PN-ABU-823
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# MANUAL

# SUSTAINABLE PUBLIC SECTOR - PRIVATE SECTOR COOPERATION

# FOR INDIGENOUS TECHNOLOGY DEVELOPMENT

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UNITED STATES AGENCY
FOR
INTERNATIONAL DEVELOPMENT (USAID)

FEBRUARY 26, 1994

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# EXECUTIVE SUMMARY

This manual is divided into two sections. **Section I** covers the need for cooperation between the private industrial sector and research institutions in order to develop indigenous scientific technology, and the role of the University Grants Commission (UGC)/USAID's Institutional Excellence Project (IEP) in developing this cooperation. IEP was designed to identify sources of scientific expertise and industrial technological needs and bring them together to work cooperatively to find solutions. Fourteen companies, who formulated sixteen problems, were identified and were brought together with departments and centers from six universities. Working agreements were concluded and the projects undertaken had a successful completion rate of 85 percent.

During this process, impediments which hindered the development of a climate conducive to industrial/research unit cooperation were identified. After the projects had gotten underway other obstacles to the promotion of successful cooperation were identified. Finally, upon completion of the sixteen projects, presentations were given to present the findings from the research efforts.

This section also briefly discusses funding categories provided by the IEP which forms a beginning basis for future funding needs.

Finally, a brief survey of the project accomplishments are given.

**Section II, Part A**, is based upon the lessons learned from the project. It proposes solutions and mechanisms to sustain future cooperation on a larger, national scale. These are contained in a set of recommendations which are divided into three major categories. The first category of recommendations concerns setting up an institutionalized Resource Center,

staffed by data base and liaison specialists. Its first function is to set up a data base of qualified scientists and identified industrial problems, to serve as a nation-wide clearing house for industrialists and for researchers seeking cooperative arrangements for solutions to problems. A second function is to develop an outreach program by giving seminars to Chambers of Commerce and scientific research centers to publicize the Centers' information base and capabilities. Finally, well-trained staff members will serve a liaison function between scientists and industrialists who are engaged in cooperative activities.

It is also recommended that a Supervisory Unit be set up that will report to the appropriate levels in the Government of Pakistan to recommend appropriate policies to overcome obstacles and to stimulate cooperative efforts. This committee should be made up of representatives drawn from industry, the research sector, and the government sector, on a rotating basis. The committee will also monitor the operation of the Resource Center. A chart illustrates the organizational setup.

The second category of recommendations concerns the role of the scientific institutions and necessary policy formulations that must be made for cooperative research such as: released time, financial incentives, merit awards and credit toward promotion for applied research, the establishment of a liaison office, and publicity.

The third category of recommendations concerns questions of funding and the role of the Government of Pakistan in promoting monetary assistance and guidance.

**Section II, Part B,** develops a model of how these proposed solutions and recommendations can promote cooperation between industry and research institutions by providing a step-by-step outline of the research process: the initial contact, the formulation of the proposal, the formal agreement, progress reports, schedule deadlines, project completion reports, and follow-up. A flow chart illustrates this process.

**Section II, Part C,** presents a summary of the most important findings from the Institutional Excellence Project.

# SECTION I

# OVERVIEW OF

# SUSTAINABLE INDIGENOUS TECHNOLOGY DEVELOPMENT

# SECTION I OVERVIEW OF SUSTAINABLE INDIGENOUS TECHNOLOGY DEVELOPMENT

## A. BACKGROUND: NEEDS, RESOURCES, AND INSTITUTIONAL EXCELLENCE PROJECT OBJECTIVES

Major portions of industry in Pakistan now depend heavily on the utilization of imported technology, but the need for indigenous technology development for economic and social improvements is becoming critically important. The Institutional Excellence Project focussed on these needs and available national strengths to provide a sound mechanism of cooperative applied research between private sector industry and research institutions to accelerate indigenous technology development.

### 1. The Need for Increased Industrial/Research Institution Cooperation

Major portions of industry in Pakistan now depend heavily on the utilization of imported technology. Imported technology, however, is frequently not at the cutting edge. The pay-back period for high cost technology plants and equipment is relatively long. On the other hand, the continuous flow of new and more efficient technologies can make the previous technology obsolete in a few years. Thus the recovery of the cost of adopting the technologies becomes very difficult. In most cases the maintenance base required for more refined high technology industries is not available in the country; thus imported spare parts and maintenance services are required which add to the cost of production. Consequently, many companies in Pakistan are left in a less competitive position in what has now become a global market. Thus, there is a major need to create such indigenous and globally competitive technology.

### 2. Resource Availability

Training during the last ten or more years of a significant number of university faculty members and other scientists and engineers to the highest levels of science and technology on world standards provides an untapped reservoir of research talent. Work under the USAID Institutional Excellence Project (IEP) has shown that this talent can be successfully applied to broad areas of industrial problem solving.

### 3. The Lack of Coordinated Industry/Research Institution Cooperation

Despite this pool of highly trained personnel, there has been little research on indigenous technology. A few individual researchers have potential contacts resulting from personal knowledge of industrial activities. However, organized, financially supported efforts by designated individuals in the institutional administration to establish broader and larger working arrangements are absent.

Industry, on the other hand, also has not sought this development. It does not carefully examine the potential value of cooperation, define important specific problems requiring expertise or services which it does not possess, nor make efforts to actively seek individuals who could provide solutions. The two sides do not come together to agree on specific approaches, time-tables, and a definition of satisfactory results. Only when objectives and requirements are clear, a level of financial support is defined, and the responsibilities are clearly understood can collaborative interactions be fruitful for both sectors.

## 4. Institutional Excellence Project

The IEP was designed to bring industry and researchers together to work in joint cooperation and to overcome the lack of communication and cooperation outlined above. The Institutional Excellence Project (IEP) was set up after a joint analysis by the USAID and the University Grants Commission of the needs and possibilities for improvement in the output of university research directed toward national economic goals. The analysis considered the present geoeconomic situation in high technology sectors, the need for increased industry/research institution cooperation, the present status of applied industrial research, the present and potential availability of expertise in universities and other research institutions, and the factors favoring or impeding the results of applied research efforts.

The IEP was structured to demonstrate the capabilities of university departments and centers to complete practical applied research for industry by establishing sixteen projects in six universities working in cooperation with fourteen companies to work on industry designated problems, the solution of which would provide immediate economic benefits. The results of the IEP provides the basis for a manual incorporating a set of recommendations which are discussed in Section II.

In promoting indigenous applied research, the IEP initially encountered a number of difficulties which had to be overcome. These can be classified as pre-operational obstacles and operational difficulties that must be removed or improved.

## B. PRE-OPERATIONAL IMPEDIMENTS TO COOPERATIVE INDUSTRY AND RESEARCH EFFORTS

These pre-operational impediments are: lack of awareness of research capabilities by industry; lack of confidence by industry; the absence of policies on intellectual rights such as patents, licensing fees, and royalties; the lack of research resources; and the lack of incentives for researchers. Recommendations to overcome these difficulties are addressed in Section II.

### 1. Lack of Awareness of Research Capabilities by Industry

An overriding obstacle to effective cooperation for IEP was the lack of awareness of research capabilities. Outside of routine testing in a few departments and a small amount of consulting on a personal basis, no formal arrangements for cooperation with industry were discovered. Only when this information was disseminated to a large number of companies was any interest aroused in possible cooperative efforts by the industrial side.

The dearth of information on possible collaborators was also evident on the researcher side. Instances of approaches to companies by universities were reported, with little or no success, but no concerted effort to determine industrial needs and interests were found. Any sustainable cooperative scientific development must overcome this communication problem.

### 2. Lack of Confidence by Industry

The next difficulty occurred when preliminary discussions were held with selected industrial companies on potential projects. The initial

reaction by industrial representatives in all cases was a lack of confidence in faculty/researcher expertise, and in their ability to work in an industrial environment. Strong doubts existed about researchers' understanding of industrial needs and the industrial process, their ability to conduct research on practical problems, and their ability to deliver results within the short time scale required by industry. This can be overcome relatively simply by improving communication.

### 3. Intellectual Property Rights for Industry

It was reported that there was no adequate system to ensure intellectual rights or property, that is, for any profits or patents to be awarded to industry, which resulted in reluctance on the part of industry to support collaborative research projects.

### 4. Lack of Resources for Researchers

In most research institutions, financial resources available for research work have been scarce. The limited resources available from government budgets were frequently not provided in a timely manner for research activities which resulted in inefficient utilization and loss of time.

The rules for obtaining financial assistance for research work were not properly understood by most research workers; others also reported the rules to be lengthy and cumbersome.

Further, industry incentives for supporting cooperative applied research were reported to be non-existent.

Researchers have a feeling of futility in proposing cooperative efforts, because of lack of response to overtures on possible support, which, in most cases were made on an individual basis. These overtures, usually were general, unstructured, and indefinite.

### 5. Lack of Incentives for Researchers

It was reported that incentives within the research institutions to undertake cooperative applied research did not exist. Not only were research workers not rewarded financially, but, recognition of their efforts was also not reflected in their career advancement.

## C. OPERATIONAL DIFFICULTIES

During the operation of the research projects, certain operational difficulties surfaced. These were poor proposal writing; the lack of research progress and project reporting by researchers; the lack of priority accorded to projects by administrators; and the lack of financial management procedures.

### 1. Inexperienced/Ineffective/Casual Proposal Writing by Researchers

The initial tendency by researchers was to prepare minimal proposals, which needed substantial revision before they could be submitted. While researchers were quickly able to respond with practical approaches to problems identified by the companies, they had considerable difficulty in translating their ideas into practical terms such as identification of necessary financial support levels needed and the formulation of written proposals. Considerable discussion and reformulation of proposals using a designated format developed under IEP were required prior to formal review by industry representatives. The development of a model format and the need to publicize it is discussed in Section II.

### 2. Lack of Research Progress and Project Reporting by Researchers

In general, research activities were carried on diligently, in spite of some major delays in delivery of necessary equipment and commodities by the suppliers. However, in several of the research units the activities were carried on in the usual academic mode, without sufficient attention being given to frequent contact with technical and managerial company personnel and provision of adequate and timely progress reports.

Continued discussion among industrial representatives, researchers, USAID personnel and Pakistani consultants improved the reporting situation, and finally resulted in well prepared and thoughtfully presented summaries of results by researchers in a project workshop which reviewed the results of all of the projects in conjunction with industrial representatives.

### 3. The Lack of High Priority and Timeliness Provided by Research Administrators

It became apparent that a high priority to project activities was not granted by most university administrators, which, at times, seriously hampered the progress and resulted in loss of enthusiasm by both of the collaborating partners. This also resulted in a loss of confidence of industry in the research institution's ability to deliver results in a timely manner.

### 4. The Lack of Financial Management by Research Institutions

An efficient but simple, central financial management system was not available at most research institutions. The principal investigators

were expected to maintain the project accounts themselves. Since a number of researchers were not fully conversant with financial rules and regulations, financial reporting at times created difficulties and delays.

## D. SPONSORED PROJECTS

Under IEP, sixteen projects involving twenty six researchers located at six universities, working in collaboration with fourteen companies were identified with the assistance of Pakistani consultants.

These projects are listed in Table I. Thirteen out of the sixteen research projects met their objectives, establishing a highly successful 85 percent completion rate.

## E. FUNDING

Certain funding requirements were necessary to promote indigenous research. In the IEP these necessary expenses included the materials and equipment needed to accomplish the various projects. Consultants were necessary to locate companies who identified technological problems they wished to solve. Supervisory personnel were also necessary to assist in the management of this initial program.

## F. CONCLUSIONS

Building upon the experience of the IEP, a set of specific recommendations have been formulated upon which to build an operational guide. These recommendations are given in Section II, A. Section II, B also provides a model that illustrates how the cooperative process would work.

## TABLE I

### INSTITUTIONAL EXCELLENCE PROJECT (IEP) AT A GLANCE

| Research Institution | Counterparts | Project Title | Total Amount of Commodity Funding ($US) | Total Amount of R&D Funding ($US) |
|---|---|---|---|---|
| NCEG, Peshawar<br>(4 Projects) | Khawaja Glass Co.<br>Khawaja Glass Co.<br>Khawaja Glass Co.<br>Oil & Gas Development Corp. (OGDC) | 1. Identification & Characterization of Quality of Silica Sand for Glass Making<br>2. Inclusion Studies of Sheet Glass<br>3. Review of Analytical Processes at Khawaja Glass Company<br>4. Sedimentalogical Studies in Potential Hydrocarbon bearing Strata | 247,376 | 42,200 |
| QAU, Islamabad<br>(2 Projects) | Bio-Tech<br>Ciba Geigy, Multan | 1. Bating Enzymes from Animal Sources<br>2. Bioinsecticides in the Control of Insect Pests of Cotton | 136,115 | 14,444 |
| UET, Lahore<br>(3 Projects) | Descon<br>Escorts<br>Multiline | 1. Microprocessor based Multimetering, Energy & Tariff Meter<br>2. Design & Development of an Expert Logic Controller<br>3. Uninterrupted Power Supply (UPS) | 89,474 | 16,800 |
| CEMB, Lahore<br>(2 Projects) | Ciba Geigy, Lahore<br>Punjab Drug House, Lahore | 1. Microbial Control of Insect Pests in Cotton<br>2. Hormone Receptors as Prognostic Factors in Health & Disease | 193,600 | 15,000 |
| GOMAL, D.I. Khan<br>(2 Projects) | PCSIR<br>STEDEC | 1. Commercial Exploitation of Taxol Anti-Cancer Drug<br>2. Commercial Exploitation of Azadirachtin | 133,300 | 17,000 |
| HEJ, Karachi<br>(3 Projects) | Hamdard Labs.<br>BASF<br>Ehsanullah Labs.<br>A.K. Labs. | 1. Investigation of Medicinal Plants for Anti-Diabetic Activity<br>2. Bating Enzymes from Animal Sources<br>3. Development and Pilot Plant Production of Medical Diagnostic Kits | 211,420 | 8,700 |
| 6 Universities | 14 Counterparts | 16 Projects | 1,011,285 | 114,144 |

NCEG = National Centre of Excellence in Geology, University of Peshawar
QAU = Quaid-i-Azam University, Islamabad
UET = University of Engineering & Technology, Lahore
CEMB = Centre of Excellence in Molecular Biology, Lahore
GOMAL = Gomal University, D.I. Khan
HEJ = H.E.J. Research Institute of Chemistry, University of Karachi

# SECTION II

# RECOMMENDATIONS

# AND

# PROCESS MODEL

## SECTION II. RECOMMENDATIONS AND PROCESS MODEL

This manual is based on the experience gained from the operation of the Institutional Excellence Project (IEP). It formulates a set of recommendations designed to serve as a specific operational guide to universities, research institutions, industry, and representatives of the Government of Pakistan, for the establishment of effective working relationships between industry and the research sector in order to provide sustainable and indigenous technology.

The first part, part A, summarizes the general findings from the operation of the IEP. It also includes specific recommendations for the establishment and enhancement of a systematic approach for the continuation and expansion of the initial project approach. Part B contains a model which illustrates how the cooperative research process works.

The manual is not intended to be a final document, but a beginning effort which can assist in the establishment of relationships and avoid major problems and pitfalls which were observed in the pilot program. It is anticipated that the manual will be continually updated as improvements are noted in the continuing cooperative process and operational details are developed.

### A. MANUAL RECOMMENDATIONS

Following are the recommendations which can serve as a guide to the cooperative development of indigenous technological research between researchers and the private sector. The recommendations fall into three categories: industry's role and contribution, the research institution's role and contribution, and the government's role and contribution.

## 1. Industry's Role and Contribution: The Resource Center

If research cooperative efforts are to develop in the future and on a larger scale, industry will have to play a more active role by promoting and supporting the institutionalizing of a RESOURCE CENTER.

It became abundantly clear during the development of the IEP that such a Resource Center was necessary. This Center should serve four functions. It can:

- *compile a data base* of industry problems;
- *compile a data base* of faculty expertise;
- *formulate an outreach program* that gives seminars at regional research institutions and Chamber of Commerce Centers on ongoing research programs, available researchers and their expertise, and industrial problems in need of research, and finally,
- *serve a liaison function* by matching backgrounds of expert researchers with potential industrial problems, establishing contacts for possible cooperative arrangements, facilitating continued discussions between company personnel and researchers, and assisting in the formulation of cooperative research proposals, budget planning, and arrangement of final agreements.

Because it is highly likely that research requests will in most cases generate first from the industrial sector, it is recommended that the Resource Center be located in the private sector.

The permanent staff of the Resource Center should consist of a manager and, as a minimum staff, two data base specialists; and three liaison specialists.

A Supervisory Unit should also be formed. This Supervisory Unit should be composed of representatives from industry and the research sector, appropriate government representatives, and representatives from the Federation of Pakistan Chambers of Commerce and Industry. Specific suggestions for membership are shown on an organizational chart, Figure I.

The Supervisory Unit should:

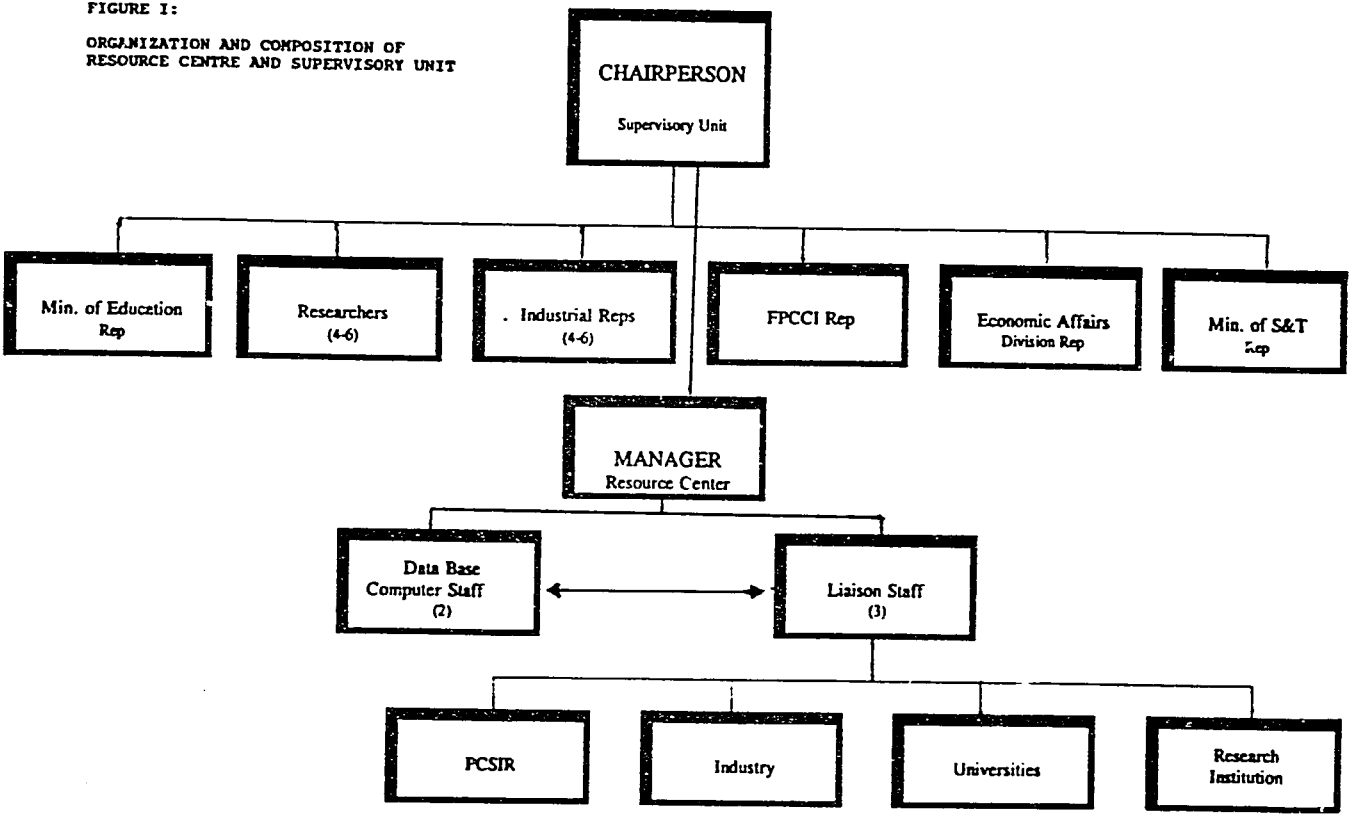
- *assess and establish mechanisms* for cooperation, manage the establishment of the data banks in the Resource Center and oversee the continuous liaison work between industrial firms and research units, and organize and direct other activities of the Center;

- *make recommendations on necessary policy and procedure revisions* to government, industry and research units.

- *propose necessary budgets, sources, and mechanisms* to provide interim support for projects until private sector support is sufficient to support the cooperative efforts;

FIGURE I:

ORGANIZATION AND COMPOSITION OF RESOURCE CENTRE AND SUPERVISORY UNIT



- *recommend and assist in appropriate training programs* for technical personnel, administrators, and technical counterparts in the essential requirements for successful industry/research unit cooperation;

- *seek cooperative funding support* from private sector firms and manufacturer's associations.

## 2. Research Institution's Role and Contribution

A major responsibility for developing technological research rests with the research sector. The initiatives of the researchers and the departments can only be successful with the support and encouragement of institutional administrators. Therefore the administrators at research institutions should make an official commitment to seek and to promote such a relationship. This commitment can be demonstrated by restructuring rules and regulations to facilitate cooperation and provide incentives for participants. These new rules should include:

- *released time* -- teaching loads and other duties should be adjusted for researchers engaged in cooperative research. Loads should be decreased as research participation increases;

- *financial incentives* -- adequate financial compensation should be provided for researchers engaged in the cooperative applied research. Researchers should also receive a share of royalty or license fee income resulting from successful commercialization of research results.

- *career incentives* -- an organized program of incentives should be provided to encourage the extra effort required to participate in this type of activity. It is also urged that service rules/career structure be adjusted to give credit toward promotion to faculty members for success in cooperative research;

- *promotional brochures assistance* -- the institutional administration should assist the researchers in their preparation of brochures by supporting and coordinating the preparation, organization and distribution of information on faculty capabilities;

- *making contacts* -- institutional administrators should assist in making contacts with potential sponsors, in meetings with company executives, appearances at Chambers of Commerce, Rotary Clubs, and technical associations. When discussions are being held with specific companies, attendance at crucial meetings by institutional administrators would add the weight of the institution in support of the negotiations.

Institutional administrators are urged to publicize the expertise and capabilities of their personnel, to establish working arrangements and facilitate work in progress. There are a number of actions that departmental administrators and faculty can take collectively which will fulfill these responsibilities:

- *departmental/institutional liaison* -- the department should designate a departmental liaison person as the contact person for routine interactions with the Resource Center, enabling the researchers to stay current with possible

research possibilities with industry. This liaison person should also be responsible for overseeing the collection of resumes and ensuring that they are forwarded to the Resource Center;

- *promoting group discussions* -- the department/institution can promote a research atmosphere by having its members meet in a group to assess members' capabilities and interests and agree to focus on applied research; and by

- *publicizing capabilities* -- brochures (not necessarily elaborately printed) should be prepared and sponsored by the institution which emphasize aspects of researcher expertise appropriate to industrial activities, with particular reference to the areas of technology which can be improved by researcher participation.

The major responsibilities of the research staff are to:

- *prepare brief individual resumes* which emphasize potential industrial applied research capabilities, for circulation as needed;

- *participate in the pooling of information;*

- *seek cooperative arrangements* by interaction with the Resource Center and companies related to their fields of expertise.

## 3. Governmental Funding and Policy Changes

It is imperative that the Government of Pakistan recognize the importance of cooperative research activities and provide sufficient resources to encourage these efforts.

For expansion of cooperative applied research as conducted under the IEP, the government, at least in the early stages, must provide both substantial financial support and review current administrative policies to overcome existing impediments. A detailed description of necessary support is provided below. The recommendations presented here are based on experience gained during the project operation, and the results of the analyses of the lessons learned.

- *Provision of Financial Support* -- It is recommended that, at least for the first five years, the government provide substantial funding for cooperative research materials, equipment and salaries. Possibly, the private sector can bear 25% of the equipment and research materials at first.

The government should also assign to the University Grants Commission (UGC) or another body the responsibility to facilitate, supervise and encourage such activity and provide the necessary guidelines to govern it.

Only research projects which designate specific industrial partners and develop formal plans and agreements for cooperation should be eligible for support from the revolving fund.

Since funds will be needed to establish the financial management units at research institutions, it is recommended that these funds be included in additional government allocations. Also, funds should be provided for the liaison individual in departments who arranges meetings, collects resumes, prepares promotional brochures, etc.

Besides research support, a significant additional expense would be the Resource Center and its staff. This expense should be borne by the private sector with initial support by the GOP.

Finally, some funding would be required for the Supervisory Unit.

- *Policy Changes* -- The government should foster a positive research atmosphere by permitting reduced teaching loads, providing financial incentives, and merit toward promotion to be based on successful research.

## B. PROCESS MODEL

The following discussion illustrates the step-by-step process whereby cooperative agreements are begun and brought to a successful conclusion:

### 1. Initial Contacts

The first step in the process is bringing together the scientific personnel and companies who need solutions to industrial problems, to formulate research proposals.

*Initiation by Industrialists* -- The initial contact can be made by industrialists in a number of ways. Industrialists may contact the Resource Center to request assistance on industrial problems. Industrialists may also be made aware of these research capabilities at Chambers of Commerce presentations, given by the Resource Center at regional capitals or from reading the promotional brochures sent to the Chamber of Commerce units by the Resource Center, then make contact with the Resource Center in order to ask for qualified personnel to work on these problems.

If contact is made by the industrialists, the Resource Center can use their data base to identify appropriate personnel. Once the prospective research personnel have been identified, a comprehensive discussion of cooperative arrangements should be held.

*Initiation by Researchers and Research Institutions* -- If contact is made by university or other researchers who are seeking cooperative projects, a search of the data base in the Resource Center outlining industrial needs and contacts can be one way to start the cooperative research process. Awareness can also come through attending seminars given by the Resource Center staff at scientific institutions. Contacts by Resource Center liaison personnel can result in locating industries interested in further discussions and possible cooperative arrangements. Again, once this is done, preliminary discussions between researchers, Resource Center liaison personnel, and the company should be held to determine whether the proposal is feasible. Figure II illustrates this process.

### 2. Preliminary Research Proposal

*Project Research Planning Proposal* -- The careful formulation and execution of the proposal is extremely important, because it forms the basis of a company's perceptions of the university and potential researchers.

Researchers are advised, once a preliminary contact has been made, to gather as much information as possible about the company and its present and potential markets, and be prepared to present recommendations and specific research plans at the first formal meeting.

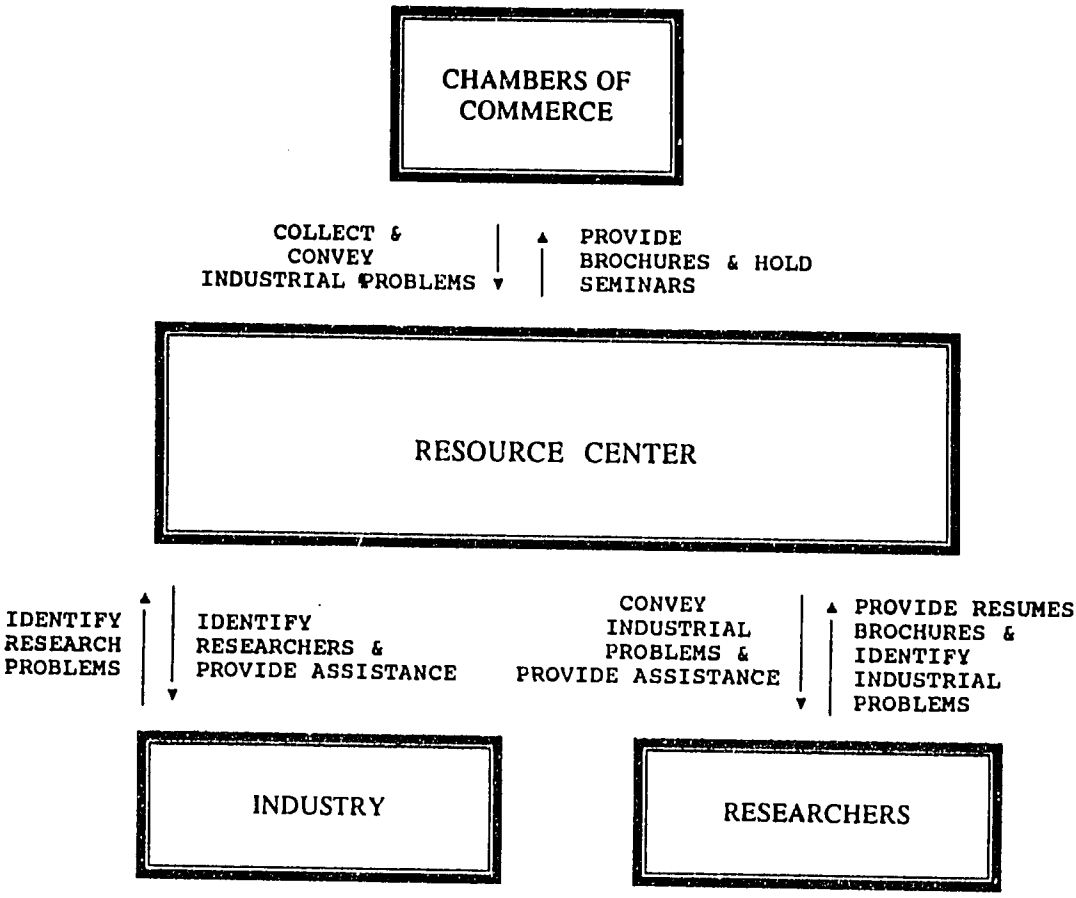



FIGURE II. THE INITIATION OF THE RESEARCH PROPOSAL

After the researchers and the company make a preliminary commitment to work together on an industrial problem, personal contacts between researchers and industrial technical personnel and managers ought to be extensive. The negotiations should be assisted as necessary by the Resource Center liaison personnel. Through these contacts and discussions the proposed problem may be defined precisely and the objectives clearly understood by both parties. This is essential for the successful completion of such cooperative work. It is particularly critical for extensive and large projects.

Care must be taken to specify individual budgets for each unit, overall administrative responsibilities for research areas, and overall administrative responsibilities for project operation.

The preliminary plan should include:

- a list of faculty and staff participants with designated responsibilities
- a design of the research program
- a list of necessary industrial personnel who will participate, with designated responsibilities
- a proposed time schedule
- a schedule for reporting (scheduled meetings, methods of reporting, etc.) and for final presentation of results (e.g., assembled equipment to be delivered, provision of sample test results, etc.).

- a proposed arrangement on distribution of intellectual property (publications, software ownership, patents, copyrights, etc.) and on questions of royalty payments, license fees or other compensation

- funding sources

Considerable discussion and reformulation of proposals, using a designated format developed under the IEP, are required before a formal review by industry representatives. A suggested format for the project proposal is given in Annex I.

Figure III. Illustrates this process.

### 3. University/Research Institution Support

Once a university/research institution has made an official commitment to seek and to promote industrial cooperation, and certainly no later than when proposal negotiations are taking place, it should establish a financial unit for research for record keeping and financial management. This unit should have the authority to monitor expenditures and be responsible for periodic financial reporting to the company. Arrangements in the financial area should include details of financial incentives for faculty participants and agreements on distribution of indirect costs to the university. Again, all this needs to be in place or designated before the agreement is signed.

### 4. Formal Agreement

After acceptance of the proposal by the company, a formal agreement should be prepared and signed by both parties. Figure IV illustrates this process.

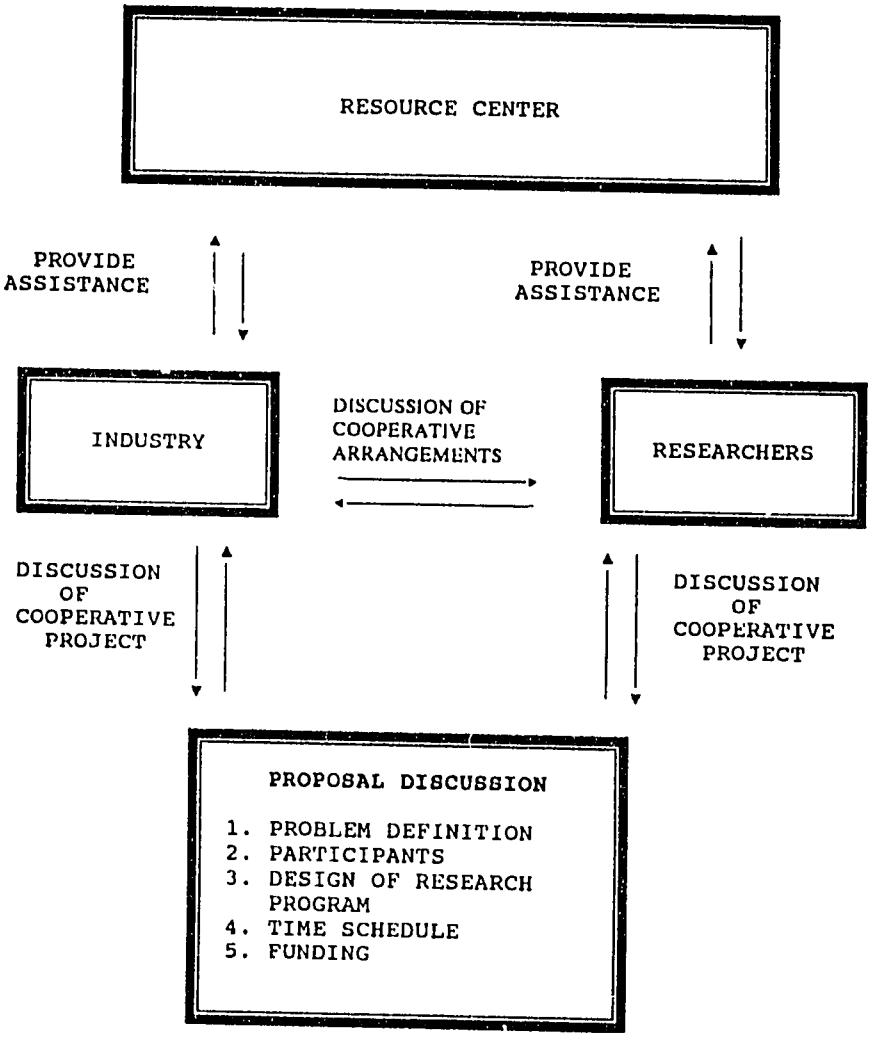



**FIGURE III. THE DEVELOPMENT OF THE RESEARCH PROPOSAL**

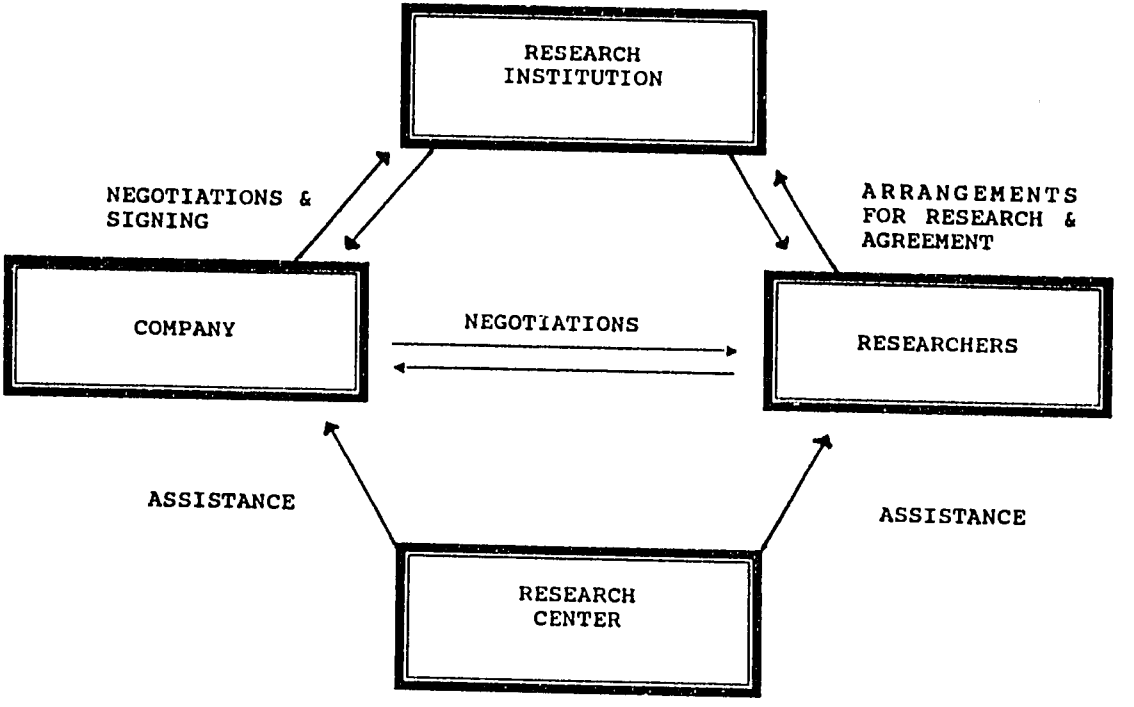



**FIGURE IV. THE FORMAL AGREEMENT**

Because rapid completion of project planning is an essential requirement from the industrial standpoint, every possible effort should be made to complete arrangements as soon as possible. After some experience the entire process can be completed in one month or less.

### 5. Research Progress

Because rapid completion of projects is an essential requirement from the industrial standpoint, the principal investigator should make every possible effort to complete the research as soon as possible. The Principal Investigator should establish definite time schedules for discrete phases of the research program and continually emphasize their importance to the research staff.

### 6. Research Reports

Reporting to the company can take a variety of forms but should be frequent, with individual visits not only to technical representatives, but also to high-level management.

Regularly scheduled written reports should be presented promptly, and significant achievements which occur should be particularly emphasized. A suggested format for written reports is given in Annex II.

### 7. Final Reports: Oral and Written

At project completion, a detailed oral presentation of findings should be arranged with appropriate company representatives, followed by a comprehensive written report which includes an analysis of the commercial value of the results achieved, and suggestions for additional research activities. For maximum effectiveness this report should be submitted immediately after the schedule project completion date.

## 8. Project Follow-Up

After project completion, principal investigators should plan periodic follow-up visits to the company to determine the ultimate effectiveness of the research, to offer continued cooperation and to maintain contacts with company personnel.

Figure V illustrates the process for final reports and follow-up.

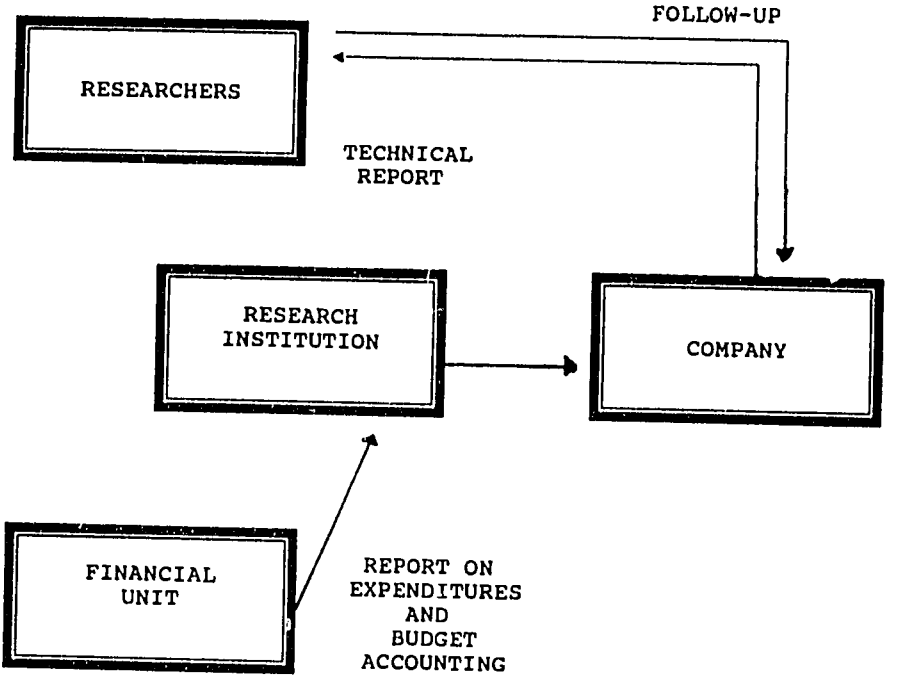



**FIGURE V. THE RESEARCH REPORTS AND FOLLOW-UP**

## C. SUMMARY: FINDINGS FROM THE IEP PROJECTS

During the progress of the project a number of findings were established.

After determining that indigenous technological research is vitally needed, a pool of highly trained scientists were identified.

Collaborative applied research work may be successfully accomplished as the IEP experience proved.

Projects which were proposed by company as being in need of solutions were managed by twenty-six researchers and came to a successful 85 percent conclusion rate, thus initiating two-way communication between the researchers and the private sector and improving significantly the research equipment at the participating research institutions.

The findings include the following:

- pre-operational and operational impediments were identified;
- the need for a Resource Center, its functions, and necessary staff expertise were identified;
- the policy changes in the research institutions that are necessary to promote research were identified;

- the necessary funding needs from the GOP and other donors, as well as necessary policy changes were identified;

- a sustainable program for the continuation and expansion of industry/research institution cooperative research was created, and finally,

- a model was created that illustrated the cooperative research process

## ANNEX I

## PUBLIC SECTOR-PRIVATE SECTOR COOPERATION FOR INDIGENOUS TECHNOLOGY DEVELOPMENT

### SAMPLE PROPOSAL FORM
### INDUSTRY/RESEARCH INSTITUTION COOPERATION

I. TITLE: (Give a title which identifies the problem to be solved)

II. INTRODUCTION: (Give an overall summary of discussions with the company, proposed cooperative activities, preliminary arrangements on cooperative agreements, etc.)

III. PROJECT DETAILS:

a) Background: (Give a brief description of the industrial source of the problem; the difficulties caused by the problem, and the economic importance of the problem in an industrial and/or national sense. Finally, list the specific objectives of the proposed work.)

b) Technical Description: (Give all of the important details of the various aspects of the research/development problem to be solved. This should include a technical description of the background and brief discussion of current status of work in progress in the field. A brief description of previous work in the field by the proposer, if any, should also be included.)

c) Scientific/Techical Contributions of the Project (Give a brief description of the technical results to be achieved.)

d) Methodology and Work Plan: (Describe the theoretical/experimental techniques to be used to carry out the proposed work)

e) Proposed time schedule: (Give a proposed time schedule for each major project objective or activity)

f) Industrial Cooperation/Participation: (Give details of participation/support to be provided by cooperating industry/company. Include any special arrangements to be made, such as industry personnel involved (including the primary contact person), financial support, secrecy agreements, royalty arrangements, publication rights, etc.)

g) Utility/Benefits: (Describe potential usefulness and economic benefits to be derived from successful solutions to the problem(s), including those which have potential for immediate application.)

IV. PRINCIPAL INVESTIGATOR: (Name/Title)

V. CO-PRINCIPAL INVESTIGATOR(S): (Name(s)/Title(s)

VI. AFFILIATION: (department/centre/university)

VII. DURATION OF SUPPORT: (months)

VIII. TOTAL FUNDS REQUESTED:

## IX. PROJECT STRUCTURE:

a) Personnel: (List personnel to be involved including duties and responsibilities)

b) Available Facilities/Equipment: (List facilities and equipment available for use in the project.)

c) Resources Required: (Describe and justify any special major items of equipment/facilities required to complete the proposed project.)

d) Budget: (For amounts requested, list overall figures for each category. For Principal Investigator, co-Principal Investigators, and research staff list compensation requested. List overall budget for permanent equipment and show specific details for equipment requested in table below. Under OTHER category list specific items requested, such as travel, audit fee, analyses, services, etc. Justify any unusual requests, such as large requests for analytical services, large requests for in-country travel, etc.)

1. Compensation:

2. Equipment:

3. Supplies:

4. Other

5. Indirect Costs

e) Equipment Specifications: (In tabular form, give details for each item of permanent equipment requested, including model number if known, and quoted price or best estimate.)

X. APPROVALS: (Signature of Principal Investigator and other required authorizing officials, if any.)

## ANNEX II

## PUBLIC SECTOR-PRIVATE SECTOR COOPERATION FOR INDIGENOUS TECHNOLOGY DEVELOPMENT

**SAMPLE:**
**RESEARCH PROJECT PROGRESS REPORT OUTLINE**

Project: _____

Department/Center/University: _____

Principal Investigator(s): _____

Associated Staff/Students: _____

Associated Industrial Personnel: (Names/titles) _____

I. Objectives of the Project:

II. Project Accomplishments: (during report period)

III. Project Plan for Next Quarter:

RELATED INFORMATION:

1. Meetings of Researchers/Industrial Staff: (list each meeting, dates, locations, personnel attending, items discussed)

2. Problems encountered in conducting Project Operations:

3. Suggestions/Recommendations: