Development Plan--metallurgy or food projects. Consideration should also be given to providing information-systems support to the two projects for which loans have been made--the pineapple project and the tomato project--or to one of the other proposed projects, such as "Standardization and Quality Control," "Packaging Materials and Containers," "Niobium Base Products," "Weathering Steels," "Surface Quality for the Steel Sheets," or "Explosive Cladding, Forming, and Welding." If resources permit, two projects should be undertaken for comparison purposes. The demonstration project should involve both the general and the special information services so that the strengths and weaknesses of both services are revealed at an early date.

(2) A second demonstration project that should be explored is the possibility of developing a project with the Federal Patent Office to provide patent information for industrial firms and summary planning information for the Secretary of Planning. Data acquired in compliance with the recent law requiring that all royalties on international contracts be reported to the patent office possibly could be summarized to indicate where foreign technology is being used. These data might also suggest areas for technological development.

Initial Consultants and Advisors

After the demonstration projects are selected (or at least potential possibilities are identified), some foreign consultation may be useful to aid in developing and executing the project, to identify necessary hardware, software, and indigenous personnel, and to suggest other consultants who might be of use. Any such consultants, however, should have actual experience in developing and running specialized information services, and their interest should be application-oriented.

Other Information Projects To Consider

(1) Export-Marketing Information Support. A distinction should be made between "market" and "marketing" information. Market information refers to the broad general demand for a product or service. Data on markets alone will indicate the general sales potential in a certain region. It will not specify who will buy products, with what specification,

* This project is consistent with item IV A.1.b. of the CET Project statement and item 5a of the IPT statement. This would be a special information project.

at what time, and under what circumstances. Marketing information, on the other hand, seeks to answer these questions.

Brazil's export revenues are the sum of individual sales by Brazilian industry to specific customers. A program for marketing-information support would help identify specific customers who require or desire a particular, differentiated product with prescribed specifications, in prescribed quantities, at prescribed prices, at prescribed times, in prescribed locations, under prescribed conditions, and with certain ancillary services provided. In addition to the buyers' preferences, each recipient country has legal standards (for example, regulations concerning the inflammable nature of materials), and an effective marketing-information system would include these legal restrictions, consumer preferences, and other economic factors.

During the import-substitution era, Brazilian business was sheltered from the marketplace and did not fully develop a market intelligence capability; yet such intelligence is now vital for increasing exports and developing new markets. Consequently, CET should develop marketing-information systems in promising export areas. Such a marketing intelligence program would require market research and investigation capabilities as well as data processing support. Working in cooperation with qualified market research personnel, the special information services group could provide the required marketing-information support.

(2) Research-Management Information Support. Elsewhere in this report the need for program, project, and budgetary management, and management control, is discussed. These important management functions can be greatly facilitated with the aid of a research-management information

system that is designed to inform the CET and operating units as to the status of projects. The special information systems group could also serve these needs.

g. Other Initial Steps for Promoting the Success of Information Services

To provide maximum support for the São Paulo Project, the information units just described should also undertake the following activities:

(1) Make and publish an inventory of information resources and a directory of experts in selected fields.

(2) Plan and carry out a seminar that will involve all potentially interested parties in discussions and exchanges of ideas about information services. Depending upon the results of the seminar, the units might also provide for continuing periodic activities of this kind.

(3) Identify industry trade journals, application journals, items on management, and case illustrations that would be useful to practicing industrialists.

(4) Develop a simple information system on the literature of computers and information systems.

h. Some Comments on the Motivational Assumptions in Information Systems

The critical factor in any information system is its people, not its hardware or its programs. Thus, an information system should focus on the problems and requirements, present and potential, of its users. The users, furthermore, should be trained to employ the system properly and to understand the assumptions that underlie the data being received. Without

effective cooperation between the users and the information centers and continual feedback between them, the information system will produce too much irrelevant data and too little relevant data. Under such circumstances, the client loses his motivation to use the system, and the system ceases to serve those it was designed to help. Maintaining user motivation, therefore, is a key objective that the industrial extension program should accomplish.

In a similar manner, those who contribute data and expertise to the system (abstracts, documents, financial transactions, estimates, etc.) should be motivated to be accurate, comprehensive, and timely. Since most contributors will have competing demands for their time and talent, they must be rewarded in ways that maintain their continual and effective participation. Rarely will the initial enthusiasm for contributing to an information system be sustained throughout its life, and some formal incentive system is normally required. Consequently, we recommend that some form of incentive be incorporated for experts in scientific and technical fields who are contributing on a part-time basis to the information systems project.

1. Concluding Remarks

In summary, we recommend that information systems components be an integral part of the Science and Technology Project. We strongly suggest that these components begin at a modest level; that they be developed for specific projects related to the overall goals of the state and nation; and that they build and expand on the basis of positive experience gained from the initial steps. Maximum use should be made of existing equipment with unused capacity and of other available information resources within the State of São Paulo.

APPENDIX A

Meeting Agenda
AD HOC ADVISORY PANEL TO CONSIDER PLANS FOR AN INTEGRATED PROGRAM
TO UTILIZE SCIENCE AND TECHNOLOGY IN SAO PAULO'S DEVELOPMENT
May 21 - 30, 1972

Sao Paulo, Brazil

Sunday, May 21, 1972

7:00 - 9:00 p.m.

Reception by the Secretary of Economy
and Planning of State of São Paulo
Professor Miguel Colasuonno

Monday, May 22, 1972

8:30 - 9:00 a.m.

Welcoming Address by the Governor
of the State of São Paulo
Dr. Laudo Natel

9:30 - 12:30 p.m.

Project Description and Discussion
Mr. Owen Lustig, USAID/Brazil

12:30 - 3:00 p.m.

Lunch with the Council of Technology
of the State of São Paulo

3:00 - 5:30 p.m.

Economics of the State of São Paulo
Dr. Alfonso Celso Pastore

Tuesday, May 23, 1972

9:00 - 9:30 a.m.

Welcome to the Institute of Technology
Dr. Alberto de Castro

9:30 - 12:00 a.m.

Group A: Standards and the Proposed
Reference Laboratories, Institute of
Technology
Dr. Paulo Sérgio da Silva

Group B: Financing for the Science
and Technology Project
Dr. Americo Campiglia, President,
São Paulo State Development Bank

Group C: Information Program for the
Science and Technology Project
Dr. José Luis Junqueira, Institute of
Technology

12:00 - 3:00 p.m.

Lunch with Staff of the Institute of Technology

3:00 - 5:30 p.m.

Executive Session of the Panel

Wednesday, May 24, 1972

9:00 - 12:00 a.m.

Meeting with Representatives from Industry (Mechanics) - State Federation of Industries

12:30 - 3:00 p.m.

Lunch with Officers and Members of the State Federation of Industries

3:00 - 5:30 p.m.

Meeting with Representatives of Industry (Metallurgy)

Thursday, May 25, 1972

10:00 - 12:00 a.m.

Food Technology Program for the Science and Technology Project - Campinas, São Paulo
Dr. Agide Gorgatti Netto, Food Technology Institute

12:30 - 2:30 p.m.

Lunch with Representatives from Food Industry

2:30 - 5:30 p.m.

Agricultural Research in São Paulo
Dr. Popilio Angelo Cavaleri, Agronomic Institute of Campinas

Friday, May 26, 1972

Executive Session of the Panel

Rio de Janeiro, Brazil

Saturday, May 27, 1972

Executive Session of the Panel

Sunday, May 28, 1972

Executive Session of the Panel

Monday, May 29, 1972

Executive Session of the Panel

Tuesday, May 30, 1972

9:00 - 12:00 a.m.

Executive Session of the Panel

2:30 - 5:30 p.m.

Report of Panel to Mission Director USAID/Brazil and Staff

APPENDIX B**"SCIENCE AND TECHNOLOGY" PROJECT**

The following memorandum was presented for review to the Ad Hoc Advisory Panel To Consider Plans for an Integrated Program To Utilize Science and Technology in São Paulo's Development on May 21, 1972, by the United States Agency for International Development Mission in Brazil.

"SCIENCE AND TECHNOLOGY" PROJECT

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- I - SUMMARY
- II - STATEMENT OF THE PROBLEM AND PROPOSED SOLUTION
- III - PLANNING AND EVALUATION PROCESS
- IV - INFRASTRUCTURE FOR PROGRAMS IN SCIENCE AND TECHNOLOGY
- V - FINANCIAL SUPPORT FOR RESEARCH AND DEVELOPMENT
- VI - SOURCES OF TECHNICAL ASSISTANCE FOR INDUSTRY, AGRICULTURE, AND GOVERNMENT
- VII - THE AID LOAN PROPOSAL

SUMMARY

Science and technology has become widely recognized in Brazil as one of the most important aspects of the development process. At present, however, there is a lack of articulation between the universities, research institutes and the productive sectors which clearly complicates the formulation and execution of science and technology linked to the development effort. The succeeding sections in this paper describe a system designed to create linkages between the producers and consumers of technology in the State of São Paulo

In Part II of the paper, there is a brief description of the problem and a short narrative on the system.

Part III reviews the roles of the Secretariat of Economy and Planning, the State Council of Technology in planning and evaluating programs in science and technology.

Part IV describes the infrastructure which consists of an information resource operation designed to provide meaningful data for the planning process, and the development of reference and testing laboratories.

Part V focuses on the financial mechanisms created to stimulate the planning and execution of research and development projects for industry and agro industry.

Part VI identifies the role of the universities and research institutions in the research and development process and suggests programs designed to strengthen the capacity of these institutions.

Part VII highlights these points within the system where foreign technical assistance could make a significant impact.

Finally, the annexes present a series of sub-projects which have been submitted to the Council of Technology by various research institutions participating in the project. These are included to help elucidate the nature of the system.

It should be stated at the outset that the design of this program is at best tentative. There are parts within the system which need further clarification.

Although we were unable to locate any precedents which would have been helpful in formulating the system, we believe that the system and project described represent a valid approach to the problem.

II. STATEMENT OF PROBLEM AND PROPOSED SOLUTION

A. THE PROBLEM

Industry in Brazil developed and nurtured behind protective screens of import substitution policies or through special inducements attracting subsidiaries of foreign-owned corporations. These policies encouraged the development of Brazil's industrial infrastructure, and brought about significant increases in production facilities. Indeed, the economy prospered under these circumstances. The problem is that the number of opportunities for the development of import substitution industries decreased significantly.

Moreover, as a result of the protective tariff devices, there was little incentive for industry to lower costs by adapting new or improved technologies to the special characteristics of Brazilian Labor and Capital, nor to develop new processes and products. Now in the face of the need to expand the internal and export markets, to improve quality of products, lower production costs, and to develop new products, much of the Brazilian industry has become technologically obsolete.

University departments of science and technology [that] could provide research assistance to the centers of technology and industry are presently highly academic with only minor emphasis on research. Centers of technology which derive most of their support from the public sector are un-aggressive in pursuing industrial research contracts. In short, much of Brazilian industry seems essentially uninstructed on the value of research and development, and unaware

of the nascent capabilities in the universities and centers of technology, while the latter pursue a variety of interests which are only indirectly concerned with development goals.

There are a number of major factors, which in addition to those cited above have tended to inhibit the process of linking indigenous scientific and technological potential to the development process. Foremost among these is the lack of an appropriate planning infrastructure to formulate policy and to rationalize the resources allocated to these sectors. The second is the absence of institutional arrangements designed to link the universities, centers of technology and industry into a dynamic system producing pure and applied research, marketing research, inventions, development design, tooling, production and marketing. Finally, there are intrinsic weaknesses in terms of human and financial resources within the university institutes, centers of technology, and extension services where scientific and technological activities are conducted.

B. DESCRIPTION OF SYSTEM

The system is designed to:

1. Assure a planning process which identifies problems in industry and agriculture, assesses the role of science and technology in resolving the problem and assists in the preparation of projects to resolve the bottlenecks.
2. Assure the rapid feedback of information into the planning process through continuous assessment of economic trends, market perspectives, etc.

3. Provide for the collection and dissemination of information to scientists, industrialists, and planners on scientific and technological data deriving from state, national and international sources.
4. Encourage industrial firms to contact contract research and development projects which will accelerate development.
5. Assure that the research institutes, planners, and scientists are sensitive to the practical needs and problems of local industry and provide in addition to research, such technical services, necessary to small and medium industry, as scientific, engineering, marketing and socio-economic investigations, and a range of other services to augment the technical and managerial competence of individual enterprises.

III. PLANNING AND EVALUATION PROCESS

A. THE ROLE OF THE SECRETARY OF ECONOMY AND PLANNING

1. The Secretary, in São Paulo, plays the role of both a Secretary of Planning and a Secretary of Industry. In the planning role the secretariat is responsible for the planning process which establishes the budgetary limitations for each secretariat and culminates in the submission of a state budget to the legislature. As a secretariat for industry, the Secretary of Planning is responsible for the development and implementation of programs designed to assist industry increase its output.
2. One of the major purposes of this project is to assist the secretariat develop a planning process which combines science planning with development planning to assure that scientific and technological resources are utilized to further industrial and agricultural development in the State of São Paulo.
3. To initiate this process, the Secretary of Planning has selected two general areas from the National Development Plan, namely, metallurgy and the industrialization of food products as two of the priority sectors to be assisted by the universities and research institutes through this project. A third area is being considered at this time and once selected would form part of this project.

To assure that this process is properly integrated into the structure of the state government, a high level council of technology was recently invested by the state government.

B. THE ROLE OF THE COUNCIL OF SCIENCE AND TECHNOLOGY (CET)

1. The Council is presided over by the Secretary of Planning and made up of representatives from the state secretariats, Universities, Centers of Technology and the Industrial Associations. It is in the process of hiring professionals to staff planning and evaluation units and an executive unit which would assist, plan, evaluate and administer state programs designed to link supply and demand for science and technology.
2. The basic functions of the Council are:
 - a. interpret national policy, determine R&D priorities for State of São Paulo, and provide overall policy planning and guidance to the SEP;
 - b. establish criteria for resource allocation to the line secretariats, research institutes, university departments;
 - c. evaluate the socio-economic implications as well as the efficiency, effectiveness and significance of scientific and technological programs in the state, and redesign projects or programs funds for new research and development projects as indicated;

- d. organize specific conventional and non-conventional training programs designed to increase the states' capacity to absorb technology;
- e. facilitate technical and financial assistance to industry and agriculture by supporting contracts between research institutes and industry and agriculture (through BADESP) both in the state and outside the State of São Paulo;
- f. maintain liaison with the Federal Ministries and the National Research Council on the State of São Paulo's activities in science and technology;
- g. promote better communications among the producers and the users of technology;
- h. provide a counseling service to industrial and agricultural firms on indigenous research capabilities as well as on worldwide availabilities of technologies;
- i. counsel the secretariat on the development of standards for industrial and agro industrial products.

The council would derive support for these functions through the development of a Data Resource Operation, which would function under the policy guidance of the Secretariat of Planning, and a Science Policy and Research Management program which will be developed within the university.

4. Under this program, the council's first step would be to hire a staff of professionals to assist in the planning and evaluation process. Subsequently, an on-the-job training program will be designed and implemented by the Science Policy and Research Management group, which will also be established under this project, and an appropriate U.S. contractor group.

In the early stages of the project, this mixed group will also serve as an advisory body to the Council and the Secretary of Planning.

5. The advisory body will be composed by the science policy and research management staff, and a representative of the U.S. contractor group working in tandem with the support staff of the CET to:
- a. assist the CET in determining the research priorities and policies;
 - b. assist the CET in the development of a decision-making process to rationalize allocation of resources for science and technology with the state budget; assist the CET and BADESP in formulating criteria for project selection and evaluation; assist the CET in proposing specific fiscal incentives and economic orientation, particularly in the establishment of policies on the transfer of technology; and

- e. assist the CET in establishing the proper linkage among all pertinent parts of the system, including the information program, research management, national and international organizations, etc.
6. In the first two years the advisory body to the Council will assist in establishing the proper technical and administrative routines for the CET. Upon the expiration of this period it is expected that the Council will have the technical competence to attend the needs of the governmental, industrial, academic and technological communities. From the third year on, the CET would assume the full responsibility for the technical and administrative coordination of the program.
7. In the meantime, the CET has selected two leading research institutes in the State of São Paulo, namely, IPT and ITAL, which could serve to assist in linking smaller centers of technology to the university structure on one hand and industry and agro industry on the other.

C. RESEARCH MANAGEMENT AND SCIENCE POLICY PROGRAM

1. The lack of managerial capacity is a critical problem in both the research centers of the State of São Paulo and in industry. The research institutions are unable to perform market studies, project evaluation, cost-benefit analysis, etc., and seldom, if ever, contract

the institutions which could provide these services. Except for the multi-national and some of the large Brazilian firms, industrial firms have no appreciation for the potential applications of either modern managerial or production technologies.

Similarly, most of the budgetary decisions made by the Secretariats in the area of Science and Technology are based on impressions rather than the empirical trends in the economy. Foundations and other institutions, supported indirectly by the state suffer the same weaknesses.

2. The program on Research Management and Science Policy will be composed of an interdisciplinary group of scientists, engineers, economists, sociologists and administrators to perform the following tasks:
 - a. Training and Extension: Initially the program will offer short courses and on-the-job training to the supporting staff of the CET. At the same time the staff will develop short-term courses and seminars on the management of research institutes for the directors, and administrators, of university research institutes and centers of technology. As the program progresses, the team will:
 - 1) develop seminars bringing together representatives from industry, research institutions,

development banks, universities and government agencies for simulation and games based upon existing problems;

2) prepare one semester postgraduate course for engineers and scientists on the management of research programs;

3) develop an industrial extension service designed to assist industrial and agro industrial firms implant modern management systems which are sensitive to technological factors affecting the present and future of the firms; and

4) assisting industry acquire pertinent economic data and market analyses, particularly benefit/cost analyses on the implementation of new processes and market perspectives on the development of new products.

b. Research: This group also will organize small interdisciplinary teams deriving from postgraduate departments within the university to perform research on problems in areas of science policy such as on policies for the transfer of technology, planning, technological forecasting, etc.

3. The program will be located at the School of Economics and Administration in the University of São Paulo and will consist of an interdisciplinary team of 5-6 Brazilian researchers.

Long- and short-term technical experts will be provided by the AID loan.

4. Initially, the staff will be supported by the Secretary of Economy and Planning through a university contract which would provide supplementary salaries, student grants and administrative overhead costs. In the second year of the program these costs will be shared by the university and by contracted training and research projects, except that foreign experts will continue to be provided by this loan project.
5. A specialized library on research management and science policy will be organized to support this aspect of the program. Books and periodicals required for the library will be provided through the loan project. Subsequently this program would have access to the information acquired by the data resource operation also to be established under this project.
6. This project will also provide short-term and long-term training grants in the U.S and third countries for professionals to improve the quality of the Science Policy and Research Management Program.

IV. INFRASTRUCTURE FOR PROGRAMS IN SCIENCE AND TECHNOLOGY

A. DEVELOPMENT OF DATA RESOURCE OPERATION

This facility will serve under the policy direction of the Council of Science and Technology and under the technical direction of the technological institute or center under which the operation is established. The purpose of this operation is to perform three basic functions which would subsequently be tied in with the national information network currently being planned by the Federal Government.

The functions are:

- a. collect and disseminate or provide access to information on scientific and technological research which would derive from state, national, and international sources to university institutes, centers of technology and industry;
- b. collect and disseminate information on patents, trademarks, etc., by establishing a linkage with the data bank of the National Industrial Property Office to assist industrial and agricultural firms in search of new and improved technologies;
- c. collect and process data which could be used as an analytical base by the planning unit in the Council of Science and Technology to make technological forecasts both in terms of developing and adapting

Industrial processes and in terms of projecting process and product trends into ideas for new products and processes which could be researched and developed in the coming years.

2. The AID loan would provide short-term consultants as required during the life of the project to assist the state to plan and organize the data resource operation. It is expected that these consultants would:

- a. examine the feasibility of the information project;
- b. assist in planning hardware and software requirements for each of the three sub-systems as they apply to the State of São Paulo.
- c. assist, plan and organize in-service and foreign training programs for the operators and users of the systems;
- d. prepare a course of action which the state should follow to integrate their systems with national and international data sources.

B. DEVELOPMENT OF MATERIALS RESEARCH AND TESTING FACILITIES

1. This service will be developed, supported and maintained by the Council of Science and Technology but would be subjected to the technical direction of the institutes within which the facilities are established. The essential role of this service is to recommend to the CET the standards, weights and measures, which should be

set on materials and products; provide guidelines to industry on quality controls; and to provide the Council of Science and Technology, and industry, with continuous evaluation (tests) of finished products and materials which would assist in designing or redesigning research and development projects, and in improving the quality of products.

2. These services would complement but not duplicate the facilities provided by the National Testing Laboratories. At present, the National Testing Laboratories lack physical facilities, and are burdened with legal inadequacies which inhibit the development of a national system of standards, weights and measures. There are positive steps which could be taken to assist industry establish quality controls, and which could, notwithstanding legal and logistical impediments, also assist in the development of a national system of standards, weights and measures.

3. Under this project, a network of testing laboratories will be created within the existing structures of state supported research institutes and centers of technology. The efforts of this network would be coordinated by three large reference laboratories which would be established by this project in three of the larger state-owned research institutions. The reference laboratories will perform the following functions:

- a. test complex systems and materials for standards and quality control;
provide CET with recommendations on the establishment and promulgation of standards and minimum specifications for materials and products;
assist the CET develop and implement a system to certify that products and materials conform to the minimum standards and specifications promulgated by the state;
assist industry in the state and out of it in the establishment of quality control systems and/or the development or improvement of testing laboratories, and on the standards and specifications required for products in foreign markets;
assist smaller research institutes in developing testing laboratories by training their personnel, counseling on acquisition of appropriate laboratory equipment, providing orientation on research and testing methodologies, and in assisting these centers to find contract work with industry and government;
assist the government and research institutions in resolving differences between laboratories regarding standards and quality of materials.

As indicated, testing laboratories would also be created in the smaller research institutions and centers of technology. For the most part, the functions of these laboratories would be to test materials and finished products for industry, and to develop small extension services designed to assist small and medium industry in the implantation of quality control systems. Hence, the basic functions of the testing laboratories would be:

- a. counsel and assist industrial and agro industrial firms on the development of quality control systems;
- b. provide independent tests of materials and finished products for industry and government;
- c. provide the reference laboratories with the results of the tests of materials and products made by the testing laboratories.

At this point, two of the three institutions which will ultimately serve as reference laboratories have been selected. These are The Food Technology Institute (ITAL) in Campinas and the Institute for Technological Research (IPT) in São Paulo. The latter will be operating in mechanics and metallurgy; the former in food technology. A third institute will be chosen in the not too distant future. Institutes to develop testing laboratories have not been selected.

6. The technical assistance, laboratory equipment and reference materials which would be provided by the AID loan are described in the succeeding section.

V. FINANCIAL SUPPORT FOR RESEARCH AND DEVELOPMENT

- A. SUMMARY: Resources which will be mobilized by the system to link science and technology to development objectives would derive from three major sources. The Universities, and Centers of Technologies would continue to be subsidized by budget allocation from the state and federal governments. Additionally under this project the government would, in certain instances, become a client of the universities and research institutes. Industry would be provided with fiscal incentives to stimulate research and development, and would be supported in the implantation of new or improved technologies by the State Development Bank and the Commercial Banking System. Finally, research institutes and centers of technology would be tied in to industry and agriculture by a fund which would provide loans to industry and government to subcontract research entities for research and development projects.
- B. FUND FOR SCIENCE AND TECHNOLOGY: Under this project the Government of the State of São Paulo, authorized the Development Bank of the State of São Paulo (BADESP), to establish a revolving fund for science and technology. The purpose of this fund is to: (1) finance research and development projects for industrial and agricultural firms which would, in turn, be sub-contracted to universities and research institutes for execution; 2) contract research institutes, centers of technology and university departments to accomplish research with high probabilities of successful use by industry and agriculture; and 3) to facilitate the prompt

purchase of equipment and commodities required by the research institutes and centers of technology to implement research and development projects contracted by industry.

1. Initially, the fund will be capitalized by resources provided by the federal and the state governments. Approximately 15 million dollars have already been provided by the federal government to start the fund. These funds will be repassed to industrial and agricultural firms throughout Brazil for research and development projects. Funds provided by the state government would be credited to the account of firms directly operating in the state and/or repassed to university research institutes and centers of technology. It is anticipated that most of the funds would be recapitalized through repayments of principal and interest by the industrial and agricultural firms participating in the project. A significant amount, nonetheless, particularly in the early years of the project, would have to be repaid to the fund from the budgets of the GOB and the State of São Paulo.
2. Financing research and development projects for industrial or agro industrial firms would include funds for:
 - laboratory work;
 - development of prototypes of pilot-scale models;
 - economic feasibility studies;
 - purchase and adaptation of required industrial equipment;and

technical assistance to firms which are in a position to support their own laboratories.

The project would make distinctions between development of pilot-scale models and the implantation of industrial equipment, particularly in terms of source of financing. For example, purchase of industrial equipment for pilot-scale models could be financed through the fund. However, the purchase of industrial equipment for industry which might have been recommended through the research and development process would be financed through their funds at commercial rates of interest. Except as explained below, however, the details have not been worked out.

3. The charts in the annex illustrate the process involved in financing projects. They are based upon the four types of requests for research and development projects:
 - the firm requests funds for work in its own laboratory;
 - the firm requests funds to finance assistance of a research institution, center of technology, or university department;
 - a research institute develops a project proposal;
 - a university department or university-affiliated research institute prepares a proposal for a development-oriented pure research project.

4. In all four of these cases, research could, if the projects meet the selection criteria, be financed through the revolving

fund mechanism. When the proposals are made by the firms, a technician from an appropriate research institute would be assigned to assist develop the proposal into a project. The project, depending upon its nature could be divided into several phases in such a way that financing phase 2 would depend upon the success of phase 1, etc. For example: a project which required a package, including feasibility study, development of a prototype, and the adaptation of the imported equipment could be submitted individually. The technician would assist the firm in making these decisions. In either case, a three-way contract and loan document bind would be developed by the bank to provide the funds, the research institute to perform the research, and the firm to repay the loan. Projects presented by universities and research institutes are in sections C and D.

5. As indicated above, the project would also provide funds for certain equipment costs. For university research institutes and centers of technology, for example, the science and technology fund could be used to modernize laboratory equipment. In this context, government sponsored research entities could make applications to purchase locally or to import equipment required to implement development-oriented research projects. Funds authorized for this purpose would require the prior approval of the State Government, i.e., the Council of Technology, the Secretary of Economy and

Planning. The state government would be required to reimburse the fund for these expenditures on an annual basis. Additionally, this portion of the fund would be continuously recapitalized by a system to be designed which would allow the fund to retain equipment costs amortized through the contracts between research institutes and industry.

C. FUNDS FROM THE FEDERAL BUDGET: The GOB, in mid-March, provided approximately 15 million dollars to the State of São Paulo to start the revolving fund. Additionally, discussions are under way with São Paulo officials and the Ministries of Agriculture and Industry and Commerce to provide funds for specific projects, outside the State of São Paulo, which would be carefully articulated with this project. For example, project proposals presented by research institutes outside the State of São Paulo could be financed by BADESP from the funds provided by the federal government. In order to assure continuation of the fund, however, the federal government would have to assure that funds expended in this way would be replenished. Without these arrangements the funds already provided by the federal government would have to be applied exclusively to proposals from industrial or agro industrial firms in Brazil. In any event, the Ministries of Planning, Finance, Agriculture and Industry and Commerce are encouraging the development of this project. Specific details concerning their inputs into the project have not yet been worked out.

D. FUNDS FROM THE STATE BUDGET: Funds allocated to projects in science and technology through the state budget are subject to the approval of the Secretary of Planning. For the most part, however, projects submitted to the Secretariat are approved mostly on the basis of availability of funds. This project will provide the Secretariat with a means of rank, ordering projects submitted by line secretariats in accordance with the development merits of each project.

Additionally, however, this project would require the State of São Paulo to set aside funds to capitalize the revolving fund in EADESP. It could also require the state to recapitalize the fund in those cases where research institutes have undertaken research and development projects or purchased laboratory equipment through the fund. The first generation funds allocated to BADESP's revolving fund by the State of São Paulo would not, in any event, be less than the total amount supplied by the AID loan. Specific details on the state's budgetary participation have not been worked out.

E. SELECTION CRITERIA: The responsibility for selection projects will be divided between the State Council of Technology and BADESP. The Council would be responsible for judging projects on their scientific, technological, and economic merit, whereas BADESP would be responsible for establishing the financial integrity of the borrower. Although the specific details of these criteria have not been developed, it is expected that in

the initial stages of the project, a simple weighted system would be applied to rate and rank order projects. Project proposals falling below a minimum rate would be rejected automatically. Others would be ranked and financed by the state on the basis of their order. An example of the criteria which might be used is as follows:

1. Economic factors
 - a. effect on domestic market
 - b. effect on export market
2. Technological factors
 - a. propensity to diffuse technology
 - b. effect on other industry
3. Manpower and labor force
 - a. effects on employment of unskilled labor
 - b. effects on employment of skilled labor
 - c. effects on training new technicians
4. Technological feasibility
 - a. state of the art
 - b. availability of personnel
 - c. requirement of foreign know-how
 - d. equipment requirements
 - e. relation of project to past or present activities of research institutes
 - f. probability of success
5. Economic feasibility
 - a. cost of project
 - b. estimated return on investment

6. Total score

a. weighted score

For projects deriving from industry, the CET would score the proposal and either pass the results on to BADESP, or reject the proposal if the score was below the minimum limit. If the score falls within an acceptable range, the CET would assign a technician from a research institute to accompany the project and second, forward the proposal to BADESP where the financial integrity of the borrower would be established. When the results are positive, the project would be at interest rates which would be determined on the basis of the evaluation score, i.e., the higher the score the lower the interest rate, and vice versa.

VI. SOURCES OF TECHNICAL ASSISTANCE FOR INDUSTRY, AGRICULTURE, AND GOVERNMENT

A. BRAZILIAN UNIVERSITIES AND RESEARCH INSTITUTES: One of the basic purposes of this project is to create linkages between the Universities, Research Institutes and Centers of Technology and at the same time to improve the indigenous capacity of these entities to train scientists and technologists who can relate to the economic and social demands of Brazil. The basic weakness is not in the lack of institutions to train students but rather in the lack of certain specializations within the existing institutions and perhaps more importantly, in the lack of a research tradition which transcends institutional boundaries.

One of the basic principles of this project is that universities and research institutes should provide more direct assistance to industry, agriculture and government in the socio-economic development process. At the level of the individual firm, this principle would be applied through the revolving fund which would enable industrial and agricultural firms in the priority areas to contract research and development projects with universities and research institutions. It would also be applied at the industry level through the revolving fund which would permit the government to contract research projects with the universities and research institutions.

To support the research and development effort, it is clear that a set of functional relationships be developed between the universities and research institutions. To assist in the establishment

of these relationships, this project would provide foreign technical assistance designed:

1. to use and improve the facilities of existing institutions for research and training.
2. to build into the curricula of university programs a means to conduct research, particularly applied research in institutions outside the university structure.
3. to provide "non-conventional" training in foreign industry as well as conventional postgraduate training to professors, students and professional researchers working in the universities, research institutions and centers of technology.
4. to enable large research institutions to assist smaller research institutions not only in keeping abreast of the latest developments in their respective areas, but in providing research which is relevant to the needs of Brazil.

THE ROLE OF U.S. TECHNICAL ASSISTANCE:

1. Essentially, the role of the U.S. technical assistance in this project would be to assist develop the capabilities of the universities and research institutes to conduct research and development projects. This assistance would be provided by three contracts with U.S. universities or research institutions and a postdoctoral fellowship program. The postdoctoral fellowship program would place young, highly-trained U.S. Ph.Ds. in the Brazilian universities and in those research institutions operating mainly at the industry

level. The three U.S. contractors would be located at the site of the reference laboratories being established under this project in three leading research institutions in the State of São Paulo.

2. Ideally, the U.S. universities would be selected by the CET in conjunction with the appropriate research institutions. Once selected, the CET would contract the services of those universities and/or laboratories. One of the important criteria in the selection process, in addition to the technical competence within the general sector, would be the universities' ability to attract professionals from other universities, research centers, and industry. The U.S. technical assistance would be provided to the appropriate Brazilian institutions under the following conditions:
 - a) that lead research centers agree to provide the universities specialized personnel for course work and seminars;
 - b) that the research centers present specific plans for the development of a capability to assist smaller research centers and industrial laboratories;
 - c) that student and professional grants will be provided by research centers so that professors and students from the universities would be able to participate actively in research projects undertaken in the institutes.

In return, the U.S. universities' contracts will provide:

- a) long and short-term technical assistance;
- b) limited commodities, particularly reference books for libraries;
- c) participant training grants

As the program progresses, the Council of Technology, acting through its Science Policy and Research Management, would contact a U.S. institution to provide U.S. postdoctoral fellows for the program. The purpose of this aspect of the program is: (a) develop capability to teach certain specific subjects, e.g., design engineering, systems analyses, etc., in the universities; (b) coordinate and assist in the development of applied research projects to be performed by students in the research institutes and centers of technologies; (c) provide technical assistance and general orientation to the research institutes as required; and (d) identify promising students for continued postgraduate training in the U.S. or third countries.

5. The CET would provide these fellows to the universities under the following conditions:
 - a) that the universities agree to use specialized personnel from the research institutes for special courses and seminars in the university;
 - b) that the universities permit students and professors to perform research in research centers for remuneration and academic credit;

c) that the universities agree to provide specialized seminars in research institutes and centers of technology, particularly in those areas in which it is receiving foreign technical assistance.

In return, the universities would receive: (a) the post-doctoral fellows for a minimum of two years per fellow; (b) at least two or three long-term training grants per fellow per year for postgraduate training in the U.S. and third countries.

VII. THE AID LOAN PROPOSAL

A. PURPOSE: The purpose of the AID loan would be to provide assistance to those links in the system through which the maximum impact could be obtained to integrate science and technology into the development process. There are obviously a number of difficulties involved in formulating this program. In the first place, the system being developed is very complex. Secondly, the broad definitions of the fields involved present a dilemma of sorts. On the one hand, sharper definitions would help maximize the efficiency and effectiveness of the technical assistance inputs. The broader definitions, on the other hand, are in part functions of an unsystematic approach which could not be remedied in the short run, at least not without technical assistance. At this stage in the formulation of the program, the mission proposes that AID resources be concentrated in the following areas:

1. Development of a Planning and Evaluation System.

Technical assistance provided to help establish the procedures and the norms for resource allocations could help coalesce the numerous entities involved into a cohesive system.

2. Development of the Infrastructure.

The provision of technical assistance in this area would help assure: (a) that adequate information is made available to the development planners; (b) that useful information

on research completed in Brazil and ultimately in other parts of the world would be made available to researchers; and (c) that industry and agriculture would have easier access to information on the availability of technologies, as well as on standards and specifications of products marketed outside Brazil.

3. Assistance to Universities and Research Institutions.

Technical assistance would help increase the capacity of the universities to train scientists and technologists; help the research institutes in applying more sophisticated methodologies to research problems; and help strengthen the ties between the universities, research institutions, and industry and agriculture.

Funds to Purchase Laboratory Equipment.

These funds would facilitate the import of laboratory equipment and concomitantly the modernization of research facilities in the universities and research institutes.

B. ESTIMATED COSTS

The AID loan would provide approximately \$15 million in technical assistance to the universities and centers of technology. Additionally, \$10 million in commodity assistance would be provided to import laboratory facilities for the university institutes and centers of technology. The total amount would be matched by the GOB and the State of São Paulo to capitalize the revolving science and technology development fund in BADESP.

The technical assistance portion of the loan would finance the following inputs:

- 1) three university contracts would provide technical assistance and on-campus research facilities in the U.S. to assist three institutes or centers of technology become leaders within the network of research centers. One university contract would concentrate on research in metallurgy and mechanics, another in food processing, and a third in an area which has not yet been selected. Each contract would provide long-term and short-term consultants and training courses in the U.S. for the staff of the institution selected.
- 2) twenty-five man-years per year of U.S. postdoctoral scholars to work in the graduate departments of basic sciences, engineering, business administration, etc.
- 3) twenty-five participants would be selected each year by the postdoctoral scholars for three-year grants to obtain U.S. doctoral degrees in the areas affected by the program. Each of these participants would be required to return to the universities to teach and research.
- 4) the technical assistance of a contract with a U.S. institution to assist the State Council of Technology to systematically evaluate their program in science and technology and to counsel the State on its changing needs. It would also provide the staff team of the institution selected to: (1) organize a postdoctoral fellowship program for Brazil, and (2) identify and employ short-term consultants as required by the CET for

their total program. The former includes identifying, employing and providing language training to young, high-quality U.S. postdoctoral scientists and technologists for subsequent employment in Brazilian universities or centers of technology participating in the program. The latter involves identifying highly specialized U.S. scientists for short-term assignments in the universities or centers of technology, as required by the program and approved by the CET.