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JOINT UNDP/UNIDO EVALUATION OF INDUSTRIAL RESEARCH AND SERVICE INSTITUTES*

(Staff Study).

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Table of Contents

PREAMBLE

1. The United Nations Development Programme (UNDP) and the United Nations Industrial Development Organization (UNIDO) have embarked upon an assessment of selected industrial research and service institutes (IRSIs) in order to determine their impact on the national industrialisation process. Although the number of IRSIs in the world has not been established during the course of the study, it is known to be very large. The majority of them is to be found in the industrialized developed countries. Some of the IRSIs in developing countries have now been in operation for approximately 10-20 years and practically all of them have received some kind of external assistance. The UNDP/UNIDO programme of assistance to IRSI started in 1961 and, in some cases, complemented bilateral efforts. In most instances, UNDP/UNIDO were requested to strengthen operations already under way. This study is aimed to ascertain the effectiveness of the multilateral assistance and the performance of the IRSIs which have been the recipients of such

2. IRSIs and their contiguous governments, as well as the United Nations system and other international agencies, are concerned in respect to the actual versus the potential role of the IRSI in the development process and are seeking means to bring about improvements. The importance of the present study rests on the fact that it follows a series of seminars, workshops, expert panels and consultant's reports sponsored by the United Nations system and others oriented towards the amelioration of IRSI problems or the improvement in IRSI operations which were identified from past explorations of their effectiveness and their successes and failures. While no single model or methodology could evolve from this study to match the needs of all IRSIs in developing countries, there are nonetheless lessons to be learned from an exchange and analysis of experiences. Older established IRSIs could benefit from knowledge of solutions devised by other similar institutions to common problems; newly established IRSIs could profit from an understanding of the experience of others; and governments of developing countries in the earliest stages of industrial development who may not have an IRSI may benefit by being in a better position to assess whether the expenditures required for an IRSI are warranted in terms of their potential impact on the industrialization process of the country and, if so, make better use of past experience in planning their establishment.

3. It is important to note that the historical industrial development of the industrialized countries did not require the presence of IRSIs. These countries did not have the advantage of national IRSIs to assist during the industrial revolution and the resulting technological advancement that came about. For the most part, IRSIs did not exist until shortly after the 1940's when it was realized that the concept of concentrated and oriented research and development required for the war effort might be equally applicable to further industrial development in contrast to R+D activity carried out by universities or private enterprise.

4. Historically, the concept of R+D in developing countries was tied to agricultural research. In the early part of this century, agricultural IRSIs were often established dedicated to the enhancement of agricultural production in order to meet needs of foreign markets and, later, to foster experimentation on specific crops and problems of the developing world. Some institutions were established for non-agricultural products, but in the majority of cases they provided basic services to larger industry and to governments and did not carry out R+D.

5. The industrialization process began in a large number of developing countries with their recent achievement of independence which in many cases began from 1950 onwards. There has been a growing realisation that if developing countries are to have political independence, they must have more technological self-reliance and thus, more control over their own economic development. In order to achieve these broad aims certain inputs are required: namely, financing and technology. The acquisition of either financing or technology (interrelated as far as technology is concerned), requires mechanisms for providing (1) supporting services, (2) extension services, (3) training, and (4) R+D. Thus, as a consequence of development, it has become necessary to have these four components in the infrastructure of developing countries to varying degrees in order to obtain, maintain and improve the required technology. An IRSI, by design, has been thought to contribute in some significant measure to each of these components.

6. However, the concept under which IRSIs were initially established, whether agricultural or industry-oriented, was not for the purpose of building a capacity—a capability—for technical self-sufficiency within a certain period of time. Other alternatives have been and are being used — to buy technical assistance outside the country, to import technology and to rely on foreign investments for industrial development. These approaches are being seriously questioned in some instances and different means are being sought to meet the national needs for establishing internal technological capability and capacity to support the industrial development effort.

7. In order to create such national capability, there is need for the existence of an effective technological infrastructure which includes not only the IRSI, in one form or another, but also the other elements of the development process-the government entities concerned, the public and private sectors, the development banks and the universities. Such an infrastructure, if functioning properly, can bring the total resources of the country to bear on the process of industrialization.

8. In this report, an assessment has been made of those factors which influence the functioning of the IRSI as one component of the necessary infrastructure in a developing country. As a result of the evaluation of the UNDP/UNIDO assistance to IRSIs in developing countries, suggestions are made aimed to improve their operations, effectiveness and impact on the industrialization process of these countries, as well as identifying major issues of concern which need further exploration.

9. The report is structured after an introduction into three parts. Part I is essentially the evaluation of UNDP/UNIDO assistance. Part II contains suggestions on the establishment and improvement of an IRIS. Part III reflects the recommendations of the study and the major issues identified in need of further discussion.

INTRODUCTION

Purpose and Scope of the Evaluation Study

10. The UNDP Governing Council at its 24th session in June 1977, requested that "In order to maximize the effectiveness of the United Nations system, the Administrator should, in full co-operation with the Participating and Executing Agencies, further develop existing functions of planning, appraisal and evaluation of operations of this kind carried out under UNDP Programmes, to consolidate them into a comprehensive system of analysis and feedback, so as to ensure the optimal use of resources and flexible system of programme management suited to each particular circumstance." In accordance with this decision, the UNDP and UNIDO agreed to carry out a joint evaluation study of industrial research and service institutes (IRSIs) with a view to assessing the effectiveness of the assistance which has been provided to member governments in this area.

11. The specific purpose of the study is: (a) to review and assess the effectiveness of UNIDO/UNDP assistance to industrial research and service institutes in developing countries in relation to the given project immediate objective; (b) review and assess the impact of these institutes in the development of the country; and (c) to determine to what extent these and similar institutions have played or can play a constructive role in the transfer and adaptation on the one hand, and development on the other, of suitable technologies in the industrialization process.

12. The ultimate purpose of the study is to provide the UNDP, UNIDO and the developing countries an opportunity to review the direction and relevance of their current and projected activities in this area, with particular reference to the potential role of IRSIs in technology transfer and adaptation on the basis of the analysis made of selected projects. The evaluation results will be used in the formulation of policy and programming guidelines through the preparation of programme advisory notes to field staff and developing countries.

13. The scope of the study is confined to industrial institutes which were purported to have a major research and development component regardless of whether they are multi-purpose in functions or multi-branch in coverage. Thus, the study excluded institutes that are designed essentially to provide certain specialized services such as quality control and standardization. The study also drew on the experience of several successful IRSIs which have been set up without the assistance of the UN system.

14. The study is essentially a process of looking into experience on the basis of technical co-operation projects as a group, rather than an appraisal of projects individually for the purpose of taking corrective action. It also involves an analysis of the results of past and on-going special studies, expert group meetings and other activities bearing on the role of IRSIs. In other words, although selected projects are reviewed individually and form the basic building blocks for analysis, the primary concern is not one of wanting to improve the project as such, but rather to form a broad idea as to the relevance and effectiveness of UNDP/UNIDO projects in industrial research in general and the potential

role of IRSIs in the industrialization process of developing countries.

Methodology Employed and Its Limitations

15. The study was undertaken in three principal phases: a desk review or preliminary analysis; visits to selected developing countries and IRSIs for in-depth analysis; and a final phase which included both a synthesis of the findings by the evaluation participants and a review of the staff report by a high-level group including representatives of UNDP, UNIDO and the developing countries. A synoptic display of the evaluation methodology employed is shown in Annex I.

16. The evaluation exercise cannot be described as truly scientific, fully objective, or necessarily representative of most IRSIs in developing countries. In the first place, the inventory and the selected samples for Phases I (desk reviews) and II (missions to developing countries) is necessarily limited to UNDP-funded and UNIDO-assisted IRSIs which are only a portion of the total universe. A further constraint is the lack of sufficient, relevant, and objective data upon which to base an assessment of UNDP/UNIDO effectiveness. On the vital question of impact, there is an unresolved difficulty both in defining the term in a general sense which takes into account the variables concerning different IRSIs and in designing a feasible methodology for identifying, tracing, measuring, or otherwise assessing the causal variables with defensible data. Also, by its very nature, an exercise of this type tends to overemphasize the problems and remedial measures required rather than fully recognize the successes achieved in the actual project or IRSI.

17. Nevertheless, and in consideration of these very important qualifications, the exercise is considered to be a comprehensive attempt to assess IRSIs based on their <u>actual</u> performance, and it is believed that the findings, conclusions, and suggestions included herein reflect <u>real</u> and <u>critical</u> problems which face <u>most</u> developing country IRSIs.

Definition of the IRSI

18. The IRSI is only one desirable component of the infrastructure for a country's industrial development. Other components include government entities, development banks, the universities, and the public and private sectors. For the purpose of this study, an IRSI is defined as a multi-purpose technological institute which provides services either to a group of industrial sectors (multi-branch) or a single sector (mono-branch), <u>and</u> which has a major research and development component. It is recognized that nearly all IRSIs will provide basic services to a varying degree, depending on industry needs, but not as a sole functional activity.

19. Industrial institutions (IRSIs, development banks, government entities, etc.) in a developing country normally have as their primary goal the promotion of the national economic policies and strategies and/or the servicing of industry needs itself. A UNIDO paper* further defines for the IRSI specifically, the purpose which establishes the

* James P. Blackledge, "Analysis of Selected Documents Relating to Joint UNDP/UNIDO Evaluation Study of IRSIs", UNIDO/EX. 70, 22 January 1979- particularly an unpublished paper by L.F. Biritz, dated December 1975 on "Industrial Research Institutes".

overall policy orientation of the institute and the functional activities as these related to staff and work organization. The following terms will be used throughout this report:

Policy Objectives

20. * "The first objective of most institutes must be the improvement of existing industries. This is accomplished by providing a variety of technical services to industry, as needed and requested. Such services include: the provision of technical information; chemical analysis and physical testing of materials and products; extension service to industry, such as plant trouble-shooting or improving plant layout and productivity, etc.

* "The second objective, and in the long run the most important one perhaps of an R+D institute, should be to lead the way and provide assistance in the transfer of technology . . . . The . . . role of industrial R+D institutes (multi-purpose or specialized) is of particular importance in: providing technological information; introducing technology by demonstrating it; training industry personnel in the new technology; and providing continued technical services and research and development work for maintaining and further developing the transferred technology.

* "The third objective of an R+D institute is the adaptation of technology to meet local requirements, thus rendering it 'appropriate' to existing needs.

* "The fourth objective is to develop new technology if it does not exist, or if development is the preferred route instead of transfer because of economic or other considerations.

* "The fifth objective, that in some instances can often be the predominated one, is research and development for industrial utilization of local raw materials and natural resources. This type of R+D work often involves the adaptation or development of new technologies and therefore is closely interrelated with these."

Functional Activities

21. * "The first type of functional activity of an institute is to provide supporting services carried out at the institute itself. Typical activities of this type are: chemical analysis of samples; physical testing of products; technical information; economic evaluations; and in the case of some institutes, the preparation and issuance of industrial standards, quality control and certification testing.

* "The second type of functional activity entails the provision of extension services to industry, including: trouble-shooting; process improvement; process rationalization and industrial engineering; quality improvement; etc. Such services are provided on-the-spot and are classified as extension services as long as they do not require appreciable laboratory experimentation or direct institute facilities backup.

* "If laboratory experimentation becomes necessary, it falls into the third type of functional activity, namely reserch and development, usually oriented towards: product development; process improvement or development; materials research and development; and application research and development. Such laboratory experimentation can range from relatively minor support work for particular extension service activities, all the way to long-range R+D work.

* "The fourth type of functional activity is the training of industry personnel. This activity is aimed always at either improving the existing technology level of the country's industry (e.g., quality control training) or introducing (i.e., transferring) new technology."

22. Many of the functional activities may be included under one or more policy objectives. For example, analysis and testing might well benefit an existing industry and also be important in studies of utilization of raw materials. A trouble-shooting extension service could result in the introduction of new technology to the country, thus resulting in a technology transfer activity. "What is important is that the nature of the work or activity is always clearly recognized by the institute's management in order to identify as early as possible anticipated difficulties and to plan the inputs, work and financial support accordingly."* It is of course evident that not all policy objectives and functional activities indicated above are necessarily required in any one IRSI, particularly for recently established ones. On the other hand, a well established multi-purpose and multi-branch IRSI would in all likelihood require most of them.

Facilities and Capabilities

23. It is not possible to describe a uniform model for an IRSI. The level of development varies greatly from one country to another. Some developing countries have established institutional infrastructures for industrial development to varying degrees. Other countries have neither appropriate development infrastructures nor industrial development policies or plans.

24. An IRSI, can be conceived in terms of activity modules. An activity module is defined as a unit which will perform a specific task or tasks within the IRSI. Examples are: management, administrative services, technical information, promotion and industrial liason, shops and services facilities, R+D laboratories, analysis and testing laboratories, etc.

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* "Industrial Research Institutes - Organization for Research, Technical and Commercial Services", a UNIDO sales publication, 1975 (E.75.II.B.9).

An activity module involves the following elements:

* Premises
* Equipment
* Professional staff and technicians
* Work routines
* Marketing functions

25. Management and administrative modules require special consideration, including:

* Organization
* Personnel functions
* Office routines
* Project management

26. Technical activity modules must include:

* The identification of the potential industries and government agencies which will use the module's services and ascertain the present and future demand for such services.
* The definition of the module's role as compared with similar or related institutions already in existence or planned for the future.
* The preparation of a development and growth plan for the module, related to short-term activities as well as to long-term projected opportunities.

27. The core of the IRSI is of course its professional staff. The most important element of it is the senior management, usually a group of three or four key individuals including the managing director. The IRSI governing council or board has a membership which includes both industrialists and government officials who participate in the affairs and decisions of the Institute.

28. Finally, an IRSI contains certain physical facilities and space which vary greatly in size, function, and quality, but most typically include office space, laboratory and pilot plant buildings and equipment, training rooms, library space and technical documents, journals, etc.

PART ONE

EVALUATION RESULTS

CHAPTER I

General Assessment of UNDP/UNIDO Project Assistance

29. The review of UNDP/UNIDO project assistance started with an inventory of all projects of assistance to IRSIs since the inception of UNIDO in 1967. There were 110 such projects corresponding to about one hundred institutes. From this total, UNDP and UNIDO jointly selected a sample of 26 projects/institutes which seemed of particular interest in the framework of the evaluation exercise. According to a pre-designed typology, profiles were then written relating to the selected institutes, each containing a description of the institute, the project, and a preliminary assessment of the effectiveness of the assistance and the impact and potential of the institute based on materials in the files. For reference purposes, profiles for two more institutes which had not received any UNDP/UNIDO assistance were included in the sample. In order to check or verify the findings of the desk study, eight projects/institutes were selected from among those in the desk sample for further in-depth analysis by way of field missions. Due to circumstances beyond the control of UNDP/UNIDO, one field mission had to be cancelled so that the field investigation ultimately covered seven projects/institutes including one IRSI which had not received UNDP/UNIDO assistance.

A. Project Inventory and Descriptive Data

30. The statistical and descriptive data included here are intended to illustrate the magnitude of the effort as well as the worldwide distribution of the technical cooperation projects. These data are based on the inventory of projects completed in October 1977, and have not been updated. Even so, the orders of magnitude remain essentially unchanged. The 110 projects in the inventory represented a total UNDP contribution of nearly $55 million. On the basis of the UNDP contribution involved, the projects can be distributed between small and large-scale assistance using the UNDP terminology by which all projects below $150,000 are classified as small-scale. In the inventory, 42 percent of the projects were small-scale but accounted for only three percent of total UNDP expenditures. At the other end of the scale, 20 projects costing over one million dollars each, accounted for more than half the total UNDP contribution.

31. For purposes of this study, four regional classifications have been selected, namely 1) Africa, 2) America (or the Americas), 3) Asia and the Pacific, and 4) Europe and the Middle East. The projects were distributed in the following manner: 14% in number in Africa, 21% in America, 24% in Europe and the Middle East, and 44% in Asia and the Pacific. The heaviest concentration is in Asia and the Pacific which is also by far the most populated region. Both for Africa and Asia, the distribution is primarily towards large-scale projects as indicated by a percentage UNDP contribution larger than the percentage number of projects. For America, Europe and the Middle East, the distribution is primarily towards small-scale projects.

32. If one is considering the least developed countries (with a GNP/head below $400/year) as distinguished from the ones above this figure the distribution of projects is oriented towards larger projects in the poorer areas and towards smaller projects in the more developed countries.

33. At the time the inventory was compiled (October 1977), 51 projects were completed and 59 were still on-going. The distribution of completed versus on-going projects according to size indicates a tendency for the monetary level of project assistance to become larger which is undoubtedly related to world inflation. The same distribution according to the recipient areas shows a definite tendency in favour of the poorer areas (as defined above) both in number of projects and UNDP contribution.

34. Three main types of institutions have been considered: 1) multi-function and multi-branch, 2) multi-function and single-branch, and 3) single-function and multi-branch, such as packaging, design or technical information. Just over half of the projects have been directed to multi-function, single-branch institutes (especially in metallurgy, electronics and textiles), about 40% multi-function, multi-branch institutes, and less than 10% single-function multi-branch institutes. Relative percentages indicate that the average project for a multi-function single-branch institute is larger than the average project to a multi-function multi-branch institute. A more detailed breakdown of the statistical data related to the inventory is shown in the statistical tables of Annex II.

B. Analysis Based on Project Profiles

35. The desk sample included 26* cases involving 31 IRSIs and 31 technical assistance projects. Some of the projects had two phases. In one case one project is related to six institutes. In some other cases, two or three projects are related to a single institute.

36. It should be noted that 19 of the 31 IRSIs included in the desk analysis existed prior to the UNDP/UNIDO assistance. The other 12 IRSIs included in the sample were designed or at least established with UNDP/UNIDO assistance. Thus, while institution-building was intended to be a major component of project assistance, in reality there was little or no opportunity in over half the cases to affect in a significant way the IRSI structure or its policy objectives, priorities, and functional activities. In these instances, the measure of effectiveness must be considerably constrained. It should also be noted that most projects were prepared according to now-obsolete project design concepts and formats. New procedures** have since then been developed which will ensure a better design of projects with emphasis on project outputs and their utilization.

* 5 additional IRSIs which did not receive UNDP/UNIDO assistance were included in the sample for comparison purposes but were not included in the analysis of "effectiveness".

** Chapter 3400 of the UNDP Manual of Policy and Procedures (1 December 1975) plus Guidelines on Project Formulation (15 September 1976).

Many of the findings and conclusions in this section therefore refer to shortcomings which occurred before the introduction of the new procedures and for which remedial measures have already been taken by UNDP and UNIDO in order to avoid such shortcomings in the future.

Project Design

37. Development objectives are understood as the higher level objectives or problems which the projects were supposed to impact on or otherwise ameliorate. Considering the general characteristics of these objectives, it was found that the development objectives were sometimes not even mentioned in the project documents (5 cases), or remained vague (6), or were too broad or high level (6). In less than half of the cases (12) they were couched in sufficiently specific terms.

38. Typical examples of vague or broad objectives were those which referred to "strengthening industry", "hastening the process of economic growth", "contributing to industrial development through industrial research", "assisting existing industries and/or establishing new industries", "providing technical services for the attainment of national industrialization objectives" etc. In some cases, the development objectives were confused with project objectives or with the IRSI policy objectives, particularly when the old format used attempted to differentiate between long and short-range objectives, for instance, "long-range objective of the project is to establish an industrial information centre to hasten the process of economic growth".

39. Specifically-worded development objectives would mention the particular development or industry problems which the projects were intended to solve or ameliorate. For instance, "improve the quality of (specified) industrial products in order to make them readily acceptable on the export markets", or "dispense with foreign assistance in the normal operation of existing cement plant and the utilization of cement". It was found that development objectives were usually more specific for projects relating to single-branch institutes, presumably because the problems were already well defined by the industries concerned.

40. Development objectives or their equivalents were most commonly linked to: ameliorating problems of industry (16 cases), especially through quality control; strengthening existing industries (11 cases); and utilization of local materials (9). In some instances, reference was made to import substitution (6), or creating new industries (6). Fewer cases were related to increasing employment (3), increasing export earnings (3), small/medium-size industries (2), or improving income distribution (1). Development objectives can fit several classifications and be implicitly related to others. For example, the development objective of strengthening existing industries is at least partially related to ameliorating industrial problems. Admittedly, the above is sometimes based on inference, since, as has been mentioned earlier, the development objectives were often vague or not even stated in the project document. In such cases, the writers of the profiles attempted to identify the development objectives on the basis of other evidence.

41. A development hypothesis is understood as the causal relationships or linkages between a project's immediate objective and national or regional development objectives. Reasonable hypotheses were found to be stated explicitly in eleven cases, and implied but easily recognized in eleven other. In four projects, no reasonable development hypotheses could be surmised, the project design being unclear as to what was intended to be accomplished. An example of a vague statement is "the project is expected to assist the government in strengthening the centre's overall capabilities in the provision of desired technical services to both the industrial community and appropriate government organizations for the attainment of national industrialization objectives".

42. Targeted beneficiaries or clients were identified in eleven projects. For instance, one project was directed to the major export industries of "timber, meat, vegetable oils, essential oils, hides, skins, cotton", another one to "the existing polymer plants", still another to "the pulp-and-paper industry". In five other projects there were some vague indications as to who the beneficiaries might be. In one regional project the beneficiaries were clearly identified by country but only vaguely by industry. Impediments were identified more or less clearly in 12 projects, and in vague terms in eight other ones.

43. Most of the projects have been institution-building (24 cases) and in ten cases also included direct support to industry. There also were two experimental projects and one project indirectly involved in institution-building simultaneously with six institutes. One project was of a preparatory nature.

44. The cross-project analysis indicated a tendency to include too many objectives in projects, thus spreading project activities and resources too thin, with the result that the project objectives were more difficult to achieve successfully. A typically over-extended project had for objectives to develop capabilities and give direct support in: carrying out technical services for all industries, adapting imported technology to local conditions and materials, conducting techno-economic studies of industrial projects, undertaking analysis and testing for all industries and all products, and establishing a technical information service. In several cases such shortcomings in design were corrected at least partly in the course of implementation through the efforts of either the UNIDO project manager or the IRSI manager. In most of these cases, however, the changes in project design involved the scheduling and composition of inputs and did not change or define the project logic except for limiting the number or extent of the immediate objectives when necessary (note - these objectives are sometimes more accurately described as outputs). In the example mentioned above, the objectives were only partly attained. In another example, out of three main objectives, one was deliberately dropped in order to achieve the other two.

45. End-of-project status indicators were supplied in only ten cases, and in very vague terms in five of those. Baseline data, i.e., conditions at the beginning of a project, was provided in only one case. Critical assumptions regarding actions outside of the project but necessary for successful achievement of its immediate objective were stated in seven

cases. The absence or deficiency of this type of data makes an objective evaluation of actual against intended results exceedingly difficult and almost impossible without a field mission. In only one case was a terminal review explicitly scheduled.

46. Project hypothesis and outputs refers to the assumption that the expected project results (i.e., outputs), including the work programme necessary to produce them, will successfully achieve the project's immediate objective or function. Projected work programmes and expected results were, in many cases, too ambitious in relation to available time and resources. Inter-relationships among outputs, work programmes, and inputs were either loose or unrealistic. In only six cases were outputs clearly stated in the PRODOC but they could be inferred in general terms in most cases. In either case they usually lacked specification. Outputs, when stated, were reasonably although sometimes loosely related to the project function and immediate objectives in 21 out of 26 cases. However, the same outputs were found to be reasonable in terms of proposed work programmes in only half the projects.

47. Activities, tasks or work programmes have not been described or presented in a very uniform or systematic way in most of the project documents reviewed. Work programmes in some instances have been very detailed. In other cases, they were very brief or administratively-oriented events and the details were left to be worked out by the project managers. Work programmes were assessed to be reasonable, in terms of time and resources available, in 12 cases. In many cases, the lack of substantive detail made it very difficult to relate the planned work programme to the expected results.

48. Inputs were most often described in considerable detail but were not usually directly related to (a) complementary government inputs and (b) the work programme planned to produce outputs. Combined with the lack of specific outputs, a targeted work programme, and the absence of end-of-project status indicators related to baseline data, it was sometimes difficult to determine on what basis the quantity and quality of input was requested.

Preparatory Missions

49. There was no preparatory mission assistance in ten of the 26 UN-assisted projects in the analysis. In five cases preparatory missions were not needed because the projects (4) were continuations of Special Fund projects or (in one case) resulted from the amalgamation of another UNDP-funded project with a previous UNIDO project. In the remaining five cases, preparatory assistance was either deemed to be unnecessary or was provided in writing by UNIDO headquarters.

50. Preparatory assistance took the form of field missions in 16 cases. The missions focused principally on formulating projects and preparing project documents. In four cases, "problem diagnosis" was specified as the main objective of the missions, and in two other cases

the objective was a "survey of demand". Some missions had two or three specified objectives. The missions varied in duration from a few days up to three months (excluded here is longer preparatory assistance which was part of the project and which might itself have been preceded by another mission). It is commonly thought that preparatory missions, more than any other elements of project design, can contribute to the success of a project. It was found, however, that some projects proved to be inadequately designed and failed to yield the intended results although they were preceded by preparatory mission assistance, which indicates that preparatory missions may fail to be useful when not well planned and when their terms of reference are not carefully and clearly established.

Problems in Implementation

51. Among the implementation problems, those most often reported were delays linked to deliveries of UNDP or government inputs. On the UNIDO/UNDP side, there were delays in recruiting experts (nine cases), fielding project managers (four), shipping equipment (four), placing fellowship candidates (eight). On the government side, there were delays in appointing counterparts (five), appointing the IRSI director (two), and providing buildings and facilities or equipment (five). Delays by the government in nominating qualified fellowship candidates must have occurred but were not reported in the profiles. No implementation problems were reported in four of the 26 projects in the sample.

52. Other implementation problems have been either rare or seldom reported but include: marginal qualifications of expert in relation to job; inadequate training of fellows; misunderstanding of expert's role in relation to project function; UNDP financial crisis; inadequate leadership. Insufficient on-the-job training was not referenced, although this must have occurred when delivery delays threw work plans out of sequence. In one project, the desire of the government to take over the project management created implementation problems which, in itself, is evidence of the "role" problem between international experts and national counterparts. In another case, difficulties in leadership occurred at the project level because of poor personal relations between the project manager and the IRSI director. In one case, the deficient leadership of the IRSI director was apparently a problem.

53. As a general statement, it can be said that the principal problems in project implementation were caused by delays in providing inputs by both the government and UNDP/UNIDO. Other implementation problems were either infrequent or, more likely, simply not formally reported and illustrate the value of on-going, comprehensive evaluations.

Project Results

54. Most projects were intended to establish or strengthen IRSIs or portions thereof. The project purpose was largely institution-building although some projects included direct support, through IRSIs, to industry. Out of a sample of 20 cases relating to completed projects or completed

first phases, it was found that in six cases the intended project results were largely obtained as planned taking into account some imprecision in project design. In nine cases, delays occurred which did not have any appreciable or discernible effect on the ultimate success of the projects. In the remaining five cases, intended results were only partially or marginally obtained.

55. Some projects were not accomplished as planned, particularly when the objectives of the project and the IRSI itself were undistinguishable. The reasons behind this lack of accomplishment can be partially traced to an overly ambitious design which included too many objectives and activities in a short period of time; consequently, some activities were not initiated or completed. Another reason for obtaining less than adequate project results was the inability of the IRSI to start or continue operations due to lack of government funding, incomplete facilities, lack of human resources, and/or lack of demand. Finally, the expected results or outputs were not always expressed in institution-building terms, e.g., a specified level and quality of service capability, but were more often expressed as the outputs or services rendered by the IRSI itself, i.e., its work programme.

Preliminary Assessment

56. Analysis of the desk profiles by a joint in-house working group and the principal consultant in Phase I suggested that the effectiveness of UNDP/UNIDO assistance, i.e., the successful achievement of a project's immediate objective(s), was very good in nearly 40 percent of the cases, good to adequate in another 40 percent of the cases, and marginal to poor in the remaining 20 percent of the cases, including one failure. From this analysis, it is clear that UNDP/UNIDO assistance was weakest in project design, including clarification of the development hypothesis and specification of intended results (outputs), but acceptable in implementation. Given the lack of verifiable indicators, etc., and the fact that in many cases UNDP/UNIDO was not requested to give advice on the role, policy objectives, structure, and priority functional activities to be provided by the IRSIs, at best this assessment of project effectiveness is subjective and incomplete, particularly in individual cases, but most probably reasonably accurate in the aggregate.

C. Verification of Findings through Missions to Selected IRSIs

57. It was recognized in the design of the evaluation exercise that the results of a desk review would not be sufficient by itself to base an assessment of UNDP/UNIDO effectiveness in providing quality and relevant assistance to IRSIs. Therefore, a Phase II was developed which included visits to seven institutes located in Africa, Asia, the Middle East and Latin America. Of these, six had received UNDP/UNIDO assistance, three projects were on-going and three were completed at the time of the missions. Pre-mission questionnaires were completed by the cooperating IRSIs, with the help of UNIDO Senior Industrial Development Field Advisers, and team members were provided with interview schedules, reporting formats and assessment factors in an effort to make reporting and assessments as

consistent and objective as possible. The resulting reports and assessments varied considerably in quality and completeness, and the attempt to make meaningful comparisons was somewhat frustrated by the lack of a universal set of standards (aggravated by the absence of pre-mission briefings) and the different contexts within which individual projects and IRSIs operate.

58. Approximately two months after the completion of the field missions, all participants reassembled at Spiez, Switzerland, to compare results and reach a consensus on critical findings and appropriate conclusions and recommendations. During these sessions, it was possible to verify many of the findings of the desk study and their implications. While the assessments in individual cases may be based on insufficient data or different interpretations of the standards to be applied, in total it is considered that an accurate picture has emerged with reasonable validity.

Project Formulation and Design

59. It was clearly demonstrated that UNDP and UNIDO efforts, and the host government's receptivity, were weakest in this critical measure of effectiveness which was assessed as fair to good in the composite. As already mentioned, some of the problems resulted from a lack of adequate project design guidelines when many of the projects were originated in the sixties. The findings also reflect, to some extent, the lack of appreciation on the part of all parties concerned of the difficulties and timeframe required for institution-building and the role to be played by international agencies. Finally, they also reflect the enormous difficulties in creating or strengthening an IRSI in developing countries, the success of which is affected by many factors outside of the control or even influence of the IRSI management and any project of technical cooperation.

60. The more important findings which are considered verified by Phase II investigations include:

* Development objectives in most cases were either not clearly identified in the PRODOC, were at the macro-level, or were otherwise vague or non-specific.

* The justification of a project (development hypotheses) in which the causal relationship or expected impact of a project on a higher level objective(s) is explained was not explicitly stated in most projects. It is more difficult to express for multi-branch institutes and in the absence of any exploratory mission for ascertaining industry problems, needs, and actual and potential demand for services.

* Projects often cover too many objectives, which causes confusion as to the purpose and function of a project and results in work programmes or activities which are spread too thin. While this shortcoming in design was corrected

by either the IRSI director or project manager in three of the IRSIs visited, in two cases this condition at least partially contributed to reduced project effectiveness and expected impact.

* The lack of clear project immediate objectives which are distinguishable from the objectives of the IRSI itself, the absence or lack of specification of expected results, and the general absence of baseline progress, and end-of-project status indicators, was not appreciably clarified by the additional documentation provided to the field missions.

* Detailed work programmes depended to a large extent on the preferences of the IRSI director and/or the project manager and were not prepared in a uniform or systematic manner. They were not usually directly related to the expected results in terms of institutional capabilities but were more often related either to the services being provided by the IRSI or to the delivery of inputs. Again, this deficiency in planning and documentation has been sometimes overcome by alert managers, as demonstrated above in the cases of design shortcomings, but it does point to a weakness which may not be entirely corrected by the new UNDP project procedures.

* In three of the projects visited no preparatory missions had been performed, although in the case of one of these, an on-going project, the associated small-scale assistance project might be considered as a preparatory or initial phase for the purpose of clarifying the objectives and defining the project design. In a fourth, on-going project, preparatory assistance involved reformulating a project transferred from another agency, but the mission had little or no influence on the choice or definition of the functions of the centre and of the objectives of the project. For one completed project, there were several missions to identify the needs and problems relating to the development of scientific and industrial research, but it was not clear just what effect, if any, these preparatory missions had in formulating the recommendations for an institutional framework which would lead to the most effective carrying out of appropriate industrial research. In the sixth UNDP/UNIDO-assisted project, preparatory assistance was extended under the form of (a) an exploratory mission which helped in formulating the project and (b) a fact-finding mission for studying the industrial market demand. Though this preparatory assistance provided some useful indications of industry needs, it did not clarify all of the issues. The survey of industrial demand revealed large requirements in basic services which the subject IRSI could not handle, while it provided little guidance as to what the purpose and policy of the institute should be in the circumstances.

* The marginal usefulness of most preparatory missions as constituted was confirmed by the field missions. In only two projects were attempts made to identify problems, survey industry demand, or provide advice on the role, policy objectives, and functional activities to be performed by the IRSI. In both cases, the preparatory missions reported their findings to the governments but did not, or could not, work as part of, or advisory to, a government team established to make such an analysis.

* There was little indication that governments and IRSIs understood or felt the need for advice on these matters but, rather, they looked to such missions merely to help them prepare a project document that will be acceptable to UNDP.

Project Implementation

61. The composite field mission assessments of UNIDO implementation judged by: (1) the quality and timeliness of UNDP/UNIDO and government inputs; and (2) project management and backstopping; ranged from good to very good. It is significant, however, that other than delays in delivery of inputs and occasional problems with the quality of inputs, e.g., expert qualifications, adequate training programmes, etc., other implementation problems were rare or seldom reported. In the case of the three on-going projects visited, interviews revealed that indeed there were or had been important implementation problems of a substantive nature but they had not been a feature of tripartite reviews or headquarters' reports. With this general qualification in mind, the field missions also provided verification of the following general findings:

* Most reported implementation problems involved delays in the delivery of inputs. This caused some work programme problems, e.g., when equipment needed by experts already in the field was delayed, but none of the IRSIs visited indicated that such delays caused any serious or durable harm.

* Nevertheless, the supply and training of qualified counterparts has obviously been a major problem. In at least two cases, the supply of qualified counterparts was a limiting factor, and in several projects visited, on-the-job and practical training was a major problem. There were several reasons for this, e.g., late or early arrival of experts in relation to counterpart completion of out-of-country training, limited knowledge of foreign languages, failure to initiate on-the-job training either in the IRSI or industry, etc. Since skill composition is the most important ingredient in the building of institutional capacity, staff development was obviously a key factor in determining success in the projects reviewed.

* At least in the case of institution-building projects, some major problems involving project design, work programmes and industry needs were not revealed by the existing reporting and review requirements.

Project Results - An Assessment

62. In the three completed projects visited, the field missions assessed project results and their relevance to the project function of institution-building as good to very good. One of these projects was considered very successful in terms of delivering equipment and training local personnel but less so in so far as creating actual demands by industry for IRSI services. In another case, it was noted that the project significantly enlarged the institutional capacity of the IRSI in terms of equipment, trained staff and working procedures. Although a number of those trained with fellowships were no longer with the IRSI at the completion of the project, most of them were still active in their fields of specialization in important positions in industry or the government where they were contributing to the industrial development of the country. In the third project, the mission verified that the project resulted in: (a) the expansion of facilities for experimentation, instrumentation, fabrication of pilot plants, technical information, and sectoral analysis; (b) amplification of training facilities within the IRSI; and (c) increase in the nation's stock of scientists and technologists experienced in applied research, some of them having moved to manufacturing industry thereby augmenting the nation's industrial capability.

63. Of the three on-going projects, one had started too recently for the mission to make any significant assessment of results to date. For one of the remaining projects, the results were found to be very modest in terms of establishing a workable and functioning institution, capable of dealing with industry's needs and demands. Though the project was successful in delivering and installing the needed equipment, the training of counterparts by fellowships and experts has been disappointing, so that the IRSI can only fulfil certain functions and still at a low level of activity. It was recognized that the marginal achievements of this project were largely due to constraints on autonomy, financial resources, personnel policy and other factors beyond the control of the project and IRSI management.

64. As concerns the third on-going project, the results were assessed as very good to excellent. The project has been very effective in building up the capabilities of the IRSI and permitted it to get contracts from industry and to be recognized as a valuable organization for technical information, services and research.

65. The findings of the desk analysis regarding the problems in defining and recognizing project results in terms of institution-building were verified. In only one project, moving into a second phase, were attempts being made to define expected results in meaningful capability terms. Nevertheless, in Phase II it was possible to arrive at some

general assessments regarding success, though, because of the lack of objective or verifiable indicators and clear statements of expected results, as already pointed out these assessments were largely subjective and empirical, i.e., based on the expert judgement of the field mission team members and the opinions of the government and recipients of UNDP/UNIDO assistance.

D. General Conclusions

66. In terms of the efficiency of UNDP/UNIDO technical cooperation, i.e., the quality and timeliness of the inputs supplied, the desk and field reviews did not reveal any unusual problems of major magnitude. Delivery delays, caused by a variety of factors internal and external to the project, occurred, but they were not unduly harmful in the opinion of the recipients. Project management and backstopping were most often adequate or better.

67. A general conclusion on the effectiveness of UNDP/UNIDO assistance is more difficult to arrive at and support. This is chiefly due to two reasons. First, effectiveness has been defined as (a) producing the intended results - or outputs - and, (b) the extent that these results successfully achieve the immediate project objective, i.e., the confirmation of the project hypothesis. Overloading a project with too many objectives, and the general failure to specify outputs restricts this type of analysis.

68. The second reason concerns IRSIs themselves. While theoretically it is possible to provide effective assistance to an IRSI which itself may be ineffective (in the manner of an operation being successful but the patient died), a meaningful measure of effectiveness should also include an assessment of the utilization of the created or strengthened capacities by the intended beneficiaries or clients, viz., industry and government. It is for this reason that the evaluation study is also concerned with the relevance, performance and impact of IRSIs.

69. Keeping these limitations in mind, the desk and field reviews indicate that the effectiveness of UNDP/UNIDO assistance to IRSIs has, with few exceptions, been at an acceptable level and, in some projects, can be described as very good. At the same time, UNDP and UNIDO have not had much success in influencing governments on the type of an IRSI to be created or strengthened, its sectoral coverage and its policy objectives, functional activities, or in developing strategies and plans for institutional growth, staff development and extension of services.

70. The problems involved in providing technical cooperation to IRSIs, while unique in every situation, are often present in one form or another in almost all projects reviewed. Some of the more important shortcomings identified include:

* The failure, inability or lack of opportunity to work with and advise competent authorities on the need for an IRSI (or component thereof), industry problems and actual or potential demand for services, policy objectives, strategies, etc., before a request for assistance is set in concrete.

* Partially as a consequence of the above, uncertainty as to how the successful completion of a project is intended to impact on a higher level objective or industry problem.

* Project design and documentation which do not clearly state the institution-building function of a project, distinguish the project objective from the IRSIs objectives, specify the intended results of project activity, and provide baseline data and verifiable indicators of progress, completion and success.

* Work programmes and budgets which are not related to expected results of the project.

* Lack of effective programmes for staff career development, including on-the-job training and practical experience in industry and staff exchange with other IRSIs.

* Absence of reporting on problems and impediments to producing expected results (outputs).

71. On the other hand, technical cooperation assistance to IRSIs has generally been successful, in varying degrees, in achieving the following:

* Strengthening the IRSIs receiving assistance. However vague the notion may be, this effect was felt even for projects the results of which could be considered marginal or failing below expectations. In some cases, IRSIs were started and their activities initiated thanks to technical cooperation projects. Though some of the IRSIs thus created fell to low levels of activity after the completion of the projects, others are performing reasonably well.

* Provision of equipment for laboratories and experimental or pilot plants which otherwise would not have been available. With few exceptions, the equipment thus provided has been profitably used for services, research and training in the recipient IRSIs.

* Provision of training facilities: either on-the-spot training with the experts or training abroad with fellowships. This important contribution has been recognised by the recipient countries which only complained about slowness in the placement of fellows.

* Introducing highly relevant research and other functional activities, e.g., providing cotton fabrics with soil resistance, fire retardency and permanent crease characteristics; quality control on steel production; and multi-IRSI research programme on development of new fibres and composites.

72. Moreover, in several cases, UNDP/UNIDO assistance prepared the ground or otherwise made possible additional assistance or co-operation. In one case the UNDP/UNIDO project acted as seed money in attracting bilateral support of the IRSI, with the bilateral contribution expected ultimately to equal the UNDP input. In another case, the UNDP/UNIDO project facilitated a twinning arrangement between the recipient IRSI and another IRSI in a developing country. The arrangement has been very successful and the benefits to the recipient IRSI can be directly ascribed to the UNDP/UNIDO project.

73. In many cases the success and results of UNDP/UNIDO assistance were limited by factors pertaining to IRSI management or, more often, to the constraints within which the IRSI had to operate. That is why, the effectiveness of UNDP/UNIDO assistance cannot be assessed in a vacuum, but is also dependent on the performance of the very IRSIs it is intended to assist.

74. The analysis suggests that UN intervention might have been more effective if it had been requested when an IRSI was still in the planning stage, rather than later when government plans had materialized and it was difficult to introduce changes. Hence the importance of preparatory missions or even, at an earlier stage, of advisory missions to coincide with the government's preliminary planning for the purpose of defining more clearly the actual need for an IRSI and the functional activities it will have to perform in accordance with the national development objectives and its own policy objectives.

CHAPTER II

General Assessment of Relevance, Performance and Impact of Selected IRSIs

A. The Role of IRSIs and their Relevance to Development

75. An analysis of the desk profiles and field mission assessments in the evaluation sample revealed that statements of the role or overall purpose of an IRSI -- as related to specific development objectives, sectoral priorities, industry problems, government needs, or the needs of intended beneficiaries -- are in most cases either non-existent, extremely vague, or simply statements of the intended sector coverage and/or the functional services to be provided. Where such statements did exist, they were apt to be more precise in countries in a more advanced stage of development or where the concern is with more than the provision of basic or routine services to industry. They were also more specific where an IRSI's coverage is single rather than multi-branch.

76. Some truncated examples of IRSI statements of purpose which did provide specific guidance to the institute include the following:

* Increase production volume, share and quality of special grades of steels in product mix;
* Improve blast furnace operations;
* Develop new processes for alloy and for product development;
* Provide technological assistance (basic services) to small and medium-scale industries in the public and private sectors of priority industries;
* Perform research in industrial materials and processes to pilot plant stage for improving nutritional quality and processing of foodstuffs, improving use, production and quality in wood, textiles and ceramics (i.e., indigenous materials).

77. Examples of statements which were vague or at such a macro level to provide little or no guidance to IRSI management included the following:

* Contribute to industrial development;
* Stimulate process of technological development in industry and assist priority industrial sectors;
* Contribute towards self-sufficiency.

78. In nearly every developing country visited, the government policy objective is to decrease dependence on foreign technology and to increase indigenous technological capability to develop needed technology. The national industrial development plans (where these exist) usually recognise this need, and a variety of measures, incentives, and constraints are being considered to affect this desired change.

79. This evaluation has shown that governments either do not know how to use their IRSIs effectively in policy and planning development, or that IRSIs have not prepared themselves properly in order to be able to provide assistance to their governments in this respect. With few

exceptions, IRSIs have not taken an aggressive position in urging and convincing their governments to accept them as active partners in planning development. While it is recognized that such activities are not often directly defined as a part of the IRSI mandate or charter, it is nonetheless evident that such assistance is in consonance with the policy objectives under which most IRSIs operate.

80. Where governments have recognized the importance of IRSI participation in the planning process the results have been highly satisfactory. The IRSIs in these countries participate in the process of choosing and adapting imported technology, and are thus more capable of developing indigenous technology suitable to their needs.

81. While the overall purpose of an IRSI is seldom articulated at its creation or early stages, and specific objectives are not delineated, it proved possible, in most cases, to infer the policy objectives being pursued by examination of an IRSI's subsequent work orientation. Based on such secondary sources of information, results were as follows:

Policy Objectives	Number of IRSIs	Percentage of sample
Improvement of existing industries	28	100
Utilization of indigenous materials	24	86
Transfer of technology	24	86
Adaptation of technology	24	86
Development of new technology	23	82
Development of new industries *	8	29

Almost all the IRSIs contained in the sample are concerned with the improvement of existing industries and the utilization of raw materials while only a small minority are concerned with the development of new industries. However, the importance and significance of the activity being carried out under transfer and adaptation of technology, as observed during the field missions, was marginal.

82. Out of the 33 IRSIs in the sample, 17 are multi-branch in coverage. Single or mono-branch institutes usually concentrate upon services and adaptation of raw materials and on new, usually imported, technology. On the basis of reporting by the IRSIs themselves, it was found that: (a) under supporting services, all the institutes were dealing with analysis and testing, most with the provision of technical information, and many with techno-economic studies though often marginally; (b) in extension services, most were dealing with product quality and improvement; (c) in research and development, most IRSIs were dealing with process development and improvement and materials research development; and (d) very few were involved in industrial training. Many IRSIs were created to serve small and medium size industry but in practice this sector often shows neither an interest in nor appreciation for R+D. While many of the IRSIs in the sample have research in their name, most are primarily service organizations.

* The most common activities under this classification involved technical and economic opportunity studies.

83. Other functions covered by most of the sample IRSIs included quality control and certification, trouble-shooting at the plant level, process improvement, process rationalization, product design and development, and application development. About half of the institutes reported provide assistance to national economic planning.

84. While only the occurence of the above-mentioned functional activities and not their intensity or quality was reported, the very ooverage itself suggests that most IRSIs are trying to do too much, too quick with too little.

85. An IRSI, particularly if multi-branch, newly established, and dependent upon general government subsidies, needs more precise statements of government policies or plans on technology and industrialization, and some indication of how its sponsor, usually the government, expects it to contribute to carrying out such policies and in helping to plan objectives and sector or functional priorities.

86. The orientation and the development of an IRSI is expected to be responsibe to the country's national development plans, policies and a set of priorities. Of particular relevance would be the guidance provided by a formulated national science and technology policy or plan. However, science and technology is often an embryonic process in many developing countries and the various agencies involved in its promotion do not always constitute, in the aggregate, a coherent and articoulated pattern of organisation. Linkages are characteristically insufficient between institutes charged with the promotion and development of new industry and those responsible for the support of existing industry. According to one observer*, the process of coordination is more often left to chance.

87. These plans, moreover, have not usually identified the requirements or provided the inputs for articulating science and technological strategies. In addition, most development plans are expressed in financial terms without translation into industry needs. In the absence of the latter, difficulties arise in deciding whether technological inputs should be imported or obtained from the domestic sources; or which technical inputs are appropriate from the point of view of resource use, basic consumption needs, and environmental effects. There is a wide and positive acknowledgement of the need to integrate the IRSI into the national development planning process but the operationalization of it seems to be low. In many cases, neither the government nor the IRSI management clearly understands what the contribution of an IRSI can or should be.

88. However, in four of the seven IRSIs visited, there is a relatively well defined technological institutional infrastructure, either in the form of a Ministry of Science and Technology or a national organization charged with the responsibility for coordinating the national science and technology policies and programmes. The position of the IRSIs in such cases is usually more clearly defined giving them a good opportunity to interact with ministries and other government agencies in all sectors of the economy.

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* V.G. Desa "Research Coordination and Funding Agencies in Developing Countries", Impact of Science on Society, UNESCO, Volume 28, No. 2, 1978.

89. There was little evidence to indicate that most IRSIs were created or strengthened to meet an identified need, respond to a specific demand or become part of a coordinated approach towards industrial development. In the absence of substantial evidence to the contrary, it can only be assumed that in too many cases, IRSIs have been established without adequate prior planning and guidance and recurring monitoring of their effectiveness. As later portions of this report will indicate, where an IRSI is close to industry, as is more often the case with single-branch institutes, or gets a good portion of its work from contract or other directed sources, this deficiency can be overcome. In other cases, however, the lack of such continual guidance has been a major contributing factor to the marginal performance of some IRSIs.

90. In the final analysis, the impact and therefore the success of an IRSI must be related to the services that it renders to its intended clients. In the case of single-branch IRSIs, the intended clients are usually quite clear. However, with multi-branch industries, the client (e.g., cottage and small-scale industry, medium or large, textiles and food processing, public or private) is sometimes not so clear or explicitly stated. IRSI surveys of industrial needs and requirements conducted at an early stage were indicated in 54% of the IRSIs included in the sample but these were usually performed by UN experts or the UNIDO project managers with only 36% of the IRSIs conducting recurring surveys themselves. Given the frequent failure of IRSIs to attract clients, these results tend to confirm the conclusion that IRSIs and government sponsors do not attach sufficient importance to identifying and declaring the proposed beneficiaries at the planning stage. Only one IRSI included in the field missions used this practical approach in a thorough manner with significant positive results.

91. An assessment of the relevance of IRSIs to national development objectives, government policies, programmes and perceptions, and industry problems and needs, was made only on those IRSIs visited because of the lack of objective data available in the project files. The composite relevance assessment by the field mission teams was highest in connexion with national objectives and lowest in reference to specific industry needs. Or put in another way, the relevance of IRSIs was assessed as highest in terms of macro or vague development objectives and lowest in terms of specific industrial problems.

92. In two out of the seven IRSIs visited, there was in existence a national science and technology plan which provided a framework of policies and national priorities to guide the IRSIs' work and, in these instances, the relevance was judged high. In few of the countries visited, however, did the industrial institutions form a cohesive system for carrying out an envisioned development and research programme for industry. Obviously, in those cases where a development plan, complemented by a science and technology policy, does not provide specific guidance for industrialization, and/or the institute has not been provided with or developed on its own a statement of policy objectives and priority activities, assessments of relevance must be made purely on a subjective basis. However, the very absence of these factors throws doubt on the relevance and significance of many of these institutions, particularly when considering the broad area of functional activities which are claimed.

B. Planning for Institutional Development

1. Strategy for Growth

93. Many of the problems, delays and failures which impede the institutional development, maturity, and viability of IRSIs can be traced to a lack of adequate planning and an assumption that, given a certain quantity of inputs, e.g., buildings, laboratories and staff, a successful and relevant institution will automatically be produced in a short period of time. While it was impossible(from the material made available to the field missions or in the project files) to study an actual statement of an IRSI's strategy and multi-year plan which were either non-existent, written only in the national language, or not otherwise available, an attempt was made to ascertain the growth strategy employed on the basis of actual services supplied or claimed. It appears that the private sector is the focus of emphasis by almost half (16) of the IRSIs included in the sample although most claim to provide services to both public and private enterprise and 11 are involved almost exclusively with public entities.

94. IRSI growth strategies tend to be more easily defined or explicit for single-branch IRSIs where the intended client industry is quite clear, a substantial amount of their work is converted by contract, and with industry often paying a substantial amount of its financial support either directly or through assessments. Multi-branch, and to a lesser extent, multi-purpose IRSIs, on the other hand, find it more difficult to attract clients and the critical efforts needed to sell itself and develop relevant skills are often ignored at the strategic and tactical planning levels. This lack of client clarification is obviously more serious when an IRSI's funding is almost totally derived from general purpose government grants or subsidies. However, experience in countries in all stages of development including the most advanced shows that it is not easy to attract and retain clients and, therefore, neglecting this problem in institutional planning is a most serious shortcoming.

95. Even when initial planning is undertaken, these plans often emphasize reaching a static goal instead of planning for gradual development and rarely include: a timetable for completing the various plant facilities; the development of service capabilities; staff recruitment plans for gradually moving into more advanced work; plans for shedding off activities which have become routine; and, finally, machinery for reviewing and adjusting objectives and plans based on experience and opportunities. In only a very few institutes of the multi-branch type, was there a discernible decision to reach a professional level in a few selected fields before expanding into other areas. This requires an appreciation of timing and an innovative role rather than a passive reaction to industry or development plans.

96. Only in a few instances did the data available indicate that serious attention was being given by the IRSI managers to the choice of problems to attack, e.g., market research, surveys of known technical problems, and subsequent development of a research strategy based on these decisions. In the case of government research institutes, or IRSIs whose funding is largely from government subsidies, the evaluation of research results and their utilization as well as the abandonment of non-productive research do not receive enough attention.

2. Autonomy, Organization and Management

97. The desk analysis shows that 14 IRSIs were classified as government (civil service) agencies and nine as government corporations. Eight were separately incorporated, among which some were cooperative centres established with industry. In practice, the distinction between a government corporation and a civil service agency is often difficult to discern. In this situation, IRSI managers are either reluctant or find it difficult to exercise the few flexibilities granted them and as a consequence the IRSIs were often plagued with poor management. The analysis also indicated that over half of the sample IRSIs have only poor to adequate internal administrative flexibility. The importance and pervasiveness of these problems were verified by the field missions. At the same time, laboratory and physical facilities were determined to be good to excellent in 89% of the IRSIs reviewed. The capability for repair and maintenance, however, was less adequate.

98. The problems found concerning administrative flexibility and management seriously affect the effectiveness of IRSIs operations and staff performance. Where strong civil service or similar government control exists, an IRSI frequently is unable to exercise sufficient discretion over its administrative policies and procedures. Flexibility for decision-making, combined with appropriate responsibility and accountability, is a rare combination for most IRSIs. While it is recognized that initially full autonomy may be neither desirable nor feasible, particularly where its funding is exclusively or largely government, government and/or industry sponsors must carefully examine in the planning stage the alternative means of providing, on an incremental and phased approach, adequate internal IRSI flexibility for effective operations. In the absence of reasonable flexibility, the functional activities carried out by an IRSI are much more apt to be routine and marginal rather than innovative and developmental.

99. In some cases, over-sophisticated or complicated organizational structures were observed which were beyond the capacity of the smaller institutes in the lesser developed countries to staff and were ill-suited to effectively utilizing the limited number of qualified officials available. Sections sometimes exist which are composed of a chief with little or no technical and secretarial support. Other IRSIs had developed elaborate interdisciplinary or matrix type organization appropriate for the sophisticated functional activities planned. In many cases, the traditional functional or discipline-oriented organizational units used in the industrialized countries were emulated. An integrated organizational and staffing plan, a major component of a strategy and plan for institutional growth, is missing more often than not.

100. The structure, organization and management of the 28 IRSIs in the desk analysis are appraised in the following table.

Institutional Capacity (Number of IRSIs)

outstanding = 5; poor = 1 *

	Ratings 5	4	3	2	1	Average Values
size of staff	5	8	6	6	3	3.2
skills composition	3	9	11	3	2	3.3
laboratories and facilities	3	11	11	2	1	3.4
administrative flexibility	0	13	3	6	4	2.8
management	2	14	4	4	4	3.2

Overall average value of institutional capacity=3.2

A similar analysis results from the mission assessments.

outstanding = 5; poor = 1

	A	B	C	D	E	F
management capacity	2	3	4	2	3	2
size and skill composition of staff	3	4	3	2	2	2
recruitment and staff development	3	2	3	2	3	1
equipment and facilities	4	3	4	3	4	3
programme and project management	3	2	3	3	3	2

Overall average value = 2.8

101. It is probable that the average value of rankings for the IRSIs in the field surveys is lower due to actual on-site assessment, whereas the desk analysis was based primarily on assessment gleaned from project

* The scale value in this and subsequent tables unless otherwise indicated, are as follows: 5-outstanding; 4-very good; 3-average; 2-fair; 1-poor.

manager and other reports and not as carefully checked. These assessments are also judgements applied by individuals whose standards of performance may be different and, certainly, the circumstances will be different. Nonetheless, the data does indicate that the IRSIs (based on average value) are only adequate in terms of institutional capacity.

103. The above described conditions related particularly to the choice of senior management. Dynamic directors and better IRSIs go hand in hand, and the survey indicates the reverse is also true. It is also apparent that there is a causal relationship between rankings for senior management and functioning of the IRSI governing council. The IRSI board of directors or governing council can play an important role in providing policy orientation and guidelines for functioning to the IRSI. Unfortunately, most governing councils tend to be more honorary than operationally oriented, so that the IRSI does not receive the guidance it requires in order to interact effectively with the government and with public and private sectors. In such instances, the IRSI director, either does not receive guidance and assistance in designing current and future programmes for the IRSI or is constrained in implementing such developmental activities by an ineffectual board.

104. It is important for government to participate actively in the IRSI board of management, but the analysis of IRSIs has shown that such participation is frequently remote. As a consequence, feedback to government concerning IRSI performance is usually inadequate for it to gain knowledge, except perhaps informally, of IRSI needs and problems and the suggestions for solutions for these which might contribute to better IRSI structure, organization, and development as well as to implement existing or improved national development policies or plans.

104. Industry participation in IRSI management and policy making was found to be considered marginal or, at best, less than desirable. In most cases, such participation consists of having one representative on the IRSI governing board, usually from the industry association. The analysis of IRSIs has shown that individual industrialists are members of IRSI boards in some instances, but usually their functions and responsibilities are unclearly defined and ineffective. Less than one third of the IRSIs analyzed report industry representation on their management boards only slightly more are involved in IRSI programme development. Therefore, industry has very little opportunity to participate, in a dynamic way, in the formulation of IRSI policy, short-term and long-term plans and priorities and in the implementation of these.

105. Industry representation with management boards is frequently more ceremonial and, in too many cases, government participation is primarily by civil servants who are almost exclusively concerned with financial or similar matters. As a result, insufficient attention is given to management and policy questions which take into account the interest and needs of the institute's major clients. With a few notable exceptions in the sample, most institutes receive 90-100% of their financing from government with only a minor proportion contributed by or earned from services to industry. This reliance on almost exclusive government financing, essential at the formative stages, provides little stimulation to the IRSI's growth and development, since government financial budgetary authorities usually discourage any growth possibilities by maintaining a

static financial input. Attempts to overcome these deficiencies by the effective participation of industry and government clients on the board of directors or governing council, and through the continued use of government and industrial representatives in committees which define priorities and review IRSI work programmes, are generally missing. Less than one third of the IRSIs analyzed report any industry representatives in their governing council with only slightly more involved in IRSI programme development.

3. Staff Development

106. While nearly all of the IRSIs have included staff development as a major component of technical assistance, less than half had a staff size assessed adequate to carry out its mission and the record was only slighly improved in terms of skills composition. Only four of the seven IRSIs in the field missions assessed their own staff size and skill composition as good or better and all the IRSIs visited believe that their recruitment and staff development programme are less than satisfactory.

107. In spite of the critical shortage of qualified staff in most IRSIs, plans to develop and expand staff capabilities are sometimes not suited to the real requirements or are simply non-existent outside of a bi-lateral or multi-lateral technical co-operation project. The importance of staff development is not sufficiently recognized at the inception of the institute. While academic or technical qualifications are often judged as good to excellent, industrial experience is almost universally in very short supply. In the majority of the IRSIs included in the sample, no systematic or continuing effort is made for the development of staff through different modes of learning. To permit growth in practical experience, major emphasis seems to have been placed on overseas fellowship training of a formal or academic nature or, to a lesser extent, is often too much emphasis on academic degrees and knowledge acquired abroad with a subsequent lack of appreciation of the real requirements and problems of local industry. Supervised research was utilized in less than 50% of the IRSIs and only one third recognized, or were able to provide, opportunities for local in-plant or industrial training.

108. While over 36% of the sample IRSIs claim staff development vis-à-vis twinning arrangements with other IRSIs, it was not possible to determine in most cases the number of staff so trained or the quality and relevance of such training. In two of the IRSIs included in the field missions, however, a twinning arrangement through a sub-contract with a smaller institute, one from a developed country and the other from a developing country, was a definite part of a staff development plan and has yielded excellent results.

109. A serious problem also appears to lie in the absence of training opportunities for sub-professionals or technicians who are urgently needed to permit optimum use of professional capabilities. The same problem exists for management personnel.

110. A most important problem discussed in almost all the field mission reports is the difficulty of the institutes to attract and retain qualified staff because of non-competitive salary level with industry and in the absence of other incentives, particularly career development opportunities. The ability to plan and effectuate a staff development career programme which includes adequate financial and professional incentives is obviously more difficult where the IRSI is a government unit with the traditional constraints established by a civil service system. A plan for overcoming or ameliorating these problems must be a critical part of an IRSI's strategy and growth plan.

4. Finance

111. The main sources of IRSI financing were found to include the following:

* Government subsidy of annual operating budget;
* Government grants for strategic research;
* Sale of IRSI services (to government and industry);
* Industry assessments or other grants;
* International and bilateral assistance.

The desk analyses revealed that 39 percent of the IRSIs obtain less than ten percent of their annual operational costs from fees/contracted services. The data are particularly skewed in this direction by the inability to determine the annual level of contracted income for 12 IRSIs or 43 percent of the sample (although this is probably also less than ten percent). On the other hand, 14% (i.e., 4 IRSIs) obtain more than 50% of their annual operational costs from contracts. If the 1977 income data for the six IRSIs which received UNDP/UNIDO assistance visited by the missions is examined, it is found that approximately $24 million in collective income, less than $11 million or 6 percent results from contracts with industry and government and fees for services.

112. <u>While many IRSIs have been established with the objective of financial self-sufficiency, it is apparent that the majority of the IRSIs have not been successful in this respect</u>. It is interesting to note that the four IRSIs who receive more than 50 percent of their annual services from contracts and fees have between ten and twenty years of experience. The seven IRSIs visited by missions reported as income from industry contracts in 1977, a collective total of $5,404,000 (approximately 20 percent of the collective gross income), of which almost $4,900,000 was received by one IRSI only, leaving $504,000 for the remaining six (less than four percent of their gross income). It is not known whether this amount represents the face value for contracts undertaken over a period of more than one year. It is also not clear whether this amount also includes routine services; usually such services are <u>ad hoc</u> and not normally contracted for. The income distribution for the seven IRSIs is shown in the following table.

113. The operational expenditure per worker is not to be construed as an average salary. However, in a very qualified sense, it represents staff costs. In some cases, the low staff costs reflect the difficulties of obtaining experienced staff or competing with industry. For example,

INCOME AND EXPENDITURES IN 1977 (1000 $U.S.)

	A	B	C	D	E	F	G
Number of employees	101	104	132	262	444	431	946
Institute Income in 1977:							
Subsidies and grants from government	420	451	-	no data	1,605	8,231	416
Contracts with government	-	-	339	-	-	12	6,519
Contracts with industry	50	-	132	-	162	163	4,897
International assistance	-	155	111	-	-	117	-
Bilateral assistance	-	-	-	-	-	-	-
Other	-	-	218	-	95	48	1,236
Total	470	606	800	1,300	1,862	8,571	13,068
Institute Expenditures in 1977:							
Operational	418	289	786	625	1,201	3,677	12,041
Equipment and Facilities	52	160	14	300	256	3,570	3,168
Other	-	-	-	-	126	-	500
Total	470	449	800	925	1,583	7,247	15,709
Operational Expenditures per IRSI staff member	$4,138	$2,778	$5,954	$2,385	$2,705	$8,531	$12,728

in one IRSI approximately 50 percent of approved staff positions have only been filled during the course of its existence. In two other IRSIs, staff salaries are believed to be more compatible (although not equal to) with those of industry.

C. Performance of IRSIs

1. Functional Activities

114. Functional activities are broadly categorized as supporting services (chemical analysis, testing, quality control, standards, etc.); extension services (trouble-shooting, process improvement, quality improvement,) research and development (process improvement or development, materials research and development, etc.); and training of industry personnel. Given the priority assigned to improvement of existing industries and the utilization of indigenous materials, the study has found that the most important functional activities are concerned, at best, with process improvement using existing technology or, at the minimum, very basic services such as testing, analysis and quality control.

Supporting Services

115. The analysis shows that the major contributions of IRSIs to governments have been through the provision of various supporting services. The most significant and relevant services include technical information, analysis and testing, establishment of standards, quality control, and, in some cases, certification of products. IRSIs sometimes engage in the identification and preparation of industrial projects and technoeconomic studies, especially at the opportunity and pre-feasibility level, which are required for national economic planning. Utilization and application of indigenous raw materials are of prime interest to governments. Thus, it is not surprising that analysis, testing, technoeconomic surveys, etc., of raw materials are undertaken on behalf of the government by the majority of the IRSIs. Such information is valuable in the establishment of national industrial development plans, and could be equally valuable to private enterprises which currently utilize imported processed materials in its production process. Examples are numerous -- kaolin for ceramics production, industrial chemicals, synthetic fibers, etc.

116. The principal support services provided by IRSIs to industries, however, are in the area of routine services, including chemical analysis and physical testing (80 percent of IRSIs), and technical information (46 percent). Less frequently, services are provided in quality control, certification testing, and industrial standards (71 percent) and in technoeconomic studies (32 percent). Of the seven IRSIs interviewed during the field missions, five self-assessed their ability in supporting services as good or better.

117. Several IRSIs, however, are involved to a minimal extent in services for analysis and testing, quality control, etc. One IRSI in the sample, based on the realization that the demand for these services is so great that their provision would overwhelm institutional staff and capacity, restricts them to industries where there is a potential to

conduct a follow-up R+D project. For example, routine metallographic analysis and mechanical testing of forged steels is expected to lead to an R+D project on development of forging dies which are currently imported. Similarly, mechanical-chemical tests on the products of a cutting tool company led to more complex research work on production of the cutting tools. These services are thus used as a demonstration of competence and establishment of goodwill.

118. Another IRSI initially undertook routine testing and analysis but this service declined as industry established internal capability to undertake its own testing. Also, the priorities of this IRSI are now being directed more towards government-supported R+D and away from service to industry as other national institutes become established and can provide industry services. Still another IRSI is largely R+D oriented, and conducts routine services for industry only to a limited extent. Other government departments and institutions are much more highly qualified to do analysis and testing.

119. It is unlikely that many of the IRSIs in the sample have thought seriously of following the example cited above of providing routine services with the view of developing follow-on R+D contracts. There are, of course, practical considerations which vary from country to country. If no other source exists for such services, the IRSI usually has an obligation or is mandated to provide these services. Nonetheless, IRSI staff and management need to be alert to the potential for converting routine services into R+D services.

120. The provision of technical information is of utmost importance and yet only 40 percent of the IRSIs provide technical information services to an appreciable extent. All seven of the IRSIs surveyed during the field mission stated that their technical information services were satisfactory, however, the number of industry information requests per year appear to average less than 100 per institute. In the majority of instances, IRSIs lack knowledge regarding collection and dissemination of technical information. This service is not a library function; skill is required to tap data bank resources. Additional skill is required to prepare and analyze technical information in a way that it will be useful to the end-user. Dissemination of technical information to industry can become the important first step in developing interaction with the industrial sector.

121. A systematic study of technologies locally available and upgrading these technologies by the application of modern science and technology know-how can be an important element of IRSI activities. However, there seems to be only limited evidence that IRSIs are involved in this form of activity to any appreciable extent. Notable exceptions were found in two countries which have tried to upgrade and improve small village technology and with some success.

Extension Services

122. <u>One of the weaknesses of IRSIs in developing countries is the lack of effective and appropriate industrial liaison and technical extension activities</u>. IRSI staff cannot develop such interaction only

through publication of reports and in the isolation of their laboratories. Furthermore not all scientists and engineers are interested in or capable of developing good industrial contacts or promoting their institute's capabilities. At the same time, particularly in some civil service type institutes, the table of organization makes no provision for such industrial liaison expertise, and institutes dependent on major funding from external sources have been reluctant to assume, as an overhead item, the costs incurred from such activities.

123. Awareness of this need has been expressed in a number of publications, reports of seminars, workshops, etc. In 1972, WAITRO conducted a survey of the priority needs of approximately 80 member IRSIs*. IRSI management perceived, as highest priority, needs having to do with identification and understanding of industrial problems and the promotion and selling of technical services. The other documents cited below, similarly, refer as a most important consideration the need for increased and improved industrial liaison. And yet, IRSI performance in this all important functional activity continues to be marginal.

124. The desk analysis of the 28 IRSIs indicated that approximately 70 percent of the IRSIs included extension services (problem-solving, process optimization, quality improvement, etc.) as part of their growth strategy. But IRSI reports have not shown much if any actual involvement in industrial liaison. Only two of the seven IRSIs in the field analysis self-assessed their ability to perform technical extension services as good or better. The desk analysis showed that 50 percent of the IRSIs had adequate to poor industrial linkages; 25 percent were classified as marginal to poor in this respect. Five of the seven IRSIs visited by missions were assessed as having made fair to poor contributions to industry. The same five IRSIs indicated a need for better industry linkages as one of their requirements for improving the performance of their institute.

125. Small and medium-scale industries hold the greatest potential and need for technical extension assistance, but usally these industries do not have the ability to pay for such services. Such industries suffer not only from lack of technical assistance but also poor management and insufficient financial support. Usually, these industries are unable to recognize the nature and extent of their problems. Nonetheless, developing country governments are interested in strengthening and expanding their indigenous industrial base. Therefore a concerted effort is required to provide suitable financial mechanisms to undergird technical extension assistance.

126. This problem has been solved in one country visited by a lump-sum payment from the government to the Small and Medium Manufacturer's Association. Thus, extension services are paid in part from such a fund which enables multi-disciplinary IRSI teams to undertake problem-solving and other services for small industry. Similarly in another country, a government scientific institution maintains an industrial liaison unit which visits small industry on a frequent basis, solving some problems on the spot, and referring other problems (along with appropriate funding) to a university or technological institution, including IRSIs.

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* "Priority of Needs of Industrial Research Institutes In Developing Countries", Publication No. 3, World Association of Industrial and Technological Research Organizations, Vancouver, Canada, pp 2-3, June 1972. See also UNIDO documents ID/WG.233/21, 31 January 1977; ID/WG.246/6, 9 March 1977; ID/WG.238/25, 28 April 1977.

127. When IRSIs can find no other mechanisms for funding or forming a technical assistance function, it is often possible to establish collaborative agreements with national productivity centres who deal frequently with small-scale industry as was observed in still another country. In this manner, the IRSI capability to provide service can be expanded, and IRSI knowledge of appropriate technology or adaptation of technology can be transmitted to the end-user through the staff of the productivity centre. While it may seem that this is not necessarily the best arrangement, it does provide a mechanism for service by the IRSI to industry. Unless an IRSI can obtain qualified technical extension staff, this mechanism may prove to be more effective.

Research and Development *

128. The visits made by the missions determined that there still is a belief the R+D services of IRSIs will be automatically sought by the industrial sectors. Therefore, governments have visualized that results of their research institutions would be directly and immediately applicable to the nation's economy and contribute to the:

* Exploitation of internal natural resources to replace or reduce imported raw materials or commodities;

* Substitution or replacement of imported technology, which would strengthen the existing national industrial base;

* Creation of new processes, products or technologies from which would stem a number of new industries capable of meeting country domestic needs, increasing employment, and contributing to increased export commodities into the world market.

129. Nearly all of the IRSIs (86%) in the sample included bench-level research in their early activities. However, four interpreted their mandate such that providing services to industry is the principal objective and regarded research as a topic to be undertaken at a later date; that is to say, these IRSIs recognize the ultimate need to undertake R+D but prefer to focus their activities at first on services to industry. Pilot scale activity was indicated in the majority (57%) of the IRSIs but reporting is subject to a serious problem of definition and the extent to which such activities have been actually pursued as reported in the desk reviews is open to some question. While no clear data is available, it is probable that actual use on a continuing basis is marginal, particularly for general purpose pilot plants, although the 14 single-branch IRSIs make frequent use of their pilot plants.

130. Where a definite R+D programme was stated, the objectives were usually clear but the expected results and plans for achieving them were often unrealistic and over-optimistic. Generally speaking, innovative research was included in the research strategies and programmes of IRSIs in the larger and more developed countries, seldom in the smaller and

* R+D is a composite function which usually includes bench-level research as well as pilot plant, and semi-commercial plant operations for experimentation based on scaling up.

less developed. Such research is valuable if planned in terms of staff development -- to familiarize them with and to find applications for advanced technology, to develop new products and processes, new uses for locally produced components and for raw materials, etc.

131. In the absence of demand pressure from industry for R+D, the growth of scientific activity is often random and rarely interdisciplinary. In these conditions, local demand is often replaced by the perception of the individual scientists (which, in the case of IRSIs, surface as in-house projects) with the result that the research output is unlikely to have appreciable economic or social pertinance to a country's problems. This is compounded by poor institutional capabilities for evaluating research projects and assessing their findings for economic and development implications. IRSIs are sometimes unequal to the task of examining national plans concerning priorities among the technological choices to be made. There is often a similar lack of technological competence on the part of industry to appreciate and absorb technology developed in IRSIs. Many industries do not have the entrepreneurship or ability to establish and manage the projects based on domestic technology or are unwilling to take the risks perceived with "unproven" technologies without special assistance, guarantees, or soft loans.

132. Of the seven IRSIs visited, six conducted bench-level R+D and pilot scale operations, although to varying degrees. Five of them self-assessed their ability in R+D as good or better. It is relatively easy to conduct R+D in a laboratory or pilot plant; the problem arises when the IRSI attempts to commercialize, i.e., apply, the research results. IRSI staff generally do not have the capability to take research results into commercialization.* Thus "in-house" R+D without direct inputs and contributions by potential end-users, will have no commercial relevance at all.

133. Nearly all of the IRSIs in the sample derive a major portion of their annual income from government subsidies or grants and R+D, therefore, tends to be "in-house". Unless IRSI management and staff are acutely aware of the real development problems (vis-à-vis industrial liaison and technical extension services, for example), benefits to industry and thus to the national economic growth are not likely to occur. As discussed in another section of the report, this argues strongly for industrial representation on the IRSI governing council and the use of standing or ad hoc industrial committees to oversee and evaluate IRSI R+D projects.

134. This is not to say that "in-house" research is inappropriate or undesirable. A number of the IRSIs included in the evaluation have used this approach to advantage in increasing the capacity and skills capability of IRSI staff. Further, in-house research has given balance and stimulation to research staff who are otherwise involved primarily in supporting services. In some cases, properly directed and oriented in-house research has led to commercially viable products or processes.

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* See UNIDO/EX/64, the Commercialization of Research Results, Joaquin Cordua, 18 December 1978.

Examples include:

* A protein-enriched tortilla flour process, sold to a foreign country;

* A texturized vegetable protein process developed and licensed to a foreign industry;

* Mechanized production of Gari, with two 10 t pd plants operating, one 25 t pd plant under construction, and three paid licensees;

* Beverage distillation from palm wine with 20 units sold;

* Kaolin refining for ceramics being used in local tableware manufacture;

* Commercialization of 17 processes ranging from industrial chemicals to food processing: An additional 17 processes or products are in various stages of commercialization.

135. There is a startling difference between the commercialized research results of the IRSIs mentioned above, each of which has more than 20 years of operational experience. The most successful IRSI in this respect is in a more highly industrialized country and entrepreneurs for risk capital financing of research results are more numerous. At the same time, with some 100 unsold processes or products in its portfolio, the IRSI has recognized the need to establish a technology development corporation, whose only function is to bring into industrial production the successful in-house research of the mother IRSI. The corporation participates with investment partners and industry in establishing the new company and provides technical and management assistance to assure successful start-up. Profits, if any, revert to the IRSI for support of additional in-house research. To date (since 1974), the corporation has been responsible for starting six new ventures and estimates that approximately four years are required to disengage from a newly started venture.

136. In consideration of commercialization of "in-house" R+D, it must be recognized that lack of interest on the part of local entrepreneurs does not necessarily mean poor IRSI management. However, IRSI management must understand that the <u>need</u> for new technology in the industrial sector does not necessarily relate to <u>actual demand</u>.

Training

137. The functional activity of training includes training of industry workers and presentation of technical industry seminars. The desk analysis indicates that 19 of the 28 IRSIs regularly provide seminars for industry on topical areas such as quality control, industrial sanitation, food processing, packaging and industrial process controls. Four of the IRSIs train industry workers in their laboratories, although the number of trainees appears to be limited.

138. It is interesting to compare the in-plant training and the training of industry workers in the seven IRSIs included in the field analysis (based on the pre-mission questionnaires). These figures cover the past five years, and include IRSI self-assessment of ability to train. (Favor to disfavor scale of 5 to 1).

No. in training	A	B	C	D	E	F	G
in-plant	0	0	0	20	0	10	15
in-IRSI	0	15	0	100	0	50	0
ability to train	2	3	5	4	1	2	1

139. <u>These results indicate that in general IRSIs do not fulfil a training function, either for Government or industry</u>. There is practically no in-plant training activity being carried out while the training within the sample IRSIs is very limited except for two of them. The trainee output is exceedingly low compared to the needs of the countries involved. It is also important to note that the ability to provide training is poor to fair. Thus the potential role that IRSIs could have is subject to significant strengthening of its capabilities with the concomitant financial implications. Tentatively, perhaps such training function might best be developed in other training institutions.

2. Maturity and Viability

140. The analysis shows that 61 percent of the IRSIs reviewed have been in existence for more than ten years and should have been well established. Twenty-five percent of the IRSIs have between five to ten years of experience. The data indicates, however, that while approximately 40 percent of the IRSIs are well established; only 11 percent are fully viable and adaptable, 36 percent are struggling but with good potential, while 25 percent of the IRSIs have serious problems and/or are close to failure. Of the eight well-established institutes, six have over ten years of experience. Of the 10 IRSIs still struggling, six have more than ten years of experience. Three of the four institutes with serious problems are more than 10 years old. The three IRSIs close to failure are all in the five- to ten-year experience bracket. The judgements from the desk analyses are summarised in the following table:

IRSI Maturity

less than five years	2	7%
five to ten years	7	25%
over ten years	17	61%
cannot determine	2	7%

IRSI Viability

fully viable and adaptable	3	11%
well established	8	29%
struggling but with good potential	10	36%
serious problems	4	14%
close to failure	3	11%

Institutional and Technical Maturity of Visited IRSIs
(rated on 5 to 1 favor to disfavor scale)

IRSI	rating	years experience
A	3	5
B	2	11
C	4	11
D	3	13
E	2	14
F	3	20
G	3	22

The average value for the seven IRSIs surveyed during the field mission is 2.86, which indicates that these IRSIs, on the average, are ranked between fair and good in terms of maturity and viability.

141. It may be inferred from these data that ten years is the minimum time required to assure that an IRSI will become well-established and viable. Time for maturation alone is, of course, not the only requirement for success. Note that the two IRSIs with serious problems are more than ten years old. All other elements of support--adequate government assistance, existence of appropriate technology policies, plans, and infrastructure, industry awareness and demand, IRSI capability and capacity related to need--are essential to the success of the IRSI. It can further be stated that the probability is strong than an IRSI will fail or have serious probleme during the first ten years of existence, unless the above support elements are provided. This does not mean that the IRSI will not continue to exist, particularly if it continues to receive outside financial support, but its usefulness in terms of contributions to national growth and development will probably be minimal.

D. Interrelationships With Government

142. As already discussed, in developing countries governments have a tendency or feel compelled to take the legal, administrative and financial measures necessary to establish IRSIs without having a full knowledge of the role, purpose, and objectives of such entities and without understanding or fully appreciating the long-term implications for continued

government guidance and financial support. Substantial funding for IRSI infrastructure and capital expenditures is usually provided through legislative measures, but after an initial start-up, provision of continued financing often becomes slow and erratic. Governments change, philosophies change, and it sometimes seems as if the IRSI has become a "stepchild," while other institutions more in favor or recently created receive new funding. Thus, older IRSIs frequently encounter serious difficulties in meeting their recurring annual operating budgets. This becomes an acute problem which will affect IRSI performance unless government has taken the steps necessary to encourage industrial utilization and financial support of the IRSI at an early stage of its development.

143. A high level of importance and expectation is usually attached to the creation of an IRSI, but the governments often do not or cannot provide sufficient political support and leadership. Industrial needs and requirements do change, of course, as a consequence of economic, social and political considerations, but this means that provision must be made, on a continuing basis, to assure that the IRSI strategy and services changes in consonance with these needs.

144. The analysis of field mission reports shows that, in four of the seven countries visited, very little has been done by the governments to establish fiscal and tax policies or other incentives to stimulate and encourage the business community, especially industry, to utilize more effectively and frequently the services provided by the institutes.

145. There is not too much reliable data on the characteristics of government interfaces regarding most of the IRSIs included in the desk analysis. However, the following table displays the relationships between the seven IRSIs included in the field surveys and their respective governments. The data are based on pre-mission questionnaires prepared by the IRSIs and field mission assessments.

146. When interviewing IRSI managers and reading their reports, the impression is gained that government entities are often indifferent to the needs and problems of IRSIs. At the same time, government officials often comment that their IRSIs are "think tanks" with little or no relevance to industrial development.

147. A few general observations derived from the study are pertinent to indicate some of the thoughts of government concerning their IRSIs. In general, the government subsidies to IRSIs are provided without a formal review of the work that these institutions have done. The review made of budget requests from IRSIs do, however, receive a very careful administrative scrutiny, particularly in terms of the different allocations that are being made. Once the allocations have been established, it is very difficult for IRSIs to change from one heading to another. The plans on which budgets are prepared are usually made one year or more in advance of actual requirements, making the IRSI an inflexible institution.

148. Some officials of government consider the IRSI to be a normal and continuing government expense which must be met. Having provided

Relationships with Government

Characteristic	A	B	C	D	E	F	G
Adequate autonomy	No	No	Yes	No	Yes	Yes	Yes
Contracts with government entities	Yes	No	Yes	No	No	Yes	Yes
Are government entities willing to pay?	Yes	No	Yes	No	No	Yes	Yes
Participation of IRSI in:							
Government planning boards	Occasionally	No	No	Yes	Yes	Yes	Yes
Science and technology commission	Occasionally	Yes	Yes	Yes	Yes	Yes	Yes
National plan	Occasionally	No	No	Yes	Yes	Yes	Yes
Government incentives for use of R+D	Yes	No	Yes	No	Few	Yes	No
Number of IRSI staff who took government positions	0	0	1	11	1	99	5
Did they help in improving relationships with government?	-	-	Yes	No	Yes	Yes	No
Assessment of IRSI: 5 to 1 favor to disfavor							
Interrelationships with government	2	2.5	2	2	4	5	5
Importance of contributions to government	1	1	2	3	3	4	4

Average value of assessment = 3.2 and 2.6, respectively.

the resources for it, there's not much concern about what is being done with it. On the other hand, there are others who feel that the government should gradually disengage from a financing responsibility. Government financing is felt necessary to start the institution, but as it progresses through its life it is considered essential for industry to take over the payment of this bill. Such a takeover is generally assumed to take place in a very short time, namely within three to five years of an IRSI's start, usually an unrealistic expectation.

149. Governments in general have taken few measures to stimulate the use and effectiveness of IRSIs. Not much thought has been provided by governments on this issue yet, on the other hand, the apparent satisfaction of governments on the performance of their IRSIs is generally not based on a real programme review of its operations but rather on a vague confidence in the people who make up the top management staff of the IRSI. This confidence, however, does not reflect itself in sufficient autonomy or operational flexibility for the institution. There are many administrative bureaucratic impediments which are placed on the top management of IRSIs so that their hands are in effect tied as far as shifting resources or addressing problems which have not been foreseen in their budget request. This lack of autonomy, however, does not necessarily mean that the government itself has very clear ideas which it can contribute in terms of certain priorities. In actual fact, many governments, if pressed, would be hard put to make decisions in reference to programmes and most often they have no substantive views concerning what IRSIs should do.

150. In the review carried out, there was one exception to this general situation. In this country it was found that the IRSI has a key formal and informal role to play with the government in terms of policy orientation. Yet it has complete operating autonomy on how to do its work and how to staff the institutions to achieve the required results of the country. In this case, the institution has had a most significant impact and has participated in the industrial development of the country.

E. Interrelationships with Industry

151. The definition of industry, from a practical point of view, includes all those enterprises providing manufacturing of goods for internal consumption and exports as well as those enterprises that provide industrial services. In this context, there have been innumerable attempts to classify industry into large, medium and small by utilization of parameters such as number of people employed, capital investment, etc. These definitions often vary from country to country. Nevertheless, there is a general national understanding of what are each of these three industry sub-categories without attempting to formalize any definitions for them. Small industry does not include handicrafts and could range in employment up to a maximum of approximately 50 persons, while normally it would average less. Medium scale enterprises probably range up to an approximate maximum of 200 persons, normally averaging less and large scale enterprises would essentially be above this figure.

152. Industry is also viewed in terms of those enterprises that utilize modern equipment and are thereby susceptible to the use of technology and methodology which benefit from the application of advanced science and technology. The traditional sector of industry utilizes equipment which is not necessarily modern but rather evolves from ingenuity and development of tools and equipment based on historical experience available within the country. It is from such traditional industry, however, that IRSIs have an opportunity to identify and adapt local technologies to improve the performance and productivity of the traditional sector.

153. Usually, industry has very little perception of IRSI actual and potential capabilities, except in the case of single-purpose IRSIs. In the least developed countries, industry has not developed to the extent that it is aware of or recognizes the need for IRSI functional services. Large scale and sophisticated industry in more advanced developing countries provides its own basic services and sometimes R+D, particularly if this industry is part of a multinational. Medium scale and national industry usually require basic services but have not fully appreciated the potential benefits of R+D. In countries where those products produced have a strong market and profits are good, only exceptional entrepreneurs are interested in making risk investments in R+D. In the absence of requirement or need for improved products, particularly for export, and of suitable government tax or other incentives for R+D, medium scale industry is not inclined to use IRSI services.

154. Small scale industry is often too geographically dispersed to make use of IRSI services. These entrepreneurs do not usually have the time or the means to avail themselves of IRSI services. More importantly, such entrepreneurs lack the conceptual understanding to analyse and recognize that they might have technical or scientific problems and therefore are not in a position to implement IRSIs results by themselves in their enterprise unless it is done for them. They generally expect to obtain a free service from the IRSI and are not prepared to pay for any results of work that the IRSIs might undertake on their behalf. Furthermore, small-scale industry is interested in practical nuts and bolts solutions and do not deal in the esoterics of development of science and technology. Such small scale entrepreneurs survive or grow based strictly on the growing market demand which may exist for their products in the absence of alternative competition from more efficient and modern industry which could supply alternative products of better quality and greater utility.

155. Industry in general is often reluctant to use IRSI services, other than for routine analysis and testing, quality control, etc., for a number of other reasons, including:

* Suspicion by private industry of the IRSI-government relationship;

* Lack of information about IRSI objectives and functions;

* Lack of confidence in IRSI knowledge and experience in industrial problems and competency on specialized industrial technology;

* Belief that the IRSI tends to carry out its activities in an "ivory tower";

* Belief that IRSI fees and costs are unreasonable (although industry is perfeotly willing to pay for other services such as attorney fees, promotion and public relations).

* Lack of IRSI appreoiation of the cost/benefit industrial motivation;

* Difficulty in obtaining firm IRSI commitments on delivery dates for services;

* Lack of IRSI response speed due to bureaucratic procedures.

156. The seven IRSIs interviewed during the field missions report a total of 2,000 industry visits per year (in 1977). It is not known how effective such visits have been since there is little comparative data in regards to the numbers of industry contracts resulting from such visits. Furthermore, there is no indication as to whether such industry visits were casual, designed to collect information, for the purpose of discussing potential projects, or were for the purpose of submitting proposals and/or discussing project results.

157. The characteristics of the relationships between the IRSIs visited and industry are displayed in the table on the next page (based on pre-mission questionnaires and field team reports). The judgements included in the desk analysis of the 28 IRSIs showed the following rankings for industry linkages whioh can be used as a qualitative measurement, with qualification, of the interraotion between IRSIs and industry.

Favor/Disfavor Scale

	1	2	3	4	5	3.1
	cannot determine, or very poor	limited marginal or low	good adequate	very good	high excellent very significant	average value
Nos. of IRSIs	3	7	4	11	3	

Given the generally marginal record at most IRSIs in securing industry contracts for signifioant services, the average value of "good" seems to reflect an optimism not yet realized in many institutes.

158. It is of interest to indioate some of the thoughts provided by industry representatives interviewed on the use that they might make of IRSIs in their respective countries. It was found that generally the

RELATIONSHIPS WITH INDUSTRY

Characteristics	A	B	C	D	E	F	G
Visits per year (number)	50	26	300	50	700	250	600
Information requests (nr./yr.)	10	no record	200	100	no record	30	no data
Surveys of ind. needs (yes/no)	yes	yes	yes	yes	no	yes	yes
Staff who went to industry	0	17	27	14	1	9	87
Staff recruited from industry	2	3	3	2	20	8	50
Staff trained in industry	15	0	0	no data	20	10	0
Industry staff trained by IRSI	no	15	3	no data	100	50	0
Equipment rental to industry	no	yes	yes	no	no	no	no data
Industrial clients:							
large-scale	8	few	10%	no data	10	2	400
medium-scale	10	most	30%	no data	100	30	100
small-scale	45	few	60%	no data	500	90	50
Assessment of IRSI: 5 to 1 favor to disfavor							
Interrelationships with industry	2	1	2	2	2	3	4
Importance of contributions to industry	1	2	2	2	2	4	4

Average values = 2.3 and 2.4 respectively

industry knowledge of the IRSI came about through visits of IRSI staff to the plants or, alternatively, to meetings they might have with the top management of industry.

159. In general, industry feels that IRSIs are too sophisticated and utilize a scientific approach to the solution of industry problems which is beyond what is required. In like manner, the industry considers the IRSIs to lack appropriate engineering capability. Thus, they tend to see IRSIs more as science centers than really practical engineering development centers. It is partially for this reason that medium and large scale industry usually prefer to use foreign consultants who they believe to be more effective, possess the know-how and knowledge to solve industry problems and who can deliver such services quicker than an IRSI. On the other hand, industry has found that it can work with IRSIs in technical industry committees oriented to the establishment of standards, quality control procedures and certification of products. These activities have been considered by industry as exceedingly useful for their operations.

160. Industry of the private sector does have some reservations on the utilization of the IRSIs since they suspect that their work could in some measure contribute to government regulatory activity for the industry. Understandably, industry is not too favorable to new government regulations and they usually prefer to be left as free as possible in their operations. The possible duality of role of the IRSI in serving government on the one hand and industry on the other presents a certain impediment for the industrialists who might otherwise have complete confidence in the IRSI. Generally, in those countries where IRSIs are functioning well, industry appears to agree that IRSI work is better oriented to larger development projects where the capabilities of the institutions are more effective.

F. Other IRSI Linkages

161. Besides interrelationships with government and industry, other linkages have to be considered. In the projects reviewed, these are principally with national universities and foreign IRSIs.

IRSI Interrelationships

162. Relationships with other institutes usually have three purposes: receiving technical assistance, extending technical assistance, or exchanging information if the institutes are at about the same level of sophistication. In a number of cases, institutes in developing countries were established and initiated with the assistance of institutes in industrialized countries. In such circumstances, privileged linkages have been usually maintained with the "founding" or "sister" institutes remaining the preferred channel of technical assistance, especially for staff training and information exchange.

163. Another important type of linkage is the twinning arrangements through which one institute extends technical assistance to another at approximately the same level of development. The main idea behind this concept is that the technological gap between two institutes in developing countries is narrower than with institutes in industrialized

countries. In these conditions, the assisted institute can more easily bridge the gap and more effectively benefit from the transfer of technology. The few existing examples have yielded interesting results to data and the prospects seem promising.

Universities

164. Relations with universities have special significance. They are usually the main source of theoretical knowledge in a country and a certain amount of fundamental research is being carried out in university laboratories by graduate students and professors. On the other hand, universities are a good source of academically trained researchers and engineers which can be easily converted to technical research. A few institutes included in the evaluation sample were established and developed with the help and under the auspices of universities, for instance CARIRI in Trinidad-Tobago and the Marmara Institute in Turkey.

WAITRO

165. On a world-wide basis, interrelationships between institutes are facilitated by the existence of the World Association of Industrial and Technological Research Organizations (WAITRO). This is an independant association of organizations either actively engaged in technological research (technical members) or interested in encouraging, promoting and supporting industrial research (sustaining members).

166. The aims of WAITRO are to: assist the development and improve the capabilities of technical members, especially in developing countries;identify fields of research needing co-operation or assistance by outside agencies; promote co-ordination and co-operation between members; encourage the transfers of research results and technical know-how between members; and promote exchange of experience and research management between members. Implementation of these aims includes: sponsoring technical meetings; training of personnel; information exchange and improvement of research facilities; operation of a central information clearing-house; exchange of research workers and use of research facilities; serving as link between members and international associations and federations; acting as spokesman for members on matters of common interest.

167. Established in October 1970, WAITRO released in 1972 a report on "Priority of Needs of Industrial Research Institutes in Developing Countries", which formed the basis of subsequent programmes of assistance introduced by the association. In 1974 WAITRO started its linkage programme under which two or more members are linked for the purpose of co-operatively undertaking technological projects for the benefit of the younger partner, such linkages or twinning arrangements being set up for periods of 2 to 4 years and financed by national and international agencies often through the intermediation of the WAITRO secretariat. The latest WAITRO meeting in October 1978, supported by UNIDO, tried to identify (a) subjects for co-operative research and (b) potential twinning arrangements. These arrangements are definitely oriented toward institution building especially through staff development.

Examples

168. Examples of the linkages described above were found in the profiles of the desk study and some were investigated further by the field missions. Here are a few illustrative cases:

* The Federal Institute of Industrial Research (Nigeria) established working relations with various African institutes mainly for exchange of technical information, and with institutes in industrialized countries, notably the Tropical Products Institute of the United Kingdom and the Denver Research Institute of USA. The DRI provided services in economic and managerial analyses, while the TRI is associated with research into indigenous materials available for use in industry and the processes which can be used most effectively to convert them.

* The Instituto de Investigaciones Tecnológicas (Colombia) sought to promote its growth by entering into general co-operation agreements with other national institutions concerned with technological development, e.g. SENA, COLCIENCIAS. The purpose was to develop the exchange of technical information and co-operate in research for the fulfilment of contracts with industry.

* The Caribbean Industrial Research Institute (CARIRI, in Trinidad-Tobago), established in 1971, has had a twinning agreement with the Research and Productivity Council of New Brunswick, Canada, during the period 1974-1977 made operative thanks to a financial contribution by CIDA under bilateral Canadian co-operation and additional UNDP funds. Under the arrangement, CARIRI staff was trained in Canada and Canadian technicians came on site to assist in solving various industrial problems.

* The Central American Research Institute (ICAITI) has special linkages with the Denver Research Institute and CODOT, a consortium of US universities concerned with the development of technology, especially for staff training and research programmes. It also has working agreements with universities in Central America and the Food Technology Institute of the Central Bank of Nicaragua.

* The Materials and Research Division (MRD) of the Marmara Scientific and Technical Research Institute (Turkey) keeps special relations with the University of Istanbul under which auspices it was established. A large proportion of the senior staff originally came from the university and some of this staff still on-board retain their professorships. Within Turkey, it has working arrangements with the other large research institute in the country, viz., the Research Institute on Mineral Resources. Abroad, it keeps contacts for information purposes with, among others,

Battelle (USA) and the Central Organization for Applied Scientific Research or TNO (Netherlands). Its internal control system was patterned after, and adapted from, well-established, successful institutes such as those two.

* Most interesting to this study, the MRD also has a twinning arrangement with the Yugoslav Institute of Zenića from which it receives technical assistance in the field of metallurgy. Through this twinning arrangement, which is sponsored by UNIDO and financed under a UNDP/UNIDO project, Zenića is retained as a sub-contractor and is providing assistance in training and research. The activities take place at the plant site of a government-owned steel plant in Turkey. The Yugoslav engineers and researchers conduct research and experiments on site and provide on-the-job training not only to the personnel of the plant but also of the institute with the purpose of building up the capabilities to the point where the MRD could carry out the same activities by itself in the future. Thanks in a large part to the UNDP/UNIDO project in general and this twinning arrangement in particular, the MRD has already developed its skills to such an extent that there is a proposal for the institute to provide technical assistance to one or several other institutes in the Middle East in the field of materials research and development.

* The Singapore Institute of Standards and Industrial Research (SISIR) has linkages with (a) the University of Wisconsin of the U.S.A. which provides training in instrumentation and electronics and (b) the Department of Scientific Research of New Zealand. At home, SISIR has established close working relationships with several institutions, e.g. the Consumers Association.

* The Korea Institute of Science and Technology (KIST) is an example of numerous and widespread linkages. It has working agreements with three national universities and co-operates with over 30 institutes abroad of which more than half are in industrialized countries. KIST has more formal linkages for technological exchanges with a number of sister organizations, viz.:

  Battelle Memorial Institute (USA)
  Research Triangle Institute (USA)
  Cornell University (USA)
  Mitsubishi Research Institute (Japan)
  Nippon Steel Corporation (Japan)
  TNO (Netherlands)
  Industrial Technology Research Institute (Taiwan)

The principal sister organization has been Battelle since KIST was established with its close assistance which was financed by U.S. bilateral aid. First, Battelle and KIST staff carried out an extensive

survey of industry needs and demand in order to find out what kind of an institute KIST should be. Then Battelle helped in the selection and training of the original staff and was instrumental in finding Koreans who had acquired R+D experience in the US. In addition to institutional and staff development, the principal value which was obtained through this relationship concerns management of research and administration of research facilities. Specifically, Battelle contributed in setting up the cost accounting system which is the backbone of the administrative procedures of KIST.

G. OVERALL ASSESSMENT

Relevance

169. The lack of a clearly stated mission and set of policy objectives related to specific technological or industrial development policies in most IRSIs included in the sample removes the principal criterion upon which to make an assessment of relevance on an objective basis. Where such statements exist or are easily inferred, the relevance appears high although it is not possible to separate and measure all the causal factors which determine industrial development. Empirically at least, it must be presumed that the degree of relevance of those IRSIs which are without meaningful guidance in the sense of specific linkages to government development and industrial policies or to industry itself, is suspect at best and probably marginal in many instances. The same general conclusion can be reached regarding their work programmes, i.e., functional activities and their probable impact. Functional coverage, for example, is often so broad that, given the limitations on staff size and skill composition, institutional capacity is often and obviously spread too thin, further reducing the effectiveness of many IRSIs in developing countries.

170. If the government is to establish new national technological and industrial policies, plans, and programmes or improve existing ones, the contribution of the IRSI can be significant but the evaluation results indicate that IRSI contributions to government decisions on industrialization have most often been minimal. With one exception, the IRSIs analyzed during the field missions were involved only to a limited extent in the development of national industrial and technological policies and planning and in the appraisal, selection, and acquisition of foreign technology. It is difficult to understand why governments generally ignore this important source of assistance, since government in every instance was responsible for establishment of the institute. IRSI staff do serve on various government committees from time to time, but it is clear that there is no consistent attempt on the part of most governments to regularly use IRSI expertise in planning and similar functions.

171. There is a tendency on the part of some to blame the IRSI itself for its inability to serve as an active partner in its country's national industrial development process, but the blame cannot be attributed to the IRSI alone. Where there is an effective development infrastructure which integrates and interrelates the activities of

government, industry, IRSIs and other elements, the potential for effective IRSI performance is strong. If these elements do not exist, or are ineffectual, the best-designed and motivated IRSI in the world will probably fail. When governments criticize their IRSIs for failure to perform, the governments should look first at their own policies, direction and supporting measures. Similarly, industry, which is inclined to criticize IRSI ability to perform necessary services, should examine closely the extent of its effective involvement in the planning, development and support of the IRSI.

172. The evaluation has shown that the more successful of the IRSIs in the sample are those that have a clear perception of the needs of industry. These institutes direct their attention to the larger enterprises and have effective mechanisms to recruit and retain the staff competence necessary to provide needed services. They usually perform extension and supporting service work which is most likely to lead to R+D contracts. They have both competence and facilities to move R+D results to the commercialization stage. While receiving appropriate financial support from government, they nonetheless enjoy sufficient autonomy and administrative flexibility to exercise independence, with responsibility, for development of programmes and projects and conduct of R+D. They exist in an environment for industrialization and development which has been clearly established through government policy.

173. The less successful IRSIs are those that seemingly have no clear understanding of the needs of industry. These neither encourage nor understand the necessity for continuing, strong liaison with industry. For various reasons, they are unable to attract or retain competent staff. They spread their efforts and the competence they do possess too thinly by attempting too broad a functional coverage. They expend most of their efforts on routine, supporting services work. It is seldom that they have mechanisms to translate R+D results into commercial utilization. Government financial support is inadequate and is not budgeted for the long range, so that frequently such IRSIs experience difficulty in maintaining sustained operations to and in achieving growth. They are impeded in operating in an effective manner, through lack of autonomy or administrative flexibility, and exist in a national milieu which has neither clear policy or understanding of the necessary interrelationship between industrialization and R+D.

Performance

174. The consensus of opinion reached by participants in the evaluation analyses is that, <u>except</u> for provision of basic services, most IRSIs can be judged as adequate to poor in terms of fulfilling their policy objectives and performing functional activities. A significant and general weakness exists in provisions of technical extension activities and in industrial liaison. Technical information services are inadequate. Small-scale industries are virtually ignored and very large industries are seldom clients. Too much emphasis is placed on "in-house" research which leads to isolation of IRSI staff from direct involvement in the national development process, "reinventing the wheel", or is of questionable value other than to a very long-

term development objective. Very little involvement is indicated by IRSIs in technology transfer and adaptation, although the potential for this particular activity is great. This is especially true in countries where governments are attempting to control or reduce importation of foreign technology in an attempt to reduce foreign trade deficits and strengthen indigenous capacities.

175. Many of the IRSIs in the sample do not carry on any significant research activity although R+D was the principal thrust of at least two of the institutes visited in Phase II. There is little evidence that the majority of IRSIs are (or can) carrying out innovative or strategic research and the well known problems of pilot-scale research and commercialization of research results have been observed, with a few significant exceptions.

176. IRSI performance appears to be particularly weak in educational and training programmes for industry workers and exchange, on-the-job training between IRSI and industry staff. Such training programmes could do much to improve the dialogue between the IRSI and industry; increase the opportunities for gaining a better understanding of industry problems, and for demonstrating the IRSI's capability to solve such problems. Most IRSIs have a larger potential for contracted services to clients than they actually use but its management is often lacking in the knowledge and skills to develop or screen projects and the methodology to evaluate the results of such work. Effective programmes of communicating with potential clients, vis-à-vis extension services, industrial seminars and workshops, and other promotional activities are usually lacking.

177. Providing services to industry, which should be a primary objective of most IRSIs, has not been found to be very effective except for basic services. This can be traced, in part, to a low level of industry sophistication and awareness. However, industry tends to suspect the close IRSI-government relationship which is presumed to exist and is hesitant to expose information about its operations for fear of possible government intervention. The lack of industrial participation in the IRSI governing board and committees for programme design and execution is clearly evident. In the absence of incentives which encourage industry to use IRSI services and demonstrated competence, it is improbable that industry will increase utilization of IRSI services to an appreciable extent. Industry generally is willing to pay for such basic services as they need from an IRSI, but is not willing to subsidize the IRSI (except where industrial associations may partially subsidize a mono-purpose institute) to provide the capabilities for more sophisticated services, particularly R+D.

178. At the same time, the study indicates that few IRSIs have made a serious attempt to conduct recurring industry surveys in order to plan IRSI activities in consonance with industrial needs. IRSIs seldom have staff with prior industrial experience, and only infrequently do they have an understanding of industrial problem-solving. Most IRSIs wait for industry to bring problems to them. Effective promotional and technical extension activities, which could bring IRSI

and industry into frequent contact, are being performed only in a perfunctory way. It is recognized that some industrial problems are not appealing or professionally satisfying to highly skilled research staff. However, a balance of "in-house" research and industrial problem-solving should resolve this, and certainly such assistance is one of the key policy objectives of most IRSIs (although usually only in theory).

179. Small-scale industries are not being adequately served, due in part to the general inability of small industry to pay for services and the limited geographical coverage and capacities of a single IRSI. Such services are usually technically possible but there is little economic or institutional payoff to the IRSI and small-scale industry problems are frequently not challenging to highly trained researchers. Technical extension services can solve the latter aspect but governments may need to develop a mechanism to provide low-cost loans or grants to small-scale industry which will encourage these to request such services and provide alternative supply sources, e.g., productivity centres, industrial estates, consulting firms, etc.

180. It is recognized that many industries in developing countries may not be able to identify or articulate their problems and, in many instances, do not have the capacity to recognize, and use the technological services of IRSIs. At the same time, it is clear that many small and medium industries do exist in these countries, that there is no correlation between industry size and sophistication of technology, and that small industries can become large industries. IRSI support to smaller but targeted industries can provide positive results and spin-off effects. Also, the IRSI must recognize its mandate to assist in strengthening the overall national technological capacity which should not be limited solely to the size of an industry.

Linkages

181. The close government relationship, mentioned above, can also impede the ability of a subsidized IRSI to interact with industry, even if the relevant competence and experience exists within the IRSI. The study indicates that IRSIs with appropriate flexibility and a minimum of government overview have the best opportunities for innovation and interacting with private industry. On the other hand, public enterprises tend to be more amenable to use of IRSI services, although they are not always willing to pay on the theory that the IRSI is already fully supported by government.

182. The effectiveness of industry linkages is particularly difficult to assess. One must bear in mind the general immaturity of industry in developing countries, their lack of experience with utilization of R+D and technical services, and their basic distrust of the IRSI-government relationship. All too often, IRSI staffs are not, by themselves or by their institute policies, motivated to develop, continue, and expand industrial relationships. Such motivation is much more obvious when the IRSI is required to obtain at least a portion of its operational expenditures from contracted services to clients.

183. With a few exceptions, IRSI linkages with other industrial institutions also need strengthening, particularly with universities and other industrial institutions. Twinning arrangements, under carefully planned circumstances, show great promise both for institutional development and joint projects but they require funding.

Growth and Impact

184. While the present status of low-level effectiveness of many IRSIs is often due to factors largely outside the control or even influence of IRSI managers, in too many instances IRSIs have not taken adequate measures to plan for incremental institutional growth within an established strategy and in consideration of such factors as client demand, staff development and skill composition, management capacity, etc. On the other hand, IRSI facilities and equipment were most often equal or superior to the tasks at hand.

185. The question of impact, as can be seen from this evaluation, is a complicated equation which is influenced by a large number of variables including institutional maturity and viability, management flexibility and quality, government policies, industry needs and perceptions, selectivity and relevance of policy objectives, functional activities and targeted beneficiaries, level of industrialization, etc., all of which affect the ability of an IRSI to provide effective services to clients. For a sponsor, i.e., government, industry, or both, it is the "bottom-line" of the ledger and should be an IRSI's raison d'être. From the general assessment of the IRSIs included in this exercise, it is clear that while useful services are being rendered in most cases, the potential of such institutes in industrial development is either under-utilized or not understood on the part of governments and industries. This problem is exacerbated, at the same time, by over optimistic expectations, particularly regarding R+D results. These conditions appear most prevalent in multi-branch institutes located in countries in the earlier stages of industrialization. In the final analysis, the only true measure of IRSI impact is the quantity, quality and significance of its services utilized by its targeted clients.

186. These conclusions suggest, first, the careful consideration of whether a multi-purpose research institute is the correct answer in a specific situation vis-a-vis other institutional or technology alternatives and, second, if it is, the necessity to plan carefully those supporting actions which are necessary for a successful IRSI. It is necessary to recall that an IRSI is only one element of the necessary infrastructural system required in developing countries to carry out effective industrialization. The other elements - Government, public and private sectors, development banks and the universities, among others - also have a significant role to play but this study has not included an in-depth analysis of their individual roles. Therefore, the conclusions of the study on IRSIs must carry this caveat.

187. On the basis of the evaluation of the IRSIs assisted by UNDP/UNIDO together with the benefit of the review missions carried out to a selected number of IRSIs, considerable practical experience was gained on the operations of these institutions. Furthermore, the meeting of all participants of the review missions held at Spiez, Switzerland, at the invitation of that Government, together with a group of selected invitees, it was realized that it would be desirable to record the vast experience shared at the meeting with other persons involved in IRSI operation. Therefore, Section II has been included in an effort to provide advice to sponsors, institutions, governments, and interested professionals on the operation of the IRSIs.

PART II

GUIDELINES

CHAPTER III

Improving Effectiveness of UNDP/UNIDO Technical Cooperation

A. Planning of Assistance

188. Project design is of critical importance to the success of an institution-building project. The overall design logic must be developed initially by UNIDO and UNDP in collaboration with the host government and intended beneficiaries, with subsequent review to develop the detail of the work programme, including the implementation schedule, to produce the outputs or results as defined by the tripartite parties. These tasks cannot be delegated solely to an internationally recruited project manager.

189. It is important and useful for government, when planning or expanding its own IRSI, to seek advice and counsel at an early stage from development agencies and other governments who have sponsored successful IRSIs. In this way, collective experience can be brought to bear on the design of the proposed IRSI and pitfalls, shortcomings, overly ambitious plans and work schedules, etc., can be avoided. Such advice, based on actual experience in developing countries, can help the sponsors and managers in planning an IRSI to meet national needs based on expected availability of resources, projected demands, and in cognizance of other limiting factors.

190. UNDP and UNIDO should develop programming guidelines for use by its staff and as advice to governments for establishing new IRSIs, or strengthening of existing ones. These guidelines should reflect the importance of developing a purpose or role for the IRSI linked to national science, technology, and industrial policies and, with such a purpose, the early development of an institutional strategy and plan for growth. This suggests the need for projects which are phased, with the first phase giving attention to the clarification of an IRSI's purpose, selection of policy objectives, and development of a growth strategy and plan, including subsequent project phases as the IRSI itself moves through the various stages of institutional development and increases the quantity, quality, and significance of the functional activities or services to be provided.

191. The importance of well-planned preparatory missions cannot be over-emphasized. Perhaps more than any other element of project design, these missions can contribute to the ultimate success of a project; if inept or badly performed, such missions, or their absence, can well contribute to project failure and the subsequent marginal impact of the IRSI. Important factors, in a rough order of sequence, involved in a preparatory mission can inter alia include the following:

* A government considers the possibility of obtaining appropriate science and technology inputs for its industrial development programme.

* A project request is included in the country programme after consultation between the government and UNDP/UNIDO.

* If the country programme includes establishment of an IRSI, or strengthening and expanding the coverage of an existing IRSI, the government and UNDP/UNIDO plan for a preparatory mission to identify and analyze industry problems together, identify project alternatives involving technical cooperation, and prepare a preliminary project design.

* The preparatory mission will include members knowledgeable of the technological problems and technical cooperation and involve the active participation of the government in all stages; and with consultations with the intended clients or beneficiaries.

* Provision of adequate time and sufficient resources to produce the intended reports/results.

* The subsequent project design should be based on findings of the preparatory mission whose report which should include: identification and analysis of industry problems; providing necessary information on government policies and objectives and industry requirements and demand, actual versus potential; alternative, intermediary and other industrial institutions; suggested methods of financing, both short and long-term; recommended growth strategy; and the need for outside assistance, including drawing up a logical framework for the proposed project with emphasis on the development hypothesis (intended impact), project objective and function, intended results, an illustrative work programme, and suggested end-of-project status indicators.

192. UN intervention should take place at an early stage of government planning for an IRSI, rather than to enter into the process after govern-

ment plans are already "set in concrete" and attempt to make changes. There is considerable support for the argument that an advisory mission should precede the preparatory mission, to coincide with the government's preliminary planning, for the purpose of defining more clearly the actual need for an IRSI vis-à-vis other options and to determine the policy objectives and functional activities it should eventually perform in accordance with the country's industrial development objectives and priorities. UNDP/UNIDO should not support projects designed to create IRSIs encompassing too many objectives and functions at their start; initial activities should be limited and based on the results of carefully conducted surveys of needs, demand, resources, and limitations. When planning or creating an overly ambitious IRSI with unrealistic expectations, government should be advised of the inherent dangers and UNDP/UNIDO assistance ought to be confined to a feasible project of limited scope.

193. Before supporting the establishment or significant enlargement of an IRSI, UNDP and UNIDO should advise the government sponsor to undertake an initial planning phase of perhaps one to two years duration during which all necessary arrangements would be made concerning the long-term programme of the institute, its structure and policy objectives, resources relations with industry, etc. When this planning is finished, and if the decision is made to continue, the government would be in a much stronger position to meet the prerequisites necessary for establishment of the IRSI and initiation of project operations. A stand-by UNIDO-organized working group could be established in order to provide written and on-site advice and recommendations to governments regarding such critical questions as alternative ways of financing IRSIs, staff development, equipment requirements, etc. UNIDO should also offer governments guidelines and advice on criteria for the selection of IRSI staff and management personnel, including plans for staff and career development.

194. UNDP/UNIDO projects should include provision in the work plan for a proper balance of necessary theoretical, practical, and on-the-job training, based on identified need instead of the usual approach of providing postgraduate academic training. Emphasis should be placed on "learning by doing" through in-plant or in-IRSI training, including twinning arrangements which needs to be a part of the project budget. All training activities should be undertaken in consonance with a pre-established IRSI professional staff development programme.

195. The outputs of technical cooperation projects should be clearly related to the function or purpose of the project. Especially important is to distinguish between direct support and institution-building. If the project is of the direct support type, for example, contributing to research on wood utilization, the outputs should be in terms of the results of the research programme itself.. If the project function is institution-building, then the outputs should be in terms of increased IRSI capability to perform a specified functional activity(s). Existing capability (baseline data) must be measured and targeted capability must be estimated, given a projected level of activity. The project output will be the difference between the two with the increased capability being measured in terms of expected services to be derived from it.

196. A convenient way of dealing with institution-building outputs for IRSIs is by reference to the concept of "activity modules".* Activity modules have been defined as service units which will perform specific tasks within the IRSI. They are directly related to IRSI policy objectives and include the staff, skills, facilities, equipment, and support necessary to perform the assigned functional activities. When planning activity modules, it is also necessary to identify the potential users, be it industries or government agencies, ascertain the present and future demand for the services to be offered by the activity modules, define the modules' role as compared with similar or related institutions already in existence or contemplated for the near future, and prepare a growth plan and strategy for the module.

197. Governments often assume that they have fulfilled their responsibilities by providing the legislation and necessary start-up resources for the functioning of IRSIs, without realizing at the time the long-term implications and commitments of such actions which concern planning and direction, continuing financing, and management of the IRSIs. Project designs must take such factors into consideration as critical assumptions so that governments will understand their continuing obligation to provide assistance and support to the IRSIs during and after completion of the project. Since project design is the joint responsibility between a government and UNDP/UNIDO, it is obvious that a government must be carefully and thoroughly briefed on the necessity for such long-term and continuous support. Otherwise, the considerable investments made both by government and UNDP/UNIDO might be wasted.

B. Implementation and Evaluation

198. One serious impediment to project implementation was the lack of qualified counterparts. Usually, the project design recognized this weakness and provided for fellowship or other training. In a number of cases, however, the provision for training abroad was not carefully co-ordinated so that some counterparts were in training outside of the country while the experts were posted to the IRSI and did not return until the project was nearly completed. The loss of opportunities for on-the-job and supervised training is obvious. The project work programme, and the job descriptions for experts, should reflect the prime importance of staff development in institution-building IRSI projects.

199. Long-term expertise was often offered to governments without assessing the level of technological development and the availability of experienced professionals in the country. There is some debate as to the relative advantages of the use of a few, long-term experts vis-à-vis a larger number of shorter term experts who return at frequent intervals to interact with their counterparts. The latter situation suggests the establishment of a twinning arrangement or linkage between fledgling and more advanced IRSIs, preferably one from a developing country depending on the needs and availability of expertise. Through such a mechanism a mature IRSI can backstop a new one and provide a variety of expertise and support as needed with a better understanding of the problems and needs faced by such IRSIs. Long-term experts should not be ruled out; however, the need for them should be carefully evaluated on the basis of country and project requirements.

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* Refer also to UNIDO/EX/65 pp. 3-4

200. In any event, the first task of a project manager, working in close cooperation with his counterpart, usually the IRSI director or division chief, is to develop a detailed work programme which will produce the expected results (outputs) within the time and resources provided in the project. The principal function of project reporting and the annual tripartite reviews is to monitor and assess the progress in carrying out the work programme, including necessary revisions, supplemented by mid-term or comprehensive reviews when changes in critical assumptions occur or other conditions change which require a reassessment and perhaps redesign of the project logic, including the expected results. It is not critical that the actual results be exactly as originally planned but that they represent a reasonable achievement given the project's immediate objective and other factors.

Prerequisites

201. In the consideration of the above suggestions concerning the improvement of UNDP/UNIDO assistance, there are some further measures that are considered important. These relate to prerequisites which would be advisable before starting to deliver the major UNDP/UNIDO inputs leading to the establishment or expansion of an IRSI. It is desirable that the government's plan to create an IRSI should begin with an advisory mission followed by a preparatory period which could be as long as two years and during which a second preparatory mission would be envisaged. The following prerequisites for the approval of the implementation phases of project after these actions should be considered by UNDP/UNIDO before formally authorizing the start of project operations:

* The government should have completed the necessary legislative action to legally and formally establish an IRSI including in it provision for granting of autonomy and flexibility on a step-by-step basis within a reasonable period of time which could be suggested as being 10 years.

* The government to submit a financial plan for a period of 5 years and including provision for incremental growth of the institution within and beyond this period.

* The function, authority and composition of the governing board of the IRSI be clearly established.

* Definition of the participation and cooperation required from other infrastructural sectors in the country which need to participate with the IRSI in the industrial development activities foreseen. These other elements should include development banks, public and private enterprise sectors, government and universities.

* Career and staff development schemes would have been articulated for the IRSI staff.

* Linkages would have been formalized with other similar institutions, usually outside the country, to support the proposed work envisaged.

* A survey of industrial needs would have been carried out with the identification of the potential clients.

* The appointment of a minimum group of national professionals would have taken place to enable the institution to start its work.

* The responsibilities and authority of the national IRSI director would have been clearly established.

* Buildings for the proposed institute would be available.

CHAPTER IV

Improving Performance and Impact of IRSIs

A. Clarifying Objectives

National Planning

202. In each country, a number of national decisions are made, or need to be made, as to the amount, types, location and timing of industrial requirements. These decisions then determine the kinds of functions and institutions needed. For example, a policy of concentrating on widespread, small-scale private industry requires completely different industrial support institutions than does a policy emphasizing a limited number of large, public manufacturing plants. The technology, financing, skills and advice needed will also depend on the type of industry. Unfortunately, institutions are often created to carry out promotional or support functions before any clear national industrial policy has been established. Where the basic factors of "mission or purpose-orientation" are ignored, an IRSI's usefulness and relevance in relation to national priorities and resource allocations will be questionable or a matter of chance.

203. There is an obvious requirement for governments to select and determine the priorities of research as related to development. Ideally, this would involve science and technology planning, policy-making and policy instruments which can be viewed as independent variables influencing science and technology functions and consisting of: (a) a demand group (demand for an absorption of technology); (b) a supply group (R+D activities, S & T services, and sources of research skills); and (c) linkage between the economy's S & T system and its productive system.*

204. Under such conditions, a technology policy would require the IRSI's purpose or role to be tailored to specific requirements thereby

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* Deem, op cit

linking it with industry and government in an operational sense and strengthening as well as creating an environment for growth by its deepening influences on industrial strategy. Such a policy might also involve monitoring "technology transfer" in the national interest and is needed to strengthen and safeguard the IRSI as a policy instrument which advances the technological, economic, social and ethical values of technology transfers. Policy support of this type will also enable the IRSI to improve its credibility and image which are essential for winning the confidence of the industrialist and the general public (See UNIDO/EX/66). Great care needs to be taken in privately oriented sectors, however, not to place an IRSI in the difficult position of requiring the confidence of the industry whom it is intended to serve while at the same time being an element of the government structure which oversees or regulates industrial activity, including technology transfer, in that sector.

205. Such guidance is of critical importance to IRSI management and its board of directors in determining institutional strategy for growth and the selection of functional activity priorities. Where the IRSI is significantly financed by industry, or where industry is actively and effectively involved in programme development and project selection, government guidance can be less critical but nonetheless necessary for IRSI management purposes.

206. While the existence of national science, technology and industrial policies cannot be a prerequisite for the establishment of a mission-oriented institute, particularly in the lesser developing countries, there is no substitute for effective government guidance and review on a continuing basis unless the IRSI receives considerable direction and support from the industry it is intended to serve. In the absence of such policies, other techniques for establishing and reviewing a "purpose-orientation" are suggested in some of the following sections as part of an IRSI's growth process.

Infrastructure

207. In national planning and priority setting, attention must also be given to planning the detailed development of, and allocations of resources to, the country's overall institutional infrastructure in relation to the support that they are to give the economic, social, industrial, and technological development which is projected in government plans. It is necessary to harmonize all of those institutions into a cohesive total <u>system</u> geared to meeting the demands of industry while being tools for implementing policies and programmes for future industrial development. The totality of these industrial institutions, particularly government policy entities, development banks, industry and universities, should form an infrastructure and work as a comprehensive industrial service support system. <u>IRSIs are a viable option for developing countries only if they are recognized as one element of such an infrastructure dedicated to national industrial growth and development goals</u>.

208. An effective institutional infrastructure for industrial development can only perform well if there is a continuous dialogue among all elements. This dialogue, and an active role by the government in the guidance and direction of the IRSI, is critical particularly where industry is in an initial stage of development, where clear cut technological and industry policies and plans are not available, and where linkages with industry are in the rudimentary stages (Desa, op. cit.).

209. A second necessary condition in the case of government created institutions is for the government to be prepared to support them for an extended period and establish the policies and environment discussed above which will enable them to grow and mature. In a number of instances, governments have established multi-branch and multi-purpose IRSIs with too many policy objectives, functional activities and responsibilities and without full realization of the constraints that will be placed on such an institution in the face of limited funding and skilled human resources. A government needs to look carefully at these factors, analyze the potential of other technological institutions and service organizations, and consider the option of a single-branch IRSI or a multi-branch IRSI with a limited purpose, at least initially, with a view for possible later expansion when conditions warrant such a change. The cost for establishing and maintaining an IRSI can represent a sizable and continuing drain on the national budget of most developing countries. No new industrial service institution ought to be created and no existing programme ought to be broadened except after reasonable assurance that the proposed functional activities are not already being performed, or cannot be performed effectively by some existing or intermediary institution.

210. In planning for establishing or enlarging an IRSI, therefore, the sponsors must take into account a matrix of variables including:

* Is the IRSI new or already established and functioning?

* Is the IRSI intended to be single-branch and single-purpose and/or multi-branch or multi-purpose?

* What is the current and projected level of industrial development, e.g., import substitution, modernization, advanced technology?

* How will the IRSI relate to other elements of the industrial development infrastructure?

211. A UNIDO study on industrial institutional infrastructure* suggests that there are some searching questions which all institutions within the infrastructure should continually ask of themselves. These questions are particularly important to governments, sponsors and to the IRSI managers in defining their role in the development process:

* Is their structure adequate for the performance of their responsibilities? Are they properly defined and organized and do they form a cohesive service system?

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* Institutional Infrastructure for Industrial Development, UNIDO/ICIS.36, July 1977

* Are their programmes properly oriented towards national development goals and do they concentrate sufficiently on new industrial priorities such as increased national processing of natural resources, development of small-scale industries and expanding training of industrial manpower?

* Do the actions of these institutions result from consultation with industry; are they fully integrated with industry's operations; and do they practically meet industry's needs?

* Are the attitudes of institutions and their staff based on concepts of cooperative, dynamic service to industry, to the use of the industrial products, and to the people of the country as a whole, as well as an appreciation of the international implications of their institutional work?

IRSI Policy Objectives

212. Both IRSIs and their sponsors must collectively examine and articulate an IRSI's policy objectives* to ascertain that it is or will be engaged appropriately in programmes and projects which relate to national development goals and priorities. It cannot be expected that in many developing countries the governments are yet in the position to articulate national development goals in such terms to have meaning and direction for the programmes and activities of IRSIs. Along the same lines, some governments do not usually have the staff or capabilities to evaluate in any depth the potential impact of IRSIs activities and little attempt is made to do so. Therefore, in pragmatic terms it must be the basic responsibility of the IRSI staff itself to plan its operations around explicit or implied government priorities and, most importantly, to develop working relationships with government and industry which will assist it in perceiving and relating to such priorities.

213. Considering policy objectives as related to national development goals, the greatest development impact is likely to derive from efforts to increase utilisation of indigenous raw materials which in turn has potential impact on nearly all elements of industrial development. Development of new technology can have desirable results in terms of import substitution, increasing national output and reducing the foreign trade deficit. Improvements in existing industries while having an indirect impact on import substitution, will have a direct effect on increasing national output by improving productivity, etc., and on reduction of the foreign trade deficit through production of quality exportable products or through adaptation of industry products or processes to meet current and future needs for goods now imported. Technology transfer and adaptation can have perhaps the strongest impact on development goals if the transfer is suitable or appropriate for the national conditions. The limited involvement to date of IRSIs in transfer and adaptation of technology suggests again the lack of clear

* Refer to UNIDO/EX/67

government policy on acquisition of technology along with effective mechanisms to regulate importation and encourage stronger IRSI involvement in the technological phases of the transfer process.

214. A feasible exercise for government sponsored IRSIs would involve ranking current or planned policy objectives and functional activities against major development goals, in an attempt to determine both their relevance and priority and where the strength and weaknesses of the IRSI lie. From such an analysis, measures can be taken to strengthen IRSI operations where skill and capabilities are already available or to add skill and capabilities where these are non-existent or inadequate. Without such an attempt and in the absence of detailed government planning, and given the general characteristics of poor industry linkage, an IRSI is apt to flounder and provide services of a marginal nature.*

Client Identification and Needs

215. Where government priorities have not as yet been articulated in terms that provide guidance to IRSI management, an alternative is to identify clearly the intended beneficiaries of the IRSI services, that is, government and industry clients. It is then essential to make a survey of their demands and potential needs, and develop mechanisms and processes for continuing surveys of their requirements. Experience indicates that the lack of these types of surveys is at least partly to blame for the frequent misdirection of IRSIs and their inability to attract clients who really have need for or want their services.

216. Client surveys in the lesser developed countries will probably show that industry demands are focussed initially on analysis and testing services. If this is the case, the IRSI can take advantage of this opportunity to develop strong working relationships with industry. Both the institute and the industry learn in the process. With time and generation of confidence, industry will bring larger and more sophisticated problems to the IRSI.

217. An IRSI has a greater potential demand for continuing surveys of industry's current and future needs than is usually realized. Such surveys can be equally important to industries, particularly if the results are analyzed by the IRSIs in terms of applicable knowledge of technology and presented with recommendations regarding specific steps which can be taken by the IRSI to help meet the needs so identified. While the primary or initial intent of such surveysis to identify the needs of clients, the very surveys themselves can become a service to both the IRSIs, who establish working relationships with industry, and industry itself since they will contain aggregate information not normally available to individual enterprises. This is particularly true when the category of information collected and analyzed includes such as availability of infrastructure facilities, identification of commercial opportunities, impact of new legislation on process and product control, alternative energy sources, industrial forecasting, productivity ratios, etc.

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* UNIDO/EX/67

218. Information detailing industrial opportunities or needs is generally available from a variety of sources and can be gathered through several means. In some cases, information can readily be obtained from government or industry associations, while in other instances, industry itself is the only possible source. The best method of obtaining survey data will depend on the exact type of information being sought as well as the needs of the potential end user. Examples of useful information are:

* Availability, price and/or quality of raw material used;
* Projected infrastructure capabilities or capacities;
* Commercial viability of a new product or process;
* Industry ability to adjust to changes in manufacturing criteria, such as new government regulations, increased energy cost, etc;
* Forecasting of business trends using, e.g., the Delphi technique;
* Process and product design modification and refinement;
* Opportunity studies for new business opportunities.

Government ministries normally compile and keep updated information on many subjects related to national business activities, including annual production figures of agricultural commodities, basic raw materials, energy cost and availability, etc. Often these data are simply compiled statistics with no attempt to analyze the impact or significance of trends on industrial performance and needs.

219. Particularly in developing countries where the industry is protected from competition from abroad, and there is a seller's market, industry will seldom recognize its need for assistance from an IRSI and is rarely motivated for research. In such circumstances, it is perhaps more effective to make a preliminary assessment of their need by analyzing the industry itself and assuming that their needs are more or less normal. In other words, plan for research capabilities and facilities proportionate to existing and planned industry with frequent checks and revisions as the demand grows and/or changes.

220. Often industry staff itself does not qualify to undertake this work or independent counsel is sought. This is especially true, of course, in the case of small-scale industry sector. As an IRSI accumulates and maintains current data banks of information in areas such as the above, its qualifications and ability for serving industry and government will increase and both will find increasing occasions to turn to the IRSI for guidance. Furthermore, the ability of the IRSI to select and monitor its own in-house R+D activities will be sharply improved.

221. Obviously, financial support is required to undertake industry surveys but where the IRSI is subsidized by the government, its management should examine carefully the benefits they can accrue from such activities which will often be more than that derived from the support of non-relevant in-house research. Government ministries could become paying clients themselves by using IRSIs, at least as an interim measure, to:

* Prepare feasibility studies for investigation of industrial opportunities, studies of trends, etc;
* Investigate natural resources;
* Prepare industrial or sector surveys;
* Provide inputs for national planning.

222. Client surveys can represent the first step in a selective programme strategy for achieving a critical mass and specialization as appropriate to the country's economy. In the absence of other guidance, it will help government and IRSI management to determine the present and potential needs of industry, on the basis of which a few high priority areas would be selected for specialization and concentration of efforts.

Limitations and Target Industries

223. An IRSI cannot be expected to play all of the many roles needed to establish new industry. While an IRSI can provide some critical building blocks, industry must normally carry the bulk of the load such as engineering, management, financing, etc. It is unrealistic to expect an IRSI to deliver turn-key projects or even produce products prototypes ready for production. To do so requires much too specialized know-how and to achieve it would use up too much of the institute's capacity so that it cannot serve a sufficient number of clients.*

224. There are similar problems in giving too much concentration to small industry. An IRSI should have equipment and skills of a more advanced type than its customers. Providing extension services all the way down to cottage industry is unrealistic for several reasons: researchers are too expensive to be used for such work, an instructor with a vocational background is often a better choice; the work is uninteresting and does not develop the capabilities of the staff; and the size of an IRSI is, in orders of magnitude, too small; and the national impact of helping just a few small enterprises would be insignificant. If there is no advanced industry in the country, or planned for the near future, there will be only a marginally important market for research and the institute might better concentrate on basic or extension services with research, if any, being of a long-term strategic nature.

* UNIDO/EX/65

225. The arguments for serving larger and more advanced industry are strong. R+D is by its nature sophisticated and advanced and only when it works for large and capable companies can results of importance to the national economy be achieved. This does not mean that small and medium industry should be ignored but only that, in many circumstances, other alternatives than an IRSI should be selected. If there is little or no advanced industry in the country, an IRSI might better concentrate on testing, analysis, opportunity studies and in-house research rather than aiming at process and product development. This is based on the proposition, accepted in this staff report, that an IRSI cannot create industry. It only helps existing industry. Grass-root, research-based industry created by an IRSI is possible but for under-developed countries, this route to industrial development is the slowest, riskiest and most costly which could be contemplated.

B. Strategizing and Planning for Growth and Relevance

1. Growth Strategy

226. Many of the problems, delays and failures which have impeded the institutional development, maturity and viability of IRSIs can be traced to a lack of adequate planning and an assumption that a successful and relevant institution can be created in a relatively short period of time and in comparative isolation. On the contrary, IRSI institutional planning needs to take into account the requirements of framing their programme of services and actions in dynamic terms, taking cognisance not only of current needs but projecting in as long a term as possible the development of the institution so that it will be prepared to give adequate support to industry and particularly that industry which is responsive to government development objectives.

227. Given the existence of explicit government policies, or alternative methods of inferring them as discussed just above, and a clear set of IRSI policy objectives, an institutional growth strategy is needed which will relate and coordinate the sub-strategies of staff development, functional activities, research and development, facilities, financing, and management, encompassing at least three future five-year growth periods, and which provides for incremental growth in staff and services responsive to government priorities and industrial needs. Such a growth plan should be considered as a guidepost and not a blueprint, to be revised as changes occur in government policies, industry needs and demands, and other basic assumptions, and be flexible enough to permit exploitation of unforeseeen opportunities. An institutional development plan should also include any desired expansion of coverage, new policy objectives, and/or assumption of new functional activities with due consideration to probable constraints, reasonable expectations on the part of sponsors and/or clients, and in consideration of similar growth patterns by other industrial institutions.

228. In the less developed countries, R+D in terms of innovation and solving difficult problems is in small demand. IRSIs in such countries have very limited opportunity or even capability for work of an advanced

nature. This only increases the importance of planning IRSI development in such a way that it can accommodate the immediate and more simple needs while at the same time building a capacity for more sophisticated problem-solving in the future. The planning timeframe must be sufficient to cover such growth and provide an IRSI's governing board and sponsors with a conception of the future as well as more precise short-term objectives.

229. When either planning a new IRSI on the basis of the equivalent of a feasibility study, or reviewing an existing IRSI with a view to strengthening or re-orienting it, the principal elements of such a plan should include:

* National technology and industrial policies and development objectives in the areas covered by the IRSI;
* Institute policy objectives;
* Survey results and assessment of industrial demand and needs;
* Organization and management, including policy direction and programming;
* Staff development and compensation schemes;
* Financing
* Management including evaluation and reprogramming;
* Functional activities (activity modules).

Principles*

230. In developing a strategy and growth plan for an IRSI, there are a number of principles postulated on the basis of experience which can be usefully considered. They include:

* Institution-building and growth is a continuous and dynamic process. As it grows, an IRSI needs to change, shedding off some activities and assuming others, hopefully, those which are more relevant and sophisticated. An IRSI's growth plan must be realistic, initiated gradually as resources and needs occur, with recognition that full maturity and viability will require a considerable length of time;
* There must be a target industry(ies) and/or government agency(ies) which needs (or will need) the services to be offered by the IRSI. It is illusory to assume that the mere presence of an IRSI will itself create such targets and demand;
* Highly qualified and motivated professional staff is a sine qua non. Plans must make it possible to attract, train and retain competent professional staff, local or expatriate, who have proper academic training and practical experience.

* See UNIDO/EX/65, pp 1-6

* Sufficient autonomy and flexibility must be provided. Otherwise bureaucratic controls, coupled with unmotivated or poorly qualified staff, will permit very little innovative and creative work and the IRSI, at best, will develop into a routine testing organization;

* A steady growth rate is essential; sudden contractions or expansions will be most harmful.

* An IRSI's plans must be flexible so that unforeseen opportunities may be taken advantage of either in terms of industry and government demands or the particular unique capabilities of existing staff and facilities;

* Unsuccessful activities and unproductive staff must be culled out;

* Adequate and continuing financing must be assured with full realization that such financing will be required for a long time.

231. Obviously, there can be no standard growth plan as the conditions in every country and in every branch are quite different. Some of the developing countries in the more advanced stages are planning industries which can compete on the open world market. Much of the experience of developed countries can be valid and assessment of the feasibility and viability of plans is an easier task. These countries, sooner or later, need all the laboratory services and research facilities that are present in the rich or developed countries. Their problem is to find a proper strategy and decide upon the sequence, pace and scope of the various institutions to be built.

232. In countries in the very early stages of development, often with a closed economy and a weak infrastructure, the planning of IRSIs must follow other lines. Much of the technology they need cannot be purchased or established by setting up foreign designed plants. In such countries, the concept of appropriate technology has more relevance and institutions need a strategy different from the conventional ones so often copied from the developed countries. The task is much more difficult.

Government Support

233. Governments can help IRSIs in the implementation of their plans in a number of fashions. For example, they can provide mechanisms to route work to IRSIs by such means as:

* Requiring or encouraging product quality control through IRSI approval or certification;

* Contracting for IRSI services to survey industrial branches for the purpose of identifying problems and recommending means of improvement, e.g., use of local rather than imported inputs, increasing production efficiency, selection of products, cost control, etc;

* Requiring or facilitating cooperation with other industrial institutions, e.g., development corporations and banks (techno-economic studies), small-scale industry promotion, investigation of indigenous resources.

234. Obligatory requirements by governments for industry use of IRSIs' services, such as requiring product quality control through IRSI approval or certification, however, should be approached with caution if it is essential that the IRSI achieve the full confidence of the industrial sector. Such certifications can be subsidized, if necessary, through value-added taxes or similar incentives but in so far as the IRSI is concerned, particularly those serving the private sector, such certification should come from requests by industry, not by government fiat. Policing actions are apt to create a sense of negative awareness and caution by an industry towards the IRSI.

235. Perhaps, the most useful function a government can perform, other than giving continuing advice on national industrial priorities, is to provide the IRSI with a sufficient general subsidy to get it through the early start-up and growth years and then gradually reduce this subsidy while, at the same time, increasing government contracts for specific IRSI services and support for strategic research and providing incentives to industry for using the services of an IRSI.

Levels and Phases of Growth

236. It is important for IRSI managers and their sponsors to recognize the stages or phases required for successful institutional development and the time necessary to achieve them. This problem was discussed in detail in a recent UNDP/UNIDO Evaluation Study of Textile Centres.* While they overlap, the major elements include:

* Early establishment of key conditions;
* Establishing an appropriate strategy;
* Staff development;
* Establishment of an adequate knowledge base;
* Utilization of developing capaoities;
* Achievement of institutional maturity and viability.

Failure to recognize these stages can result in unrealistic expectations and subsequent disappointments.

237. To be effective, a growth strategy should be planned for different levels and phases of IRSI operational or functional activities (UNIDO/EX/66, pp 11-13). For example:

Level A

Routine services including testing, analysis, standardization, technical information services, raw material

* UNIDO Funded and Supporting Activities in the Textile Industry Sector, ID/B/C.3/73, 19 October 1978

surveys, instrumentation, etc., with, in the least developed countries only, perhaps an initial orientation to small-scale industry.

Level B

More general technical services including trouble-shooting, simple product and process R+D, plant lay-out, standards and specifications, quality control, feasibility studies, long-range forecasting, etc., with the emphasis more on intermediary industry.

Level C

More sophisticated services to advanced and large-scale industry, including consulting services, applied R+D for adaptive and innovative technology, pilot scale operations, new product and processes.

238. When designing an IRSI, it is important to think in terms of capabilities and tasks. These combinations can be described as activity modules, that is a unit which will perform a specific task or group of tasks within the IRSIs. Examples of such modules are: management; administrative services; technical information; programme and industrial liaison, shop and service facilities; R+D laboratories; pilot plants; analysis and testing laboratories; etc. The activity modules must relate to IRSI policy objectives and programmed functional activities. In using such an approach, not all activity modules will necessarily be established at the same time, but will be added at appropriate growth phases.

239. Establishing an activity module involves the following elements, all of whioh must be carefully planned:

* Premises with appropriate utilities, work-benches, furniture, chemical hoods, equipment, location, etc.;

* Equipment - major, minor, and expendable - spare parts, safety equipment, handbooks and manuals;

* Professional staff and technicians, who will perform the activities of the module, operate, calibrate, and maintain the equipment;

* Work routines, including performance, monitoring, reporting and evaluating the activity;

* Marketing functions to sell the services of the module (where appropriate) and to establish good working relationships with potential clients.

240. The management and administrative modules must receive special consideration if the IRSI is to perform in an effective manner. In addition to premises, office furniture, office equipment, etc., the following are of extreme importance:

* Organization, established lines of communication, assignment of authority and responsibility, job definition, general operational policies;

* Personnel functions - staff contracts, salary policy, staff benefits such as vacations, retirement or pension plans, insurance, continuing training and education, travel and other expenses, regulations, canteens, etc;

* Office routine - accounting and auditing, filing and typing, handling of mail, purchase and billing procedures, secretarial procedures, etc.;

* Project management - Contract format for confidential and unrestricted projects, project approval and implementation forms, reporting, cost controls, project termination, etc.

241. When planning technical activity modules, the following must be considered as a precursor to their establishment:

* Identify the potential industries and government agencies which will use the module services and ascertain the present and probable future demands for such services on the basis of the client surveys;

* Define the modules' role as compared with similar or related institutions already in existence or planned for the future;

* Prepare a growth plan for the module, related to short-term activities, as well as to the long-term projected opportunities.

2. Research Strategy

242. Ideally, an IRSI research programme in its area of pre-determined coverage should represent the operating level of a national science policy and its implementation. When an IRSI is to emphasize research and development as a functional category, a specific research strategy is necessary to identify clients, select priorities and approaches, provide a balance of in-house and sponsored research, avoid costly or premature investments, plan for necessary linkages, etc.

Strategic v. Tactical

243. In some of the least developed countries, there may not be a significant industry needing advanced services of an IRSI but one may have reason to expect that within ten to fifteen years the market for research will be there and of great importance. It takes time to develop advanced research modules, and in order to be able to meet the future needs one may have to start immediately. This type of endeavour may be called strategic research, while catering to immediate research needs, if they exist, may be termed tactical research.

244. The government must pay for strategic research as there will be no other financing source but industry should be invited to serve on steering committees, etc., so that they will be involved in its earliest stages. Such projects can, for example, be studies of certain technologies like laser technology, computer application or computer building, solid-state technology, explosive forming, new energy resources, bio-chemical conversions of waste, etc. It must be understood by the sponsors that the purpose is not primarily to produce some invention but to develop know-how and skills believed to have a market in the future. Some new process or product may result but should not be the yardstick of success. The important output of strategic research is skilled people and research facilities.

245. In the less developed countries, R+D in terms of innovation and solving difficult problems is in small demand, and IRSIs in such countries have very limited capability for such different work. In these conditions, it appears more appropriate to concentrate on the simpler and more routine services and tactical research which can be successfully carried out and be of immediate use. Even in the more developed countries, plans for ambitious R+D programmes should be rigorously assessed since the cost and the risk are very high.

246. A research strategy involves making some assumptions in developing operating policies with respect to a number of important parameters which include:

* Whom to serve, i.e., small, medium or large-scale industries, joint ventures, national firms, private and/or public industries, etc., which must be in harmony with current or projected IRSI capabilities and national industrial plans and policies, to the extent these exist;

* Selection of priorities, i.e., emphasis on routine non-research services and consulting or extension services vis-à-vis more sophisticated services and applied research;

* Human resources, i.e., availability of skilled researchers (national v. foreign), need for staff training programmes, mechanisms to motivate R+D staff, appropriate management, etc.;

* Extent of engineering involvement, i.e., concentration on the scientific approach to solve basic problems and produce knowledge with industry and/or engineering consulting firms applying the results vis-à-vis the IRSI involvement in pilot scale prototype developments and plant design.

In-house v. Directed Research

247. Another aspect of research strategy involves in-house research. Such research can be planned in terms of staff development (to familiarize them with and find applications for advanced technology), to develop new products or processes, to find new uses for local components or raw materials, etc. A proper balance between an in-house and outside work must be achieved. Too much in-house work keeps the IRSI staff insulated and without industrial feedback. On the other hand, sponsored projects may be too trivial to develop the staff and provide job satisfaction or unrelated to the IRSI's prime mission. As a guide, the more mature IRSIs do not usually permit more than 20% of their staff time for in-house research. In any event, the same conditions of practicability and applicability of tactical or sponsored research should apply.

248. Another useful strategy is to give priority to activities which help a group of enterprises, e.g., upgrading product control or by solving problems common to many users, for example, corrosion problems and standardization. To help industry help itself is much more useful than to do for them what they ought to do themselves. Routine and simple testing, rather than more sophisticated testing and analysis, will not help the IRSI which should instead be helping industry to establish its own laboratories and capabilities and/or shed off this activity to a non-research institution.

249. R+D conducted by the IRSI should be directed towards industrial application and/or the country's economic development. This does not preclude in-house research activities or government supported research but rather establishes the focus of an IRSI's activities. It is important to avoid R+D which clearly has no relevance to industrial development needs, at least in the near future, and to be fully aware of similar research which has already been done elsewhere. It is unlikely that an IRSI will conduct original or basic research but rather will devote its R+D energies to application of existing knowledge for local needs. There is no way to define the appropriate level of R+D sophistication except on the basis of impact on country economic development and the actual or projected level of industrialization. The tendency for researchers everywhere is to be involved in research on the frontiers of knowledge but this should be rejected in the majority of cases by IRSI management, particularly where current development needs call for practical problem-solving and there is a scarcity of skilled human resources. Conduct of R+D in the developing countries with little or no relevance to demonstrated industrial need is a luxury that few countries can afford.

Pilot Plants

250. Another approach, sometimes utilized, but with varying degrees of success, is to go all the way through pilot-scale plant design and even to construction, start-up, and "hand holding" until viable production is achieved. This approach can be successful and economic in small or less developed countries where the technology is traditional and simple and the projects are small. However, if this approach is used for developing complicated and large-scale processes, e.g.,

petrochemical, extractive, and metallurgical industries, the risk of failure increases rapidly and even success may be constrained by delay, changing marketing requirements, high costs, and other factors.

251. The ineffective and costly experience of both developed and developing countries in the use of pilot plants underscores the importance of giving careful consideration to this subject in developing a research strategy. The purpose of a pilot plant should be to bridge the gap between the laboratory researcher and the plant design. This is a difficult task which is likely to fail if not undertaken in close cooperation with a capable industrial counterpart. General purpose pilot plants have generally proved to be uneconomic and ineffective. Their use for market research and as a means of attracting investors has also been disappointing and there are usually serious problems connected with scaling down operations. On the other hand, use of pilot-scale plants for demonstration, training and testing (e.g., for process experiments and testing raw materials), has been more promising and cost-effective, particularly in single-branch IRSIs. While there are undoubtedly conditions which will justify the use of pilot plants, the high cost and risk of such a strategy and the "sunk" investment required should be carefully considered by IRSI managers and their sponsors.

Securing Clients

252. While there is no substitute for demonstrated IRSI capability, an IRSI should make a considerable effort to promote its services through use of such devices as publications, industrial seminars, plant visits, self-initiated surveys of common problems, dissemination and application of general technological information, involvement of government and industry representatives on board of directors and other ad hoc committees, short term staff exchanges, etc. In addition, it might also perform certain self-initiated surveys of common industry issues which can further reveal its deficiencies and needs. These can include studies on such questions as: quality control; quality of goods produced; productivity and other indicators of efficiency; market trends; maintenance problems; need for automation and control system; scope and use of computers; means for substituting inputs by local ones; identifying promising import substitutes. Annual reports and other public relation efforts can also help in establishing closer contact, but the best way of selling research and finding out the needs of industry is by doing successful projects in close cooperation with them. Only when the researchers become intimately involved with the industry they are to serve will they discover the needs which they can satisfy.

253. In terms of government clients, an IRSI can provide significant inputs for decision-making. Most research today is not laboratory-based but field and desk work such as market and economic and social studies. IRSIs should develop and promote their capabilities in these areas. There are a number of techniques for securing clients which can be considered including the following:

Directed use such as:

* Compulsory quality control;
* IRSI included in government planning machinery;
* IRSI recommendations required for licenses or other government support;
* Sole source in centralized economies.

Government stimulation to industry such as:

* Research expenses refunded in full or partly;
* Financing of prototypes;
* Soft loans, etc., when research results are being commercialized;
* Tax benefits and other protection and/or incentives.

Government assistance to the IRSI:

* A research council or similar agency provides grants for strategic research;
* Award of R+D contracts directly to IRSIs;
* Purchase of specific services.

3. Management Strategy

Staff Development

254. It is a clear finding of the evaluation exercise that the absence or inadequacy of staff development plans has been a major obstacle to the growth and success of IRSIs in the developing countries. This deficiency coupled with high staff turn-over caused by non-competitive salaries and unattractive conditions of service, can quickly lead to stagnation of institutional development.

255. Good IRSI leadership is the most predominant requirement for staff motivation and morale. It is the director's responsibility to assure that government provides as part of the IRSI's charter or mandate a workable professional staff development and career policy which includes, to the extent possible, the following elements:

* Selection of personnel based on qualifications and experience;
* Establishment of training programmes within the institute and industry which define the methodology of research, team work, specialization, adaptation to local conditions, identification of needs and priorities, extension work and public relations;

* External activities such as specialized training abroad as appropriate, sabbatical leaves for research and study, participation in national and international professional seminars, TCDC activities, workshops, societies, etc.;

* Ability to recruit specialists either national or expatriates well in advance of need;

* Exchange of staff with universities, other technological institutions, and industry.

256. It can be useful to use the activity module concept previously described in developing and planning staff size and skills composition. An activity module should not be established unless at least one senior professional, two junior professionals, and several technicians are available, i.e., a critical mass is provided, and the module development plan calls for additional professional staff in the near future. If an experienced senior professional is not available, then establishment of the activity module might better be deferred until a latter phase.

257. It is important to define the ratio of professionals to non-professionals for the various activity module. This ratio will vary according to government and IRSI policy and the character and requirements of the activity module. For example, it is usual to maintain a ratio of 1:1 to 1:2 between professionals and non-professionals in a research and development module, whereas in analysis and test modules, pilot plants, services and shop modules, and administrative services, the ratio will be as high as 1:4 to 1:5. In some countries, university graduates with a baccalaureate degree are used in a supporting staff role due to a shortage of trained non-professionals. The IRSI management must recognize this waste of talent and undertake vocational training programmes for staff to release the junior professionals for more important work. The ratio between technical and administrative staff should be kept as low as possible in order to maximize technical inputs.

258. Skills composition is equally important. Academic training, per se, is not sufficient to qualify a staff member to undertake industrial problem-solving or operate a pilot plant. It is not often that staff members with industrial experience can be attracted from industry, although expatriates who have been trained and who have worked in a foreign locale are a good potential source (KIST in Korea and Marmara in Turkey have had outstanding success in attracting experienced expatriates by offering a good incentive programme). If appropriate skills are not available, it is desirable to defer activation of a module until personnel can be trained or acquired.

259. Finally, it is important to consider minimum or "critical" size. An IRSI with less than ten professionals cannot possibly offer, in an effective manner, all of the services that may be required. It is far better to limit the number of activity modules so that these can operate efficiently, rather than to spread the IRSI efforts too thinly

as is so often the case. An IRSI with 30 to 40 professionals can be expected to have the potential for performing effective services to industry and government, but, even so, such services should be limited to staff skills and capabilities. The IRSI's reputation will be severely damaged if services rendered are inadequate.

260. Staff development is probably the slowest and most difficult function to plan for, whether in extension services, supporting services, or R+D. It is usually the principal constraint in a developing country whose importance is often underestimated on the assumption that like plant and equipment, personnel too can be imported at will. Neglecting this function also contributes to the so-called "brain drain". Staff training and development have to be conceived in terms of incentives, maintenance of a high-level of morale, and the fostering of creative abilities, individually as well as in groups. The IRSI needs to have a clear and consistent policy on development of professional staff in order to ensure institutional stability and maintain the ability to attract, retain and/or replace competent staff. Such a policy should include favourable working conditions compared with other sectors of the society, incentives and professional enhancement opportunities, and above all, recognition if the status of research and development is to be on a par with university professors and other professionals.

Organization, Management and Financing*

261. The ultimate research strategy in any country has to be worked out by its own nationals in consideration of local conditions, and this includes the organization of the IRSI itself. In any event, in-house organisation, policies and programmes need to conform to basic criteria essential for the efficient conduct of mission-oriented research and development and scientific and technical services. These criteria include:

- Mission or problem-oriented work should be carried out as far as possible within their respective operative sectors, e.g., individual enterprise, group enterprises, and government units;
- Research units need a critical mass of personnel and facilities to be effective;
- Efficiency of factor combination is a crucial organizational consideration. These include physical resources, management, investment, marketing, manpower development, employment, regional development and many other elements (UNIDO/EX/66).

262. One principle which cannot be emphasized too strongly to the smaller or least developed countries is the need for simplicity in institutional structure. At the early stages of national industrialisation there is no need for a complex institutional structure such as

* See also "Industrial Research Institutes: Organization for Effective Research, Technical and Commercial Services", ID/161 (UNIDO/ISID.119/Rev.1), UN Publication, Sales No. E.75, II, B.9, 1975

found in the IRSIs of some of the more advanced developing and industrialized countries. This concept needs to be applied at two levels, i.e., to minimize both the number of institutions and the individuals involved in them. The fact must be faced that in the average small and least developed countries, the supply of managerial skills, industrial specialist technicians and public budget resources are so limited that the number of individual departments, divisions or institutions must necessarily be restricted.

263. IRSIs frequently are organized along lines which include traditional science and engineering disciplines, instead of a service or activity orientation, which experience shows is an ineffective approach to industrial development. No matter what its mandate and policy objectives, IRSI management must be alert and capable of changing the IRSI organizational structure and operations in accordance with changing client or user needs. When an IRSI is a civil service type of organization under the total control of a government ministry, such changes are usually difficult to accomplish. For this reason, there is increasing interest in structuring or restructuring IRSIs as autonomous foundations or limited corporations which, even though continuing to receive major government financial support and overall direction, still permit the IRSI management discretion in salary schedules, utilization of generated income, and provide more flexibility in changing IRSI activities to reflect changing industrial needs.

264. While the need for autonomy is repeatedly stressed by IRSI directors, this does not mean freedom from review and accountability by its sponsors. The crucial need is for management to have sufficient flexibility, both in the choice and staffing of programmes, to develop innovative institutional capabilities, seize opportunities as they present themselves, and respond to unforeseen problems. Government should also recognize that the civil service regulations which apply to normal government operations, will, if applied to IRSIs, stifle the creativity and innovation of IRSI staff and management. Researchers must receive recognition in society as researchers, not as civil servants who may be performing routine activities. This means that government should recognize researchers at the same or higher professional level as professors in universities. It would be best if the need for this flexibility is understood at the beginning by the sponsors and its means are built into the charter and institutional development plans for the IRSI.

265. Perhaps the most important decision in the early phases of an IRSI is the selection of the director or the chief executive of the IRSI. On his professional and national stature, proven competence, personality and dynamic qualities of leadership and integrity can depend the success of an IRSI more than anything else. The IRSI director should be appointed on the basis of his management capabilities and not simply because he is a renown scientist. As a matter of experience, such people usually do not make good directors. His principal responsibilities are to motivate and stimulate the technical staff, to provide positive leader-

ship, decision-making and guidance to IRSI programmes, and to be innovative and imaginative in his relationship with the government, the IRSI board of directors, and with past and present clients. At the same time, as stated above, he needs the opportunity for reasonable operational autonomy, flexibility and decision-making, coupled with the responsibility and accountability to the IRSI board of directors. It is particularly important that he be able to delegate authority for daily routine in order to have time for effective planning and cultivating and maintaining outside linkages. Each IRSI director must attempt to gain a clear insight into the relationships between IRSI inputs, such as staff, equipment, and facilities, and IRSI outputs such as quantity and quality of functions performed. Serious attention should be given to the process of project screening, implementation and periodic evaluation, including costs. A project screening and evaluation committee is extremely helpful.

266. It is also important to define clearly the functions and responsibilities of senior IRSI management. These should include not only external relationships with government and industry but also internal responsibility with regard to generated income, operational budget, professional staff development, delegations of responsibility, development of effective work programmes designed to meet national needs and so forth. It is desirable for the IRSI director to be solely responsible for these functions to his governing board who will assist him in making these decisions.

267. A strong and well functioning IRSI board of directors or governing council can provide effective leadership to IRSI management. The most appropriate board composition is a blend of representatives from:

* The government agency (or agencies) responsible for industrial development;
* Industrialists of large-, medium-, and small-scale enterprises;
* The government agency responsible for the technological development of the country;
* Other scientific and technological institutions (e.g., universities, other technical institutes, etc.);
* Financial institutions (development banks, etc.).

The governing board should be small enough (perhaps ten to twelve members) so that it is both representative and able to function effectively.

268. It is necessary that the board of directors meet frequently and consider the following as a part of its normal functions:

* Review and up-dating of the IRSI's general policy, objectives and mission or its role in the industrialization process;
* Ensure and endorse the mid-term and long-term strategies and growth plans of the IRSI;
* Approve the annual work programme of the IRSI;
* Reourring evaluation of the IRSI programmes and activities;
* Facilitate high-level relationships with government and the public and private industrial sectors.

The IRSI director should prefsrably be responsible only to the board or council for all executive functions and IRSI daily operations and be an ex officio member but, under no circumstances, should he be the chairman. In case of government-sponsored IRSIs, this role should be carried out by a senior official of the principal ministry or agency involved. When industry is also providing support, the chairmanship might rotate. Particularly where the IRSI director is not clear in his own mind as to the purposes of his institute, guidance can be provided by a strong board of directors which takes an active role in programme direction.

269. The board of directors cannot be entirely dependent on IRSI management for information, but should have access to alternative sources of information in order to carry out its assessment of the IRSIs activities in the most objective manner. The board is also the logical forum for all entities in the country interested in or related to the IRSI's activities. In order to accomplish these tasks more efficiently, the board should create sub-committees such as panels of expert groups for particular economic sectors or industrial branches, and which can assist the IRSI in establishing priorities for proposed programmes or projects.

270. A cruoial part of any growth plan involves funding both for facilities and operational expenses. Even if an IRSI is established in close co-operation and with the support of industry, it is likely to require considerable government support for a good many years until it reaches maturity and probably beyond. In the early stages, such funding will most often and appropriately take the form of general subsidies for operating expenses and strategic or in-house research. As the IRSI's capabilities to perform useful services increase, however, plans should be made for decreasing this dependence on government funding by not only seeking other sources of funding, that is, payment for services rendered to industry and government, but by changing the nature of government funding to contracts for services, including tactical research. While it is unrealistic, and perhaps undesirable to expect a government created IRSI to even become completely financially self-supporting, its ability to sell an appreciable portion of its services inevitably must be a major measure of success and justification for continued support.

271. Funding to provide services to small-scale industries, who frequently are unable to pay poses an acute problem in the absence of government subsidy or other mechanisms for payment for the services rendered to this sector. An appropriate mechanism could be to establish a grant, from which the IRSI can draw funds under conditions of proper accountability, to provide services to small industry under pre-established criteria and priorities. In this manner, at least some of the needs of small industry will be met, their contributions to economic growth and development will increase, and the IRSI will be generating income for the support of its facilities and staff.

272. The need for tax or other incentives to encourage and stimulate industry use of IRSI services has been mentioned earlier. The incentive can take the form of a value-added tax, payroll tax, provision for income tax exemption or tax holiday, etc. Government can rebate or credit the tax directly to industry with the clear understanding that the tax incentive will be used to obtain R+D or other services, either from the IRSI or another institution. Alternatively, government may wish to establish a fund from which costs of projects jointly proposed by the IRSI and industry will be paid.

273. International and bilateral assistance is extremely valuable to the IRSI in entering new fields and types of functions. But such assistance should be accepted with full realization that the assistance will be limited in duration. Governments and IRSI management should take this factor into serious consideration when designing or expanding an IRSI in order to avoid fluctuation and regression of IRSI operations when the external assistance is no longer available.

Equipment and Facilities

274. When designing an IRSI building, consideration must be given to adequacy of several types of working space in terms of the potential for efficiency of workers. As a general rule, only about 60 percent of the total floor area of a laboratory and pilot plant building will be available for technical activities. The balance of the floor space will be occupied by offices, library, rest rooms, corridors, storerooms, etc. The following figures for average working space for each professional worker represent general experience:*

- 20 square metres is crowded, inefficient;
- 20 to 40 square metres is adequate;
- 40 square metres is liberal and permits considerable expansion in staff.

275. Other criteria cannot be stated quantitatively and must be judged on the basis of functionality. These include: general suitability for efficient technical work such as cleanliness, appearance, lighting; suitability of laboratory furniture, offices; utilities; safety features; ease of access to storerooms, offices, library, conference rooms, rest rooms, shop facilities, etc.; locational features such as access to parking, transportation, buses, etc.

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* Industrial Research Institutes: Guidelines for Evaluation, UN Sales Publication No.E.71.II.B.22, 1971

276. In highly industrialized countries, the cost of a facility for research services usually represents the equivalent of the annual operating cost of the research group that the building houses (exclusive of equipment). This may be seen to represent a capital investment per worker similar to that in capital-intensive industrial installations. Even though salaries and other operational costs are lower in developing countries, the ratio of building to annual operational costs appears to remain essentially constant with, of course, realization that operational costs (and building costs) are programmed for steady-state instead of start-up costs.

277. Similarly to building costs, there is no formula that will define the capital investment in equipment. Equipment costs will vary greatly depending on the nature of services to be performed. Pilot plant equipment or sopnisticated equipment may entail an initial high cost. The necessity for such equipment must be carefully appraised in terms of actual and potential use. It must also be recognized that equipment will become outdated or obsolete so that an IRSI will be faced with recurring costs to procure new equipment. It is reasonable to assume that, after an IRSI is established, the annual expenditures for new equipment and replacement of obsolete equipment will amount to approximately 10 to 15 percent of the annual operational budget. Spare parts and appropriate maintenance represent additional costs which should be included in equipment acquisition budgets.

278. It is essential that a minimum collection of 2,000 to 5,000 volumes and journals be available to supply technical information to a professional staff of 50 persons. The number of journals to be obtained on a subscription or exchange basis may run from 200 to 300. If the average cost of a book is based on U.S. $20 per volume, the rate of growth of the library collection should be based on a ratio of 1.5 to 2.0 times the rate of growth of the professional staff. The availability of micro-film, microfiche, and other modern library aids can reduce the cost involved, but the number of library acquisitions still must be recognized as essential to the provision of technical information services.

C. Performance

1. Overcoming Barriers

279. It is useful to repeat here some of the obstacles confronting IRSIs in providing effective service to industry. These are:

* Industry lacks confidence in the ability of IRSIs to provide meaningful solutions to their problems in a reasonable time and cost;
* Industry (including public enterprise) believes that it should not pay for the services provided by an IRSI when the institute is largely subsidized by government funds;
* Industry usually is wary of the IRSI-government relationship which could result in disclosure of potential patent possibilities, technical secrets, or management information to government agencies or competitors;

* Industry does not often evidence a genuine interest in the research results of an IRSI until these have been carried through a pilot or demonstration plant phase and production, economic, and marketing feasibility problems have been resolved.

280. In an earlier study of IRSIs and their effectiveness,* 17 IRSIs in Latin America and Southeast Asia (some of the IRSIs are included also in this current evaluation) indicated some of the internal and external constraints which inhibited their ability to interact effectively with industry. The most important internal constraints consisted of: inadequate knowledge of industry; poor marketing skills; low-pay for professional staff; inexperience; disinterest in practical problems; inadequate information sources and lack of physical facilities. External constraints included: lack of mutual interest and understanding; inadequate technological payoffs; lack of confidence in IRSI capabilities; industry bias; and ties to foreign companies. Regardless of the weights which must be assigned these factors in individual cases, the important point is that IRSI management must consider carefully such internal and external constraints and devise ways and means to overcome them and improve the performance and effectiveness of services rendered to the industrial sector.

281. An analysis of barriers to institute effectiveness, vis-à-vis constraints, becomes more subjective in nature but a few examples illustrate the problem:

* Civil service rigidity and limitations;
* Budgetary constraints and lack of discretionary control;
* Lack of coordination between national plan and institute programmes;
* Inappropriateness of institute programmes;
* Lack of client-oriented promotional and programme development activities;
* Problems of professional staff recruitment, development and incentives;
* Management limitations on development, delegation of authority and encouragement of staff;
* Failure of universities to train potential institute staff members appropriately;
* Government intervention which impedes institute-industry interaction.

282. It is necessary to differentiate between barriers and constraints on the basis that the IRSI may be almost completely unable to influence

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* James P. Blackledge, "The Industrial Research Institute in a Developing Country - A Comparative Analysis", USAID, August 1975, p. 43

the barrier (e.g., civil service rigidity and limitations, availability of risk capital, etc.) to effective interaction with public and private sectors, while there is some hope that constraints (unawareness of industrial needs, inadequate technological information, etc.) might be altered or modified with appropriate skill, consultative assistance, etc., to encourage and, in fact, achieve increased industrial interaction.

283. What are the most appropriate methodologies to follow which will assist IRSIs in solving or at least ameliorating those barriers, constraints and operational problems over which they have some control? What can be done to assist these IRSIs in becoming more adept at recognizing and solving the problems of public and private enterprise? What strategies are of value in helping IRSIs to achieve more effective and productive interaction with government as well as industrial sectors, and thus become recognized contributors to their nation's economic growth and industrial development?

Linkages and Networks

284. Two eminently practical and proven mechanisms are available to assist in the above. These are linkages—from advanced to developing, or developing to developing IRSIs—and networks, focused on specific problems and involving either regional institutions (including universities), area institutions, or other mixes. Linkages and networks have considerable potential for providing broad-scale, appropriate technical and management assistance.

285. Many IRSI directors have indicated a need for an integrated approach to expert assistance. They want to be able to call on several disciplines relating to IRSI management, promotion and development, research, etc., perhaps at the same time, and quickly. Thus, IRSI directors have expressed a strong interest in the establishment of linkages created around specific problem areas and with opportunities for a two-way flow of people, a variety of training programmes, management and technical assistance, and joint participation in research.

286. The nature of the linkage will vary according to the level of sophistication and needs of each participating institute. However, in each case, the linkage should be specifically directed toward assisting the IRSI in its own institutional development so that it will be able to improve and enhance its interrelationships with those public and private sectors it is intended to serve. It should also be recognised that linkages, in order to be successful, must be long-term in nature and must be funded and provided with continuity for a period long enough to carry the programme through to completion.

287. In all such linkages, it is important, if possible, to create relationships not only between advanced country and developing country IRSIs, but also among several IRSIs in the same country or region, so that, with time, these institutes continue to interact with each other in a multi-directional manner, sharing experiences, problems,

available or adaptable technology, etc. Also, it will be important for some of these institutes, again with time, to become the nucleus of a smaller network of institutes within their own country or contiguous region and assume the leadership role of implementing and expanding the goals and objectives of the linkage. Admittedly, it may be most difficult to overcome problems of communication and sharing of data, information, experiences, etc., among institutes in different countries. Indeed, at times, governments may even impose constraints. Nevertheless, a continuing attempt to achieve such interactions will pay off.

288. Examples of management and technical assistance available through a linkage mechanism include:

* Short-term, repetitive management consulting and technical assistance between linked institutes which can guide IRSIs in their institutional development. This level of assistance should concentrate on the solution of IRSI problems which relate to those external forces (development banks, public-enterprise, planning agencies, industrial sector) that influence or constrain effectiveness of the IRSI's interaction with potential users of technology and those internal sources that might augment or inhibit the IRSI's ability to become involved in such external interaction. In other words, the objective is to assist the IRSI director and staff in learning the management tactics and techniques necessary to become technological entrepreneurs.

* Identification of priority problems and courses of action to be followed by the IRSI director and his staff. These include: organizational changes; promotion and programme development; professional staff development; programme budgeting; internal project evaluation; long-range planning. Also to be included are the design of R+D programmes relevant to local and national needs (including co-operative research in selected cases) based on: technical assistance and consulting to small and medium industry; technical extension services; problem-solving and trouble-shooting; applied research through the pilot or demonstration plant stage; economic feasibility and market analysis; analysis, tests, and standards. Consideration can also be given to entry into new areas of research.

* Administrative and operational problems to include project management, fiscal controls, financing mechanisms and alternatives, contracting principles, full recovery of cost versus cost-sharing, facilities administration, and accountability to government or other sponsors.

2. Research and Development

289. The conduct of R+D, whether in-house, externally sponsored, or part of a linkage agreement, should be submitted to the following analysis and assessment:

* Has the research already been done elsewhere;
* Can marketing and economic justification be demonstrated;
* Has the research proceeded for an extended time without demonstrable results;
* If being performed under contract, has the project exceeded the projected cost estimates;
* Is the project in consonance with the IRSI's goals and objectives, the national need; the requirements of the client?

The above criteria are essential elements for sound IRSI performance in R+D and cannot be ignored or evaded.

290. Because of the importance attached to pilot-scale plants by many IRSIs in the sample, some additional guidance may be useful. To begin with, the term "pilot plant" requires some definition.* In some instances the pilot plant is regarded as a small-scale simulated factory process, larger than a laboratory setup or so-called bench scale, but smaller than a production plant. In some developing countries, however, the pilot plant may, in actuality, be of a size sufficient for commercial operations. Pilot plants can be used effectively for one or more of the following:

* Experimentation with equipment and process conditions for the purpose or developing a process as such;
* Testing of raw materials with respect to processing conditions and material quality;
* Production of small lots of the contemplated product for the purpose of market research;
* Determination of process economic feasibility and process production parameters; and
* Demonstration of the reliability of a process to a potential end-user.

291. The value of pilot plants for such experiments in multi-purpose IRSIs is often marginal, and pilot plant construction and maintenance should be avoided unless a client (government or industry) is prepared to share the cost and use the results. In some IRSIs, industrial sectors or industrial associations have contracted with the IRSI to establish pilot plants to develop a specific process or product.

* UNIDO/EX/65, p. 7

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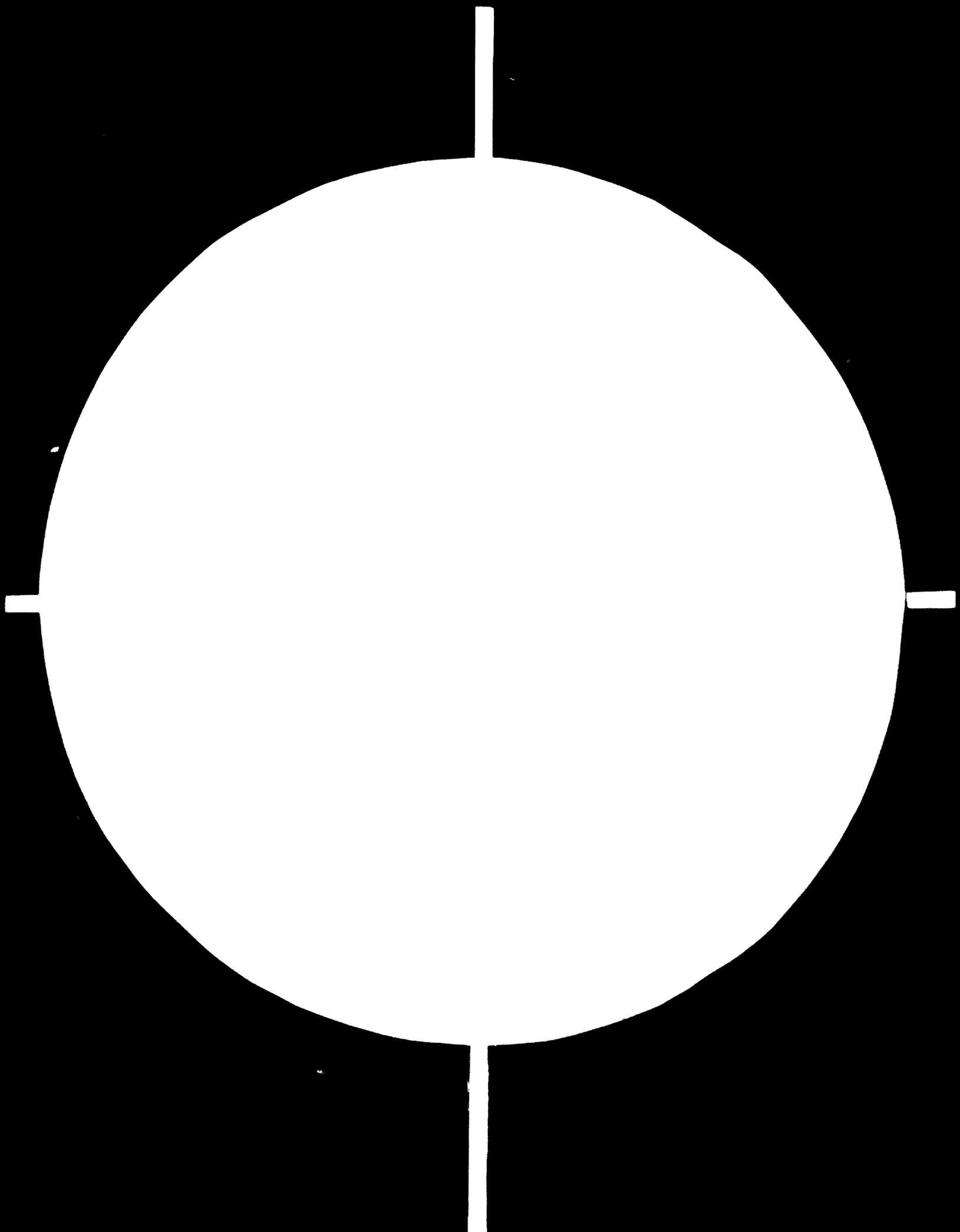

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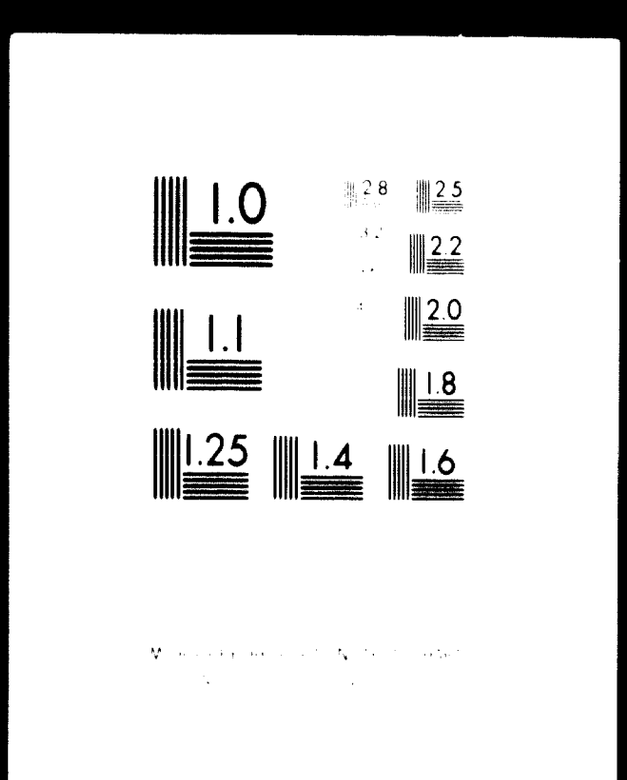

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292. A single-branch or similar IRSI will frequently have special pilot plants, designed for specific processes such as tanning, food processing, textiles, etc. The purpose of these plants is chosen so that these pilot plants will be used regularly. In such cases, the IRSI can justify the support of a staff thoroughly familiar with process operations and usually will have enough projects to pay for at least a substantial amount of the operating costs. The purpose for such plants can be: teaching and training; process optimization; treatment of various raw materials; testing of new raw materials, additives, chemicals, etc. Such tasks can usually be well defined and justified. The equipment is standard for the processes and products. Experiments in such pilot plants are usually of a routine nature, needed by an established industry sector which must be large or have a very good potential. If such industry sectors do not exist or will not share the pilot plant operating costs, it is unlikely that such pilot plants will be justifiable.

293. Pilot plants should normally and preferably be located on the premises of the industry concerned, not at the IRSI. Industry personnel have the process experience not usually possessed by IRSI staff. If the pilot plant is semi-commercial or commercial in size, transition to industrial production occurs more easily. The very fact that the industry builds the pilot plant is an indication of industry's interest in the results. Obviously, IRSI staff members can provide technical assistance to the pilot plant operation and have an opportunity to receive practical industrial experience at the same time.

Selling Results

294. IRSI research is of little value to the national development process, unless the research results are capable of commercialization. Some of the reasons for lack of commercialization have already been stated, e.g., absence of techno-economic feasibility studies and market analysis to indicate product or process potential, unwillingness of industrial entrepreneurs to take risks on unproven technology, lack of adequate financing mechanisms and incentives, etc. It is also clear that IRSIs, as a general rule, do not possess the mechanisms and capabilities to sell the completed research as a "package" acceptable to the entrepreneur.

295. Thus, there is a potential and a need for establishment of a technology development organization (TDO) to work in collaboration with the IRSI divisions to develop further research results and sell them to industrial entreprises. Several organizational structures can be considered:

* As a branch or unit of the IRSI staff;
* As a joint venture of an IRSI and a developmental entity (e.g., government agency or development bank);
* As an independent institution or corporation created by the government.

296. To perform their role, TDOs can use their own technical resources, rely on their units within the IRSIs, or rely on outside expertise such as consulting firms, universities, etc. The following are the most important functions of a TDO:

* To search for, evaluate, and select new technologies, doing the necessary market research and techno-economic feasibility studies;
* To further develop and adapt technologies for potential users;
* To promote and sell technologies;
* To assist industry in the implementation phase of innovative projects;
* To administer a special loan scheme with low interest rates for firms that have no access to venture capital on reasonable terms;
* To provide equity capital for new technology-based enterprises.

The last two functions are particularly important for TDO effectiveness, because the financing of technological innovation is a highly specialized and risky operation—normally not performed by ordinary financial institutions. A public fund, sharing the risks, can significantly improve the attitude of industry towards buying the results of R+D.

297. Notwithstanding the previous statements, there are some important limitations to the role that the TDO can play in under developed technological markets. The main limitations, some of which have already been analyzed, are:

* Local enterprises frequently lack confidence in the capacity and capability of national institutions to generate new technologies and are especially reluctant to use technologies that have not been tested in production;
* The cost of developing new technologies is relatively high for small industrial markets;
* It takes a long time to create new technologies when considering the general instability of some developing countries;
* Market conditions are often unstable and rapidly changing;
* In many cases, imported technologies are more convenient in terms of cost, availability, and guarantees;
* It is difficult for government agencies to hire and retain TDO specialists with broad industrial experience.

3. Extension Services

298. In the face of the oft-stated lack of confidence by industry in the IRSI, it seems obvious that this problem can be overcome to an appreciable extent if IRSI staff (or preferably its technical extension representatives) were to dedicate a certain portion of their time and energies to plant visitations. In the course of this process, the IRSI staff would be able to learn at first hand the realities of production, to identify potential areas of research, alternative technology application, or other service problems, and would be in a good position to promote their IRSI's capabilities. It is clear that aggressive salesmanship is required, backed by effective laboratory services, if an IRSI is to improve its relationships with industry. It is likely that initial technical extension assistance will be limited, at first, to provision of know-how information or to make the industry aware that analysis, testing, and quality control services are available through the IRSI. A practically oriented, alert observer, however, may be able to identify a real problem which often exists beneath the surface symptoms recognized by the industrialist and point this out to him, thus again leading to an opportunity for the IRSI to provide technical services.

299. The <u>technical extension agent</u>, with responsibility mandated for frequent and continuous contacts with industry, can, if well trained, experienced, and backstopped by his IRSI, perform the following functions:*

* On-the-spot problem-solving;
* Identify industry problems solvable by the IRSI;
* Refer technical information needs to the IRSI;
* Serve as "translator" between IRSI results and industry utilization;
* Refer industry to alternative assistance;
* Assist in the promotion of and awareness by industry of IRSI capabilities.

300. Through the mechanism of a two-way exchange of information about industry needs and IRSI capabilities (communication) both the IRSI and industry will begin to understand the need to work together. The IRSI is thus brought out of isolation and gains an insight into the nature of industrial problems. Industry which, under other circumstances, may not even be aware of the existence of the IRSI, can learn to recognize the potential which exists for technical assistance and services. A technical extension agent performing this function on a frequent basis will have an excellent opportunity to promote IRSI research efforts which have a potential for commercialization, but which have not been recognized for exploitation by

*UNIDO/EX/68, pp 9-11

entrepreneurs, who usually are not aware of the IRSI's research activities.

301. The extension agent could assume the responsibility for follow-up on all IRSI-industry interactions to assure that industry is satisfied with results provided by the IRSI, has been able to utilize and/or apply the results satisfactorily, and that the problem has been or is being solved. All too often, technical staff tend to believe that, once a report is prepared, there are no further steps necessary. But, if the research or service results are not implemented, then the IRSI effort may be meaningless. The technical extension agent, through his frequent contacts with industry, has an excellent opportunity for follow-up to assure that the IRSI provided what was needed and that industry benefited from the results and, as necessary, to recommend internal remedial measures.

4. Self-evaluation

302. Every IRSI should undertake continuous self-evaluation of its operations, its activities, and its relations with clients. Such evaluations are admittedly difficult and at best are subjective and open to a certain amount of bias. However, if a respected client no longer utilizes the services of the IRSI, or the responsible government entity appears to be indifferent or non-responsive, there should then be real concern on the part of IRSI management as to why. Attempts should be made by IRSI management to contact clients and government entities on a frequent basis and ask pointed questions regarding their views of the IRSI effectiveness. If the IRSI performance has been unsatisfactory, an attempt should be made to learn the reason, e.g., poor or unsatisfactory results, lack of understanding of the problem, unreasonable costs. Whatever the reason, IRSI management then has an opportunity to rectify the situation, obviously a more desirable route than to have a dissatisfied client talking to his colleagues about his negative experiences with the IRSI.

303. The IRSI director should periodically ask himself the questions posed in paragraph 210. In addition, he should ask of himself and his staff the following questions:

* Is the present institutional framework (multi-purpose or specialized or other) the most suitable for the institute? Does the institute have sufficient freedom and autonomy to operate?

* Are all technological sectors adequately covered by the institute as required by the country's industrialization? Are the individual departments sufficiently equipped and staffed?

* Has the institute a well functioning governing body? Does it understand its duties? Does it provide sufficient guidance to the institute in defining the IRSI overall policy objectives?

* Are there policy objectives established for each of the departments of the institute? Are these regularly reviewed and adjusted? Priorities established?

* Is the organization and administration of the institute commensurate with its policy objectives and functional activities?

* Has the management of the institutes established a work programme for the institute as a whole and for each respective department commensurate with the policy objectives? Does its management understand the concepts involved to convert such policy objectives into work programmes and projects?

* Is there a well functioning project system (i.e., selection, implementation, and control) in effect?

* Does the institute have a good management and leadership team and management system?

* Does the institute have adequate financial resources and financial autonomy to cope with the work and responsibilities it is charged with? Does the governing body provide help and backing to the institute's management in this respect?

* How well does the institute perform, department by department, in achieving its policy objectives as related to: improving existing industries; transfer of technology; adaptation of technology; development of new technology; and utilization of raw materials?

* How well does the institute perform, department by department, to discharge its functional activities as related to: supporting services; extension services; research and development; and the training of personnel?

* Are the contacts of the institute with industry and the business community good? Are contacts with other organizations, such as other R+D institutes, universities, government bodies, adequate?

304. The above is a formidable set of questions, and few IRSIs would be expected to receive high marks on such a test, particularly in the short term. They are, however, the types of questions which should be constantly before the IRSI director and his governing board who should take the necessary action, to the extent possible, to arrive at satisfactory answers.

D. Impact and Relevance

305. In summary, IRSIs in developing countries can and should have a greater potential for impacting on government and industrial sector development plans and needs than the IRSIs studied actually achieve in most instances. Where policy objectives and functional activities are succintly defined and aggressively pursued, and if government and industry are partners with the IRSI in the process, then it can be demonstrated that IRSIs do have measurable impact provided they are properly funded. A number of times, this necessity for purposeful interaction has been noted. All elements of the development infrastructure—governments, development banks, industry, IRSIs—must continually assess their respective responsibilities to contribute to the system, and to achieve changes necessary to impact on industrialization. There is no way that the IRSI can achieve success on its own, in the absence of appropriate inputs from other elements of the system.

306. This is not to say that the IRSI should not attempt to assume a leadership role in bringing about effective interaction. However, the other elements of the infrastructure must also recognize their responsibilities, if the IRSI's efforts are to be successful. Particularly, if the IRSI is the principal or sole technological institution in the country (and this is frequently the case), then there appears to be little justification for ignoring or reducing to second-class status, the opinions and potential of the IRSI regarding national development.

307. IRSIs must recognize and relate to the actual demands of public and private sectors who may be at various levels or stages of development. Technical extension services can have a much more effective, direct impact on national development than is usually recognized. Such services, combined with an effective information service, can assist the IRSI in better understanding industry's needs—be it utilization of raw materials, improving existing industry, or developing new technology -- or in the process of technology transfer and adaptation. A well-trained extension agent will be alert to potential industry problems which require laboratory of R+D services, and will be able to advise industry about alternative technologies, processes and/or products which will relate to import substitution market possibilities.

CHAPTER V

Expanding IRSI Services - Alternatives and Complementary Choices

A. Critical Services

308. While IRSIs generally perform satisfactorily in providing basic services, a potential exists for greater involvement by industry committees in establishing standards, parameters and limits for adequate quality control, certification, etc. It is clear that where IRSIs use consultative industrial committees, industry acceptance of standards and quality control regulations is much better than is the case when the decisions are made by the IRSI alone, or in collaboration with a government regulatory agency. Quite frequently, if industry is a partner in the process, the results will be more meaningful and satisfactory to industry, the government, and the consumer. Industry also learns, through the process of involvement, ways to improve its product or process, thus leading to potential requests for IRSI assistance. It is perhaps at this stage of basic services that the greatest potential exists for establishing good working relationships, mutual confidence and trust between the IRSI and industry.

309. Process quality control is particularly important. The IRSI usually gains entrance into the industry's facilities; an alert observer, who is involved in quality control aspects of the process, may also be able to identify process problems and discuss these with IRSI staff members who can recommend improvements or desired change to the industrial client.

310. IRSIs can provide invaluable services to government in such areas as sectoral surveys, techno-economic opportunity studies, utilization of raw materials, etc., as these have a potential for impact on the national development objectives of increasing industry outputs, decreasing imports and increasing exports of products and goods. Industrial sector surveys are particularly important, since such surveys will not only provide government with a profile of industry coverage, along with existing or potential strengths and weaknesses, but also the IRSI will learn from analysis of such surveys more about industry's problems, actual demands, and thus be in a better position to suggest services to industry that will more appropriately meet industry's needs.

Opportunity Studies

311. If the results from industry sectoral surveys are coupled with the results of techno-economic opportunity studies, then the IRSI will be in an even stronger position to be able to exploit services required to satisfy industry's actual demands, by having available data which will help to persuade industry that a potential market exists, that investment in process or product development is feasible both from a technical and economic point of view, and that the IRSI is sufficiently knowledgeable about both aspects to be able to provide valuable assistance to industry.

312. Both industry sectoral surveys and techno-economic opportunity studies are particularly pertinent where utilization of raw materials

of natural resources is concerned. So often, in developing countries, raw materials are exported with little if any processing and subsequently re-imported as semi-finished or finished products. The potential for adding value to raw materials through initial processing or semi-processing is very great indeed. In some instances governments tend to subsidize importation of critical raw materials in a processed condition without appropriate recognition that their country possesses the same raw materials and that the national IRSI may have the potential to develop appropriate processing methodologies. Thus, it is incumbent on government, the IRSI, and industry to collaborate in identifying opportunities for improving or-upgrading and processing of indigenous raw materials.

Information Services

313. Provided that an existing technological information service does not exist in the country, the IRSI can assume responsibility for creating a technological information unit and to start collecting, analyzing, evaluating, and disseminating relevant information to interested parties in government, public or private sector organizations and industries. The nature and extent of the information obtained and disseminated must, however, be related to the needs of the end-user. Again, this relates to industry sectoral surveys and techno-economic opportunity studies, as well as to a strong understanding, by the IRSI, of government, public, and private sector operational activities.

314. In the course of a recent study of some 18 international scientific and technical information services*, a typology of three different types of problems and the information services which correspond to them was developed. These are:

* Development-Oriented Systems, which provide an aggregated information input on "big" technical-economic-social-political problems to government planners, international aid programs, etc.;

* Research-Oriented Systems, which provide a disaggregated, purely scientific or technical information input on specific scientific and technical questions to research scientists and engineers;

* Implementation-Oriented Systems, which provide practical answers to nuts-and-bolts questions in the form of semi-aggregated technical-economic-purchasing and other inputs to design engineers, managers, entrepreneurs, etc.

The conclusions, supported by experiences in developing countries, indicate that most technical information systems end up as research-oriented systems, which obviously have value to in-country R+D efforts, however, the greatest need exists at the implementation-oriented level for practical problem solving.

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* James E. Freeman, "Improving Technological Information Exchange with Developing Countries: A Feasibility Study of the Progressive Establishment of an International Information System for Technology Transfer and Assessment," Phase I Report to UN/OST, Denver Research Institute, January 1975.

315. Implementation-oriented systems are more appropriate to the needs of potential IRSI clients. Particularly, in the case of medium- and small-scale industry, information needs are more often directed towards "nuts and bolts" answers than to empirical solutions to problems found in professional scientific journals. The need is for information such as machinery or equipment specifications, design data for plant construction, availability of components that might be assembled in a local production operation, etc. There also is a need for information about patents or processes, perhaps not economically useful elsewhere, but still appropriate for application to the market available in a developing country. Finally, information is required regarding the possibility of process scale down through use of new equipment, design parameters, etc. While the IRSI may not have such information in its own library, recent development of a number of worldwide information systems makes possible, through linkages with IRSIs or other organizations in advanced countries, acquisition of such required information rapidly and at the lowest possible cost.

Cooperative Research

316. An important potential for the more effective conduct of R+D by IRSIs in developing countries is increased use of the interdisciplinary approach, either among several units of the IRSI, between an IRSI and a nearby university, or with another center. Very few R+D problems are mono-disciplinary, particularly if the project is intended to result in commercialization of a process or product. Thus, IRSI economists, information specialists, potential end-users, and the researchers need to be drawn together as active participants in project design, periodic review, and analysis of the final results. It is axiomatic that no R+D project intended for commerdialization should be undertaken prior to a techno-economic opportunity study and a market analysis of the potential for the project. Such pre-R+D studies are seldom undertaken, however, thus leaving the IRSI to learn at a later date that the research results have no commercial viability. It is also obvious that industrial liaison and technical extension units, as described earlier, are an important element of the process.

317. There is a strong opportunity for IRSIs to examine traditional technologies and to improve or upgrade these, through substitution of better-performance equipment components, quality control and other instrumentation, etc., in order to increase productivity and quality of product. Adaptive research and development has the obvious advantage that a product market already exists: process improvements which lead to improved or increased products thus do not involve the uncertainty usually inherent when a new product is being developed. Since improvement of existing industries is claimed to be the main policy objective of the IRSIs included in the evaluation, adaptation and improvement of traditional technologies appear to be areas of considerable potential for R+D inputs.

318. Cooperative research, vis-à-vis linkages or twinning arrangements among IRSIs, holds yet another potential for IRSIs seeking to benefit from the experience of others, to share experiences and common

problems, to save valuable time and avoid duplication of research efforts already completed elsewhere. Some of the reasons for conducting cooperative research are:

* It is impossible and too costly for every technological research institute to possess facilities, equipment, and staff composition and skills to solve all of the problems encountered;

* Much valuable time and effort can be saved if a cooperative agreement can be established with another research institute which has prior experience in the problem area;

* Often a client is more willing to sponsor a research project if he knows that the research institute in his country is being backstopped or assisted by another research institute--particularly if the backstopping institute has demonstrated expertise in the problem area;

* It is easier to gain technological information and "know-how" when two or more research institutes have developed the ability to work together.

319. These reasons thus define the essential components of cooperative research. They are:

* technical information and know-how exchange;

* staff training and two-way flow of staff;

* availability of specialized, expensive, but infrequently used equipment;

* opportunity for transfer or adaptation of technology;

* joint research on specific and, at the same time, common problem areas such as utilization of raw materials or natural resources, alternative energy sources, pollution control, food processing, etc.

320. As an example of opportunities for cooperative research, many institutes are concerned with bio-gas production from agriculture wastes; protein enrichment of foodstuffs, particularly for low-income groups; and processing or at least semi-processing of local raw materials now exported and subsequently reimported as finished or semi-finished products.

321. The most effective means of encouraging and achieving cooperative research is through a "linkage" or formal working agreement, wherein specific decisions are reached between research institutes to undertake cooperative projects. The linkage can be established between research institutes in advanced and in developing countries or between institutes in developing countries or developing regions. The primary objective of such linkages is to stimulate and assist developing country research institutes in achieving increased awareness of methodologies

and rationale for more effective interaction with industry and in restructuring of research institute research and development goals and problems in order to provide priority support towards the needs of industry and government.

322. While there is a strong potential for inter-cooperation among IRSIs in the development of cooperative research, the actual occurrence of such cooperative research does not often take place, either in a developing country or within a developing region. The reasons usually are:

* lack of mutual knowledge about capabilities and facilities of technological institutes which have a potential for cooperation;

* lack of an effective mechanism for inter-institutional information exchange;

* lack of mechanisms for exchange of staff;

* lack of appropriate and necessary funding.

323. Irrespective of whether R+D is undertaken solely within the IRSI or as cooperative research, there are a number of common sectoral priorities for R+D which ought to be considered.* First is the need to develop technology for the rural areas. In order to satisfy basic human needs, technologies to be developed and/or transferred relate to food, clothing, and shelter. Maximum use needs to be made of existing indigenous resources, whether they be human resources, raw materials, or common natural resources such as water, wind, or solar energy. More specifically, reference has been made to specific sectoral problems such as post-harvest problems; agricultural machinery; multi-purpose vehicles for rural areas; use of waste; use of fertilizers, including slow-released pelletized fertilizers; agricultural by-products; renewable energy; and a number of others.

B. Technology Transfer and Adaptation

324. The potential role of the IRSI in the technology transfer and adaptation process is admittedly complex. The IRSI is only one element of the technological infrastructure where transfer of technology is involved. While the average IRSI cannot (and should not) assume all the major responsibilities involved in technology transfer, nevertheless its selected inputs can be significant and helpful to government, the development bank, and the recipient enterprise or industrial sector.

325. While it is comparatively easy to import foreign technologies, and this may be necessary in initial stages of national industrial development, developing country governments usually recognize the necessity ultimately to create or strengthen their national technological capacity and capability to assess imported technology, to adapt such technology to local conditions and raw materials, and to develop new technologies in anticipation of future needs. An IRSI could assume an important

* Report on the Meeting of Selected Heads of Research Institutes", UNIDO, ID/WG.233/21, 31 January 1977.

role in such functional activities.

326. At the national policy level, and in order to promote industrialization, an IRSI has a potential for orienting the establishment of a technology transfer strategy as part of a national technology development plan becoming part of the mechanism for implementing the national strategy. IRSI participation in such activities could start by providing information on the alternative technologies available within the country or abroad, the sources of technologies, etc., which would accelerate the selection and choice of the most appropriate technologies required.

327. As governments begin to regulate the hitherto indiscriminate importation of technologies, IRSI involvement in the transfer and adaptation process, as shown in the following table, becomes increasingly important and delicate. It needs to be recognized that an IRSI can perform only that portion of the transfer process which relates to technology. Other factors such as negotiation, financing, legal matters, etc., must be performed by a government entity, or the industry themselves. However, with respect to technological choice or alternatives, the IRSI, if properly oriented, could provide invaluable service both to government and to industry. Industries in developing countries are often not in a position to acquire outside, unbiased expertise. On the other hand, IRSIs with strong technical information services, and particularly where a linkage exists with an IRSI in a developed country, are in an advantageous position to obtain the desired information about a particular technology and to make a critical assessment of its applicability to local conditions.

328. It may be seen from the table that acquisition of technology for national development implies much more than the procurement of plant and specialist or other activities through foreign or domestic investment. Technology costs and technology choice are interrelated. Basic criteria relating to raw materials, choice of process, plant location, availability of labor, layout designs, economics of scale, and training require a strong technological input, particularly where over-dependence on external sources would not be in the interest of the project or national economy. The ultimate costs of technology are dependent in a cumulative manner on the choice, procurement, installation, and sustained operational costs. The reduction of these costs are difficult to achieve without proper knowledge and experience which cannot be satisfactorily obtained without proper support.

329. One of the best opportunities for making accelerated advances in industrialization lies in adapting technologies already proven and used elsewhere. This potential role should be of considerable interest to the development banks who are called upon to provide loan funds for imported technology and to industry who may otherwise purchase an obsolete technology, one that is inappropriate, overpriced, or already available within the country or region. Costs and efforts involved in adapting technology are relatively small when compared to the cost of developing a new technology which must subsequently undergo the rigors of proof of applicability, persuading an industry that the technology will meet its requirements, and convincing the industry to undertake

THE ROLE OF AN INDUSTRIAL R+D INSTITUTE IN THE TECHNOLOGY TRANSFER PROCESS

TECHNOLOGY TRANSFER STEP		ROLE OF INSTITUTE	
A.	**Information on Selection of Technology:**		
(i)	obtaining and providing information on desired technologies;	(i)	major responsibility: must maintain up-to-date technological information service;
(ii)	identification of alternate technological possibilities;	(ii)	major responsibility: ties in with (i);
(iii)	techno-economic and opportunity studies	(iii)	depending on responsibilities and capabilities of the institute; input can therefore be major or minor;
(iv)	selection of the most desirable technology;	(iv)	only technical and techno-economic inputs, ties in with (iii); legal and financial considerations outside the institute's responsibility;
(v)	identification of alternate sources of the desired technology;	(v)	major role; ties in with (i);
B.	**Acquisition and Application of the Technology to be Transferred:**		
(vi)	acquisition of rights to technology and technology know-how, including the formulation and closing of all types of technology transfer and licensing contracts;	(vi)	this is not a responsibility of R+D institutes, except to provide technical information during negotiations; ties in with (i) and (iv).
(vii)	establishing physical facilities and factories;	(vii)	not the responsibility of the institute;
(viii)	absorption of transferred technology, i.e., training of staff and personnel using technology;	(viii)	a major responsibility of R+D institutes; one key function is the introduction of new technologies through the institute's laboratories or pilot plants by demonstrating these to industry personnel, i.e., introduce, apply, and manage the technology through training;
C.	**Maintaining, Supporting, and Further Developing Transferred Technology:**		
(ix)	providing technical services for the transferred technology;	(iv)	a major responsibility of R+D institutes;
(x)	carrying out R+D for improving and further developing the technology;	(x)	a responsibility of the institutes;
(xi)	continuing training of industry staff and personnel;	(xi)	a continuing responsibility, although not always carried out by R+D institutes;
(xii)	maintain information surveillance in the related field of transferred technology;	(xii)	an important institute responsibility;

the development risk. When so many opportunities exist for adapting known technologies, it is difficult to understand how a government or an IRSI could justify any more than a minor portion of the annual budget alloted for conducting R+D on new technologies.

330. It seems that the experience of several developing countries in transferring and adapting technology, however, has been unsatisfactory, and priorities are being shifted to national technological independence. Even so, government, industry and IRSI itself should examine critically the potential for increased involvement of the IRSI in the technology transfer and adaptation process as possibly a more cost/effective option.

331. Technological information services have been mentioned earlier as a fundamental requisite to technology transfer and should be a priority functional activity for an IRSI which is involved in the transfer process. Knowledge about alternative technologies is essential. Technical data and scientific information is becoming available in computerized and sophisticated data bank networks but it is not yet fully useable by most developing countries.* It is often also possible to obtain design data, including blueprints, operational details, results, etc. Patent literature is also a valuable source, particularly where adaptation or reduction in scale is desired.

332. To summarize, the IRSI has a potential and major role in the technology transfer and adpatation process, which includes the following:

* Providing information on desired technology
* Identifying alternative technological possibilities
* Identifying alternative technology sources
* Selection and adaptation of technology
* Techno-economic opportunity studies
* Providing technical services
* Performing back-up R+D
* Personnel training.

At the risk of repetition, the comment must again be made that industrial liaison and technical extension activities are crucial elements of the process of technology transfer and adaptation.

C. Alternatives and Precautions

333. Is it necessary for lesser developed countries to establish their own IRSIs, reoognizing the tremendous investment in facilities and skilled personnel and the considerable time required to reach institutional maturity and viability? Do these countries really require

* Attempts to adapt such data for developing country use are being made, viz. UNIDO's Industrial and Technology Information Bank (INTIB).

the services of a full-fledged research institute at the present time, or will it be required for some distant future? What alternative choices or precautions can a developing country make in order to both reduce the risk and satisfy current or short-term needs and which could be adopted in time to meet anticipated long-term requirements?

334. Consideration of these questions does not necessarily mean a decision to delay or disapprove the establishment of an IRSI. Rather, with full realization of available alternatives, a government will be in a stronger position to design an IRSI which will match available resources to the assumption of additional new functions as time, financing, and availability of skilled personnel permit, i.e. institutional development. In view of the large amounts of money made available to IRSIs over the past twenty years by developing country governments and bilateral and international assistance organizations, and the relatively marginal contributions of many IRSIs to industrial development, the questions are appropriate and timely. Alternative mechanisms for obtaining services, heretofore considered the exclusive domain of IRSIs, should be considered carefully both by their sponsors and by funding agencies who are asked to provide technical and financial assistance.

335. There are viable alternatives if a government is willing to forego the prestige value of having a research institute in favor of the pragmatic approach of using existing organizations to provide IRSI-type services. Such organizations include the universities, vocational training and productivity centers, independent and government testing laboratories, and private engineering consulting firms. Perhaps these organizations will not meet fully the long-term national development goals, but they do provide a mechanism to undertake a number of IRSI-type services in the near term while skilled human resources are being marshalled.

336. If one examines the four major categories of functional activities, an infrastructural system can be conceived which provides an opportunity for obtaining full coverage in all areas. However, a great deal of governmental guidance, management, and supervision will be required which, as has been stated earlier, is not often provided by government to existing multi-branch IRSIs.

Functional Activities	Alternatives to IRSIs
Support Services	
analysis, testing, quality control, certification, etc.	government or independent testing laboratories
technical information	national libraries university libraries
Technical Extension Services	
problem solving, trouble-shooting, industrial engineering	productivity centers consulting engineering firms

Training

graduate level	universities
vocational level	productivity centers

Research and Development

product or process development, materials research, etc.	mono-branch IRSIs universities.

337. Independent testing laboratories can be contracted by government to provide basic services for a fee. The possibility always exists that, given adequate financial incentives by governments, industrial sectors can be encouraged to establish joint testing and analytical laboratories as a service to their own industry. Similarly, productivity centers already exist in a number of countries and are providing vocational training and technical assistance to small industries, principally in areas of agriculture, agro-business, traditional industries, etc. There is no reason why such productivity centers, given the proper mandate and incentives, cannot expand their interests to include assistance to basic manufacturing industries and to teach skills required by those industries.

338. Universities generally are reluctant to engage in applied or even directed basic research. At the same time, there usually exists within a university one or more faculty members who have a strong sense of responsibility toward development and who can serve as the nucleus of an applied R+D center. There is a considerable amount of information available which details ways in which universities do become involved in research relevant to national need. Usually the incentives are based on contracted services to the university for research on a specific topic, with additional payment to the faculty member who undertakes the research. This is a common practice in a number of industrialized countries such as Japan, Korea, Turkey, Great Britain, and the United States, where universities are involved to an appreciable extent in development-oriented R+D.

339. While university faculties may not often have "hands-on" industrial experience, they nonetheless do possess strong technological capability which is not usually utilized effectively by developing country governments. Instead of attempting to create anew such skills by establishing an IRSI, it is sometimes more realistic to use these existing skills, at least in the interim, until people who will eventually staff an IRSI can be trained appropriately. One of the arguments posited by faculty members is that they do not have time for research nor do they have research equipment. Yet, in so many instances, university professors "moonlight" on one and sometimes more extra jobs and are often given as much as 75% of their academic time to perform R+D or other activities. Additional payments for directed or purpose-oriented research could take the place of secondary employment. Research equipment that would be needed could be supplied at no greater, and perhaps at even less expense than that required to equip an IRSI.

340. Whether the university is contracted to provide research relevant to national need, the university subsidy is increased, or other mechanisms are used, the important point is that the university become an integral part of the industrial development infrastructure. There are few developing countries who can afford the luxury of underutilizing skilled human resources and at the same time attempt to develop yet another body of skilled scientists and engineers.

341. Other alternatives, or a mix thereof, exist for conduct of R+D. These are:

* Buy technology from abroad (appropriate only in short-term);

* Government funds to industry to conduct their own R+D;

* Ad hoc approach--i.e., buy services on a specific task, such as cement additives from rice hulls, from an IRSI in another developing country or advanced country;

* Rent facilities from another IRSI and send nationals to do the research.

None of these alternatives may be appropriate over the long term. However, such alternatives can provide developing country governments with the opportunity and breathing space to make an assessment of the real need and potential for R+D before making nearly irrevocable commitments to an investment in an IRSI which may never adequately fulfill national development needs and expectatations.

342. As previously demonstrated, IRSIs are often established with a mandate to do everything. When human resources are limited, the result will be that nothing is done well. Therefore, it is important for the government, when planning an IRSI, to recognize the actual limitations which will confront it. Perhaps a mono-branch or mono-purpose IRSI is most appropriate initially, which can be expanded at a later date as the first phase of the IRSI reaches practical levels of achievement accompanied by growth in a particular industry or group of industries. Where other infrastructural elements are already in existence, the governments can continue to use their services and assign only one or two functional categories or activities to the new IRSI, thus permitting it to become solidly established before attempting expanded coverage. While a full range of functional activities have been described as important to assist the IRSI in establishing industrial relationships and serving their needs, poor performance as a result of trying to do too many things can be more detrimental in the long term.

343. As long as adequate coordination exists, it is expedient if not necessary to use a number of resources to perform the services which a fully mature IRSI may be expected to perform at a later date. This is not to say that an IRSI should be planned so as to exclude all such functional activities, or to eventually cover all of them, but rather that careful consideration be given to integrating selected functions into the IRSI as time, staff capabilities, and IRSI capacity permits.

PART THREE

SYNTHESIS

CHAPTER VI

Recommendations

344. Throughout this report, but particularly in Part II, V, there are a large number of conclusions, suggestions and guidelines set out for consideration by IRSI managers, sponsoring governments, clients, and the providers of technical cooperation, namely the UNDP and UNIDO, based on the results of the joint evaluation study and the collective experience of the people involved in the exercise.

345. The recommendations that follow are an attempt to select and summarize some of the more significant findings and suggestions for the purpose of bringing them to the attention of reviewing bodies and senior officials as well as to provide a framework for the consideration of appropriate follow-up actions. They are not intended to be all-inclusive or necessarily in any order of priority. In the case of projects, they are primarily concerned with institution-building. In the case of IRSIs, their applicability and criticality will, obviously, vary from country to country and institute to institute.

A. Improving Effectiveness of UNDP/UNIDO Assistance

346. UNDP and UNIDO, in particular their field representatives, should attempt to intervene as early as possible in the government process of creating or enlarging an IRSI. Among the services UNIDO should offer sponsoring governments are:

* Technical and staff assistance in analyzing industry problems and the need for, and alternatives to, an IRSI;
* A methodology for, and assistance in, performing client surveys, analyzing short and long-term industry requirements, and determining the need and priority of feasible IRSI functional activities;
* Assisting IRSI sponsors in considering its purpose and policy objectives;
* Financing visits by government and industry sponsors to successful IRSIs in other developing countries to discuss their experience in establishing, supporting and using an IRSI.

347. Governments should be encouraged to devote a reasonable portion of their IPF resources to funding advisory and preparatory missions which, in addition to carrying out the activities suggested above, might also:

* Assist in the development of institutional strategies and growth plans;
* Provide advice on staff and career development;
* Analyze short and long-term financing schemes;

* Develop alternative research strategies including in-house, bench-level, pilot scale, etc. - for consideration by sponsors.

348. Particularly in dealing with institution-building projects, UNDP and UNIDO should issue programming guidelines which:

* Detail the preferred use of preparatory missions;

* Emphasize project design and management within the framework of the project function and intended results;

* Plan projects in phases which roughly parallel the stages of institutional development utilizing the concept of "activity modules";

* Emphasize the importance of staff development;

* Encourage twinning arrangements and cooperative research;

* Restrict projects to only one or two objectives.

349. UNDP and UNIDO should provide assistance for institution-building on a large scale project basis subject to formal prerequisites which ought to include:

* Government completion of enabling legislation;

* Functions, authorities and composition of IRSI governing board established;

* Responsibilities and authority of IRSI director established;

* Identification of client needs;

* Definition of IRSI relationships with other industrial infrastructural elements;

* Preparation of five year growth and financial plan;

* Preparation of staff development plan;

* Appointment of nucleus of professional staff;

* Buildings and facilities available.

350. Provide continuing support and direction to WAITRO as a mechanism for:

* Locating, arranging and managing twinning agreements for institution-building purposes;

* Identifying topics and IRSIs for cooperative research;

* Assisting in the exchange of staff, technical information, training materials, etc;

* Creating a network of research institutes working on common problems of industrialization in developing countries.

B. Improving Relevance and Impact

351. Sponsoring governments must assume the continuing responsibility, in the absence of specific national scientific, technology and industrial policies of providing a purpose orientation to IRSIs. Some of the means by which this can be accomplished include:

* Providing guidance on priorities for IRSI policy objectives and functional activities;

* Effective government participation in IRSI strategizing, planning and management;

* Encouraging close industry linkages through: financing client and technology surveys; chartering industry associations providing financial incentives to industry to use IRSI services; and

* Increasing government contracted or directed research and development.

352. IRSI management, in pragmatic terms, must also assume the basic responsibility to plan its operations around explicit or implied government industrial priorities and develop working relationships with government and industry which will assist it in perceiving, relating, and adjusting to such priorities.

353. The policy objectives for IRSIs which appear most relevant to countries in the earlier stages of industrialization and modernization are (a) helping to improve existing industries (b) increasing the use of indigenous resources and (c) technology transfer and adaptation. In any case, an IRSI needs to select a few things it wants to do well and concentrate on them.

354. If the targeted industry is small or medium-scale, or more traditional than advanced, serious consideration should be given to alternatives to IRSIs, e.g., a mono- rather than multi-branch IRSI, an industrial service institution which provides basic services but does not include a significant R+D component, importation of suitable technology, etc.

355. Governments can also encourage or require IRSIs to collaborate with other industrial and intermediary institutions in the national infrastructure, e.g. productivity centers, vocational schools, industrial estates, consulting and engineering firms, particularly in providing technical extension and training to small and medium-scale industry.

C. Improving Performance

356. There are a number of actions which sponsoring governments can and should take to improve the performance of their IRSIs including:

* Requiring and assisting IRSIs to plan for institutional growth on an incremental and long-term basis with periodic revisions and updating;

* Provide IRSI with sufficient managerial and organizational flexibility, both in the choice and staffing of programs, to develop innovative institutional capabilities, seize unplanned opportunities, and respond to unforseen problems;

* Increase effective government and industry participation in the affairs of an IRSI, from planning through evaluation;

* Provide liberal, general purpose grants or subsidies during the early years of an IRSI's growth but changing the mix gradually to increased use of government contracts for research and other services;

* Encourage increased industry support, either through general assessments and/or payment for special services;

* Finance strategic research;

* Contract for surveys of client requirements, problems, applicable technologies, etc. which will increase linkage with, and appreciation of, industry needs;

* Establish a technology development organization, separately from or within an IRSI, to assist in the commercialization of R+D results;

* Provide financial incentives to industry for the use of IRSI capacities.

357. There are also a number of actions which IRSI managers can and should take to improve their own performance including:

* Prepare a long-range staff development plan based on an institutional strategy for increasing its capabilities and services;

* Seek out collaboration with other industrial research institutions, including the use of twinning arrangements, to help in institution building and cooperative research;

* Organize itself to promote its services to clients, including assistance in the utilization and commercialization of R+D results;

* Increase the priority given to technical extension services, industry sectoral surveys, and technological information services while shedding or spinning-off simpler and more basic services;

* Concentrate on what it does best and avoid over-extending itself;

* Encourage and assist industry to assume its proper role in quality control and testing, engineering, pilot-scale development, management, financing, marketing, etc.

358. Every IRSI should have a long-range research strategy as a major sub-component of an institutional growth strategy and plan and which reflect the consideration of the following critical factors, among others:

* First priority to application of existing knowledge to national needs;

* The need for both strategic and tactical and in-house and contracted research in a proper balance in relation to policy objectives and institutional growth plan;

* Encouraging and assisting the conduct of marginal research, e.g. product development and process optimization, within industry itself, with innovative research the eventual domain of the IRSI;

* The high costs and limited utility of pilot-scale plants and equipment;

* The need to involve the potential utilizers of research results as early as possible in the R+D itself;

* The advantages of cooperative research with other institutions, domestic, foreign and international;

* The likelihood of low demand and appreciation of research by industry, particularly small-scale and traditional;

* The need to balance and correlate research and development with other functional activities;

* The inherent difficulties in the commercialization of R+D results in developing countries.

CHAPTER VII

Principal Issues Posed by the Evaluation Study

359. In the light of the findings, assessment and conclusions of this study, three major issues come through concerning the basic rationale for using an IRSI. These issues need to be highlighted.

360. It is a fact that the critical mass for an IRSI is large. The infrastructure costs for building and ancillary services, equipment etc., are comparatively high. The UNDP financial resources allocated to assist in the institution building of multi-purpose IRSIs have been significant and the assistance usually must be provided for the periods which cover at least two phases for a project or durations equivalent to a minimum of 8 to 10 years. For the governments of developing countries, particularly those of the least developed, the financial resources for infrastructure are limited when industrialization is in its formative stages. What is even more critical is the availability of a minimum cadre of professional technical staff which it is often not possible to concentrate in the numbers required in one institution. These cadres also frequently lack the necessary industrial experience which is relevant to industry. The study has found that it takes a minimum of 10 years before an IRSI begins, in the most favorable of circumstances, to return some practical benefits to the country.

361. Furthermore, an IRSI is only one element of the total system required to support, service and perhaps lead industrial development. It must be recognized however that an IRSI by itself is more than anything a service institution that follows industrial development rather than a promoter of it. In terms of the system required, it is often the least developed countries which lack or have extremely weak elements to complement the possible activities of a multi-purpose IRSI.

362, This situation raises the fundamental question as to when and if it is appropriate for a developing country to establish an IRSI. This study has not been able to offer a simple solution and it is recommended that a high level representative group be convened to discuss this matter so that the international system could provide advisory guidelines to governments which represent a consensus of experience and expertise.

363. A second issue is the consideration of alternative ways to serve the needs of developing countries, particularly to least developed countries which do not yet have an IRSI. It is apparent that there are a number of countries which will have great difficulties in assembling the critical requirements for an IRSI. Yet they need and perhaps possess the available capacity to carry out at least some of the functional activities of a multi-purpose IRSI. In chapter V, the study has addressed the question of alternative ways to serve the needs of such countries and some suggestions have been offered. However a more thorough discussion of this issue is considered necessary by a high level review group to determine the comparative effectiveness of alternative mechanisms and measures that would seem relevant.

364. Lastly, it is recognized that some IRSIs, particularly in the more advanced developing countries, do have a role to play and in fact to a considerable degree are serving industrial needs in particular environments. A weakness found from the analysis carried out in this study is that the IRSI potential has not been fully developed in the majority of cases in spite of the fact that some institutions have existed for as long as 20 years. In Part Two, many suggestions are made to improve this situation. Nevertheless this topic also merits further consideration and discussion.

365. The study has found that services rendered by the more successful IRSIs are usually geared to serve the larger industries as they can assimilate and use the advice. The magnitude of the problems of larger industry are more complex yet at the same time more discreet. Furthermore, capable technical expertise is usually found in the enterprises of larger industries which complement the professional capacities found in the IRSIs. The problem that arises is that service to smaller industry is very difficult to render. Even if the suggestions of this study are fully carried out this problem is still likely to exist.

366. Frequently IRSIs are called upon to do work in excess of these capabilities and at the same time to work on technology improvements already carried out elsewhere. Consequently, the issue of strengthening established IRSIs is very fundamental and needs further discussion and possibly study so as to devise appropriate mechanisms for the improvement. Linkages among IRSIs, particularly in reference to information services as well as in co-operative research and specialization, need further consideration.

367. These major issues have surfaced as a result of the evaluation. To the extent possible, they have been studied, assessed and discussed in this report. However, the issues are regarded as so fundamental and pervasive that further discussion, validation, and review is considered not only desirable but essential.

ANNEX 1

SYNOPTIC DISPLAY OF EVALUATION METHODOLOGY employed in joint UNDP/UNIDO study of INDUSTRIAL RESEARCH AND SERVICE INSTITUTES

1. DESIGN AND PHASES

- Purpose of exercise and overall methodology jointly developed
- Phase I, desk study
- Phase II, field missions and synthesis
- Phase III, review of report
- Phase IV, dissemination and follow-up

2. FIRST APPROXIMATION

- developed project inventory
- extracted appropriate statistical data
- established criteria for sample selection
- established in-house working group
- review made of past and on-going in-house studies relevant to evaluation
- developed standard terms and definitions

3. SECOND APPROXIMATION

- established sample of project/IRSIs
- developed, tested and revised typologies for data collection and analyses (profiles)
- profiles prepared by working group with consultant assistance
- design of analytical techniques for comparisons
- comparative (cross-project and cross-institutional) analyses prepared and displayed

4. THIRD APPROXIMATION

- established selection criteria for IRSIs to be included in in-depth study
- IRSIs selected for field missions by working group and UNDP
- pre-mission questionnaires designed and distributed through SIDFAs and Resident Representatives
- interview checklists designed
- special issues identified for in-depth study by consultants
- standard field mission report and assessment ratings designed
- in-depth interviews held on-site with pertinent parties and additional data collected and analyzed
- field reports and issue papers prepared and distributed to all field mission participants
- comparative analysis made of questionnaire data and field assessment
- identified critical elements of selected UN and other documents for comparison and integration with findings

5. SYNTHESIS OF DATA

- developed outline for staff report
- prepared work assignments and method-of-approach for review of results by participants
- all Phase I and II participants collectively reviewed data and developed major findings, conclusions and recommendations (including guidelines)
- consensus working papers developed and issue papers revised as necessary
- comprehensive draft staff report prepared by UNDP/UNIDO co-ordinators and principal consultant and "screened"

6. REVIEW, FEEDBACK AND DISSEMINATION

- preliminary findings presented to peer group (WAITRO seminar)
- staff report prepared
- staff report and major issues reviewed and validated by high-level group representing interested parties and geographical areas
- prepared summary versions to be presented to UNDP Governing Council and UNIDO Industrial Development Board
- special derivative reports and publications to be prepared and distributed for each major audience, i.e., (1) donors (programming and design guidelines), (2) developing country governments (establishing and supporting IRSIs) and (3) IRSI managers (guidelines for improving effectiveness) and clients

7. PRINCIPLES APPLIED IN CONDUCTING EVALUATION

- maximum use of in-house staff, i.e., UNDP and UNIDO staff members with interest in IRSIs
- use of exercise to co-ordinate and/or encompass prior and on-going activities and studies concerned with the contributions of research, and research institutions, to industrial development
- use of consultants for additional expertise, objectivity and augmentation of available manpower
- design a systematic, rigorous, and standard approach wherever possible
- face critical issues with clear and as objective analysis as possible

8. CONSTRAINTS AND LIMITATIONS

- absence of tested and feasible methodology
- in terms of assessing technical co-operation effectiveness, general lack of clear-cut objectives and baseline data in pre-1976 project documentation
- inability to look at all IRSIs in developing world
- lack of sufficient and/or reliable data on IRSIs included in inventory (first approximation) and profile sample (second approximation)
- absence of pre-mission briefings of team members

- difficulty in defining "impact" and large number of causal variables which affect industrialization
- shortage of time and resource available on site to identify, trace or otherwise measure or assess causal variables with supportable data
- vagueness of IRSI definition and variables, e.g.,
  new or mature
  multi-branch or single-branch
  stage of national industrial development
  policy objectives and functional activities
- need to translate specific findings into generalized findings for acceptance and utilization

COST/SIZE DISTRIBUTION OF PROJECTS BY TYPE OF INSTITUTION

ANNEX 2-Table 1

Type of Institution	Total Contribution		Small-scale Up to 50,000		50,000-150,000		Large-scale 150,000-400,000		400,0001-1 million		Over 1 million	
	$ cost	No.	$ cost	No.	$ cost	No.	$ cost	No.	$ cost	No.	$ cost	No.
Multi-purpose, multi-branch	18,881,109	44	320,090	20	329,116	3	1,048,221	3	6,494,459	10	10,689,223	8
Multi-purpose, single branch:	31,230,629	56	197,204	11	760,157	9	3,279,432	12	9,576,896	14	17,396,940	10
building materials	1,557,367	5	—	—	111,836	2	100,529	1	1,257,002	2	--	--
metallurgy	8,149,773	7	512	1	100,000	1	227,000	1	1,509,772	2	6,312,489	2
metal working/ engineering/ electr.	6,900,039	9	63,000	2	129,600	1	177,450	1	2,583,692	3	3,945,497	2
electronic/fine inst.	2,254,382	3	--	--	--	--	--	--	1,202,381	2	1,052,001	1
chemicals/ plastics	3,069,255	11	96,192	4	--	--	1,706,175	6	--	--	1,186,888	1
textiles	5,150,321	10	11,000	1	154,500	2	530,450	2	2,059,196	3	2,394,265	2
leather	2,239,592	6	—	—	284,221	3	369,718	1	442,353	1	1,143,300	1
food	1,387,400	4	24,900	3	--	--	--	--	--	--	1,362,500	1
other	522,500	1	—	—	—	--	--	—	522,500	1	—	--
Single-purpose:	4,874,582	10	12,750	1	130,842	2	257,450	1	2,103,135	4	2,370,405	2
packaging	3,005,474	7	12,750	1	74,211	1	257,450	1	1,649,523	3	1,011,540	1
other	1,869,108	3	--	--	56,631	1	--	--	453,612	1	1,358,865	1
TOTAL	54,986,320	110	530,044	32	1,240,115	14	4,585,103	16	18,174,490	28	30,456,568	20
Percentage Distribution	100		0.9		2.3		0.3		33.1		55.4	
Completed (as of 10/31/77)	12,369,060	51	383,515	26	572,872	7	1,599,076	6	6,342,615	9	3,470,982	3
Ongoing (as of 10/31/77)	42,617,260	59	146,529	6	667,243	7	2,986,027	10	11,831,875	19	26,985,586	17

ANNEX 2-Table 2

REGIONAL DISTRIBUTION OF PROJECTS BY TYPE OF INSTITUTION

Type of Institution	Africa		Americas		Asia and Far East		Europe and Middle East		TOTAL	
	$ cost	No.	$ cost	No.	$ cost	No.	$ cost	No.	$ cost	No.
Multi-purpose, multi-branch	4,076,000	5	6,241,340	13	4,067,759	17	4,496,759	9	18,881,109	44
Multi-purpose, single branch:	5,903,084	8	3,274,894	10	18,854,796	27	3,197,855	11	31,230,629	56
building materials	300,365	3	--	--	--	--	1,257,002	2	1,557,367	5
metallurgy	2,262,489	2	1,027,512	3	4,859,772	2	--	--	8,149,773	7
metal working/ engineering/ electr.	2,076,989	1	307,050	2	4,452,200	4	63,800	2	6,900,039	9
electronics/fine instruments	571,709	1	--	--	1,052,001	1	630,672	1	2,254,382	3
chemicals/plastics	--	--	577,832	4	2,491,423	7	--	--	3,069,255	11
textiles	691,532	1	--	--	3,928,229	7	530,560	2	5,150,321	10
leather	--	--	--	--	2,047,171	4	192,421	2	2,239,592	6
food	--	--	1,362,500	1	24,000	2	900	1	1,387,400	4
other	--	--	--	--	--	--	522,500	1	522,500	1
Single-purpose:	1,465,152	2	--	--	2,546,138	4	863,292	4	4,874,582	10
packaging	1,011,540	1	--	--	1,187,273	3	806,661	3	3,005,474	7
other	453,612	1	--	--	1,358,065	1	56,631	1	1,869,108	3
TOTAL	11,444,236	15	9,516,234	23	25,467,944	48	8,557,906	24	54,986,320	110
Percentage Distribution	20.8		17.3		46.3		15.6		100	
Completed	824,636	4	5,495,615	16	3,266,187	21	2,782,622	10	12,369,060	51
Ongoing	10,619,600	11	4,020,619	7	22,201,717	27	5,775,284	14	42,617,260	59

ANNEX 2 - Table 3

DISTRIBUTION OF PROJECTS BY REGION, LEVEL OF DEVELOPMENT, AND TYPE OF INSTITUTION

	GNP per head				TOTAL	
	Less than $400		Over $400			
	$ cost	No.	$ cost	No.	$ cost	No.
AFRICA						
Multi-purpose, multi-branch	2,134,000	3	1,942,000	2	4,076,000	4
Multi-purpose, single branch	5,903,084	8	--	--	5,903,084	8
Single purpose	453,612	1	1,011,540	1	1,465,152	2
Total: AFRICA	8,490,696	12	2,593,540	3	11,444,236	15
AMERICAS						
Multi-purpose, multi-branch	46,000	1	6,195,340	12	6,241,340	13
Multi-purpose, single branch	--	--	3,274,894	10	3,274,894	10
Single purpose	--	--	--	--	--	--
Total: AMERICAS	46,000	1	9,470,234	22	9,516,234	23
ASIA AND FAR EAST						
Multi-purpose, multi-branch	1,194,008	9	2,073,002	8	4,067,010	17
Multi-purpose, single branch	17,613,361	24	1,241,435	3	18,854,796	27
Single purpose	2,546,138	4	--	--	2,546,138	4
Total: ASIA AND FAR EAST	21,353,507	37	4,114,437	11	25,467,944	48
EUROPE AND MIDDLE EAST						
Multi-purpose, multi-branch	--	--	4,496,759	9	4,496,759	9
Multi-purpose, single branch	--	--	3,197,855	11	3,197,855	11
Single purpose	--	--	863,292	4	863,292	4
Total: EUROPE AND MIDDLE EAST	--	--	8,557,906	24	8,557,906	24
TOTAL	29,890,203	50	25,096,117	60	54,986,320	110
Percentage Distribution	54.4		45.6		100	
Completed	1,907,499	18	10,461,561	33	12,369,060	51
Ongoing	27,982,704	32	14,634,556	27	42,617,260	59

ANNEX 2-Table 4

SUMMARY DATA OF PROJECTS

	DP Small-scale		DP Large-scale		SIS		TOTAL	
	$ cost	No.	$ cost	No.	$ cost	No.	$ cost	No.
Type of Institution								
Multi-purpose	1,254,718	24	48,485,171	57	371,849	19	50,111,738	100
Single purpose	130,842	2	4,730,990	7	12,750	1	4,874,582	10
TOTAL	1,385,560	26	53,216,161	64	384,599	20	54,986,320	110
Regional Distribution								
Africa	284,136	3	11,098,400	10	61,700	2	11,444,236	15
Americas	265,455	5	9,182,917	14	67,862	4	9,516,234	23
Asia and Far East	353,128	9	24,892,779	27	222,037	12	25,467,944	48
Europe and Middle East	482,841	9	8,042,065	13	33,000	2	8,557,906	24
TOTAL	1,385,560	26	53,216,161	64	384,599	20	54,986,320	110
Level of Development								
Less than $400 GNP	648,084	11	29,078,717	30	163,402	9	29,890,203	50
More than $400 GNP	737,476	15	24,137,444	34	221,197	11	25,096,117	60
TOTAL	1,385,560	26	53,216,161	64	384,599	20	54,986,320	110
Percentage Distribution of Total	2.5		96.8		0.7		100	
Completed	765,388	16	11,412,673	18	190,999	17	12,369,060	51
Ongoing	620,172	10	41,803,488	46	193,600	3	42,617,260	59

ANNEX 3

DOCUMENTATION USED IN THE EVALUATION

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ANNEX 4

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ANNEX 5

Report of the High-Level Review Group
on the principal issues posed by UNDP/UNIDO
IPSI Evaluation Study

INTRODUCTION

1. At the invitation of the United Nations Development Programme (UNDP) and the United Nations Industrial Development Organization (UNIDO), a high-level and representative group was invited to convene at Vienna on March 28-30 to discuss and analyze major issues concerning industrial research and service institutes in developing countries. These issues have been identified as a result of the joint UNDP/UNIDO Evaluation Study and included (1) the relative cost/effectiveness of IPSIs versus other alternatives, (2) making more effective use of existing IPSIs, and (3) their potential. To facilitate the discussions, the group was provided with the evaluation report (id. 79-11) in advance of the meeting for their perusal. The Group greatly appreciated the scope, significance and value of the in-depth study, but refrained from assessing specific findings or endorsing specific recommendations as this was beyond its terms of reference. The deliberations concerning the issues presented and subsequent recommendations are based primarily on the individual and collective expertise and experience of the respective members but included consideration of the results of the evaluation study.

2. By way of an introduction to the meeting, senior representatives of UNDP and UNIDO gave some background information on the reasons why the group has been convened. The two organizations thought that additional outside guidance and advice was needed in order that the results of the evaluation study could find the widest possible application to help developing countries, particularly those in the earlier stages of industrialization, in building up their indigenous technological capabilities.* The issues are regarded as so fundamental and pervasive, that further discussion, validation and/or review was considered essential. The following is a summary of the concensus reached by the participants.

* Refer to Chapter VII, paragraphs 359-367, of the UNDP/UNIDO evaluation report for fuller discussion of purpose of the review and principal issues.

ISSUE I: "Is an IRSI, involving a significant R + D component, a reasonable option for developing countries which have not reached a more advanced stage of industrialization?"

3. To establish an IRSI is a major step in the evolution of a developing country. A number of prerequisites or conditions has to be met or created prior to the successful establishment of an IRSI. Prerequisites include: Government policies, programmes, development goals and priorities and the necessary environment and institutional infrastructure, such as science and technology departments of universities, multi-functional service institutes, productivity centres, consultancy groups, technological information systems, etc. Where such infrastructure does not yet exist, the country may better start with uni-functional service institutions to offer industrial information, standardization, metrology, quality control, testing and analysis, and other basic services. Therefore, it is clear that a definite stand on the question of setting up an IRSI is closely related to the level of development, including the scientific and industrial technology and infrastructure, that exists within the country.

4. An IRSI, as defined in the evaluation report, may or may not be the model suitable for every country. The institution must be dovetailed into the national goals and priorities and will vary both in structure, purpose, and type of activities it will undertake. The principal requirement is that every country, at an early stage of development, should resolve to take adequate measures within its means to create and make the most effective use of its indigenous scientific and technological capabilities, trained technical manpower and its natural resources. A country should have a clear-cut development policy indicating its goals, objectives and priorities and also defining the technological tasks to achieve those ends. At this point, an assessment should be made regarding the facilities that already exist for undertaking such technological tasks. These should be put to effective use and may be complemented and supplemented by additional facilities as and when required. It is only then one should consider setting up more complicated and sophisticated institutions like IRSIs.

5. On the other hand, IRSIs may be an important element in a country's industrial development, especially in the more industrially advanced countries, but they must be built around the existing critical

service institutions. As soon as it is determined that single or multi-functional service institutions are operating effectively, the creation or strengthening of IRSIs with a research and development component should be considered.

6. In the earlier stages of industrialization, a single-function institution can be adequate to provide basic services to small and medium sized industries or to participate in technical studies with respect to national objectives such as better use of the natural resources in exploitation as well as in processing to serve local needs or to contribute to the trade balance of the country. However, as soon as it appears that those types of options are not sufficient to deal with the evolving questions and problems, establishment of one or more multi-functional IRSIs must be taken into consideration. The scientific and technological infrastructure should be designed in such a way that it fits into the stage of development of the country concerned. There must be a climate of confidence, appreciation and motivation of the clientel that is relevant in playing a role for sponsoring and making use of the activities of the IRSI concerned.

7. For the success of industrial research and development organizations, an environment which encourages and permits innovation is called for. Management must be flexible, venture-oriented and autonomous. Necessary conditions should be created for this purpose. Developing indigenous competence, training technical manpower, creating necessary infrastructure with the required expertise and experience, is a continuous and time-consuming process. Therefore, it should be started as early as possible to meet the growing needs and the demands of the industry, and even to keep ahead of the industry.

8. From the foregoing, it is clear that each country must study and decide for itself on the successive steps to be taken for the type of institution to be set up, its organizational structure, and the activities required to develop and improve its competence and to serve its clientel best. In such an exercise, governments should take advantage of past experiences and the help of UN system and other development agencies.

9. When it is clear that IRSIs are relevant choices in a particular country, the question arises what should be the reasonable expectations by governmental and industrial sponsors. The suggested expectations are the following:

(a) to develop the necessary indigenous competence, i.e., human resources, to collect information, to assess, analyze and provide alternatives for decision-making bodies;

(b) to adopt and improve upon the existing or imported technologies, to generate technologies relevant to the needs of the industry - small, medium and large-scale sectors, and provide problem-solving capability, industrial information, consultation and extension services.

Experience shows that IRSIs have not often succeeded in fulfilling all these expectations. It is, therefore, suggested that IRSIs only accept responsibility for those activities which are in consonance with their competence and the priority needs of the clientel including those functions not already dealt with by other organizations or institutions.

ISSUE II: What can Governments and industries do to make more effective use of existing IRSIs?

10. Recognizing that in certain countries IRSIs will have to operate in the absence of clear-cut policies, programmes, or specific demands placed on them either by the government, industry, or other clientele, the onus of responsibility will be with the institute to develop a common industry research culture to make itself effective. The institute should seek every avenue possible to involve the clientele, for example, through industry participation in an advisory committee, to gain its confidence, and to make use of its clientele in the advisory, executive, and other committees.

11. Another question considered is whether an IRSI in a developing country should serve government or industry only, or both sectors together. Any nationally funded institute is set up to serve the nation and ought to serve government as well as industry.

12. The primary objective of an IRSI is to develop indigenous competence and necessary qualified manpower for it. An appraisal of an IRSI's effectiveness must be judged primarily by the increased competence it has provided. Therefore training of manpower both in the country and outside and the exchange of personnel and experts will become a necessity. In this process one should consider ways and means to improve the existing performance.

13. To supplement and complement the local competence within the country, assistance from other regional or international organizations are also options for governments to provide the needed contribution in serving the national technological goals. For useful national, regional, and international linkages and cooperation, the prerequisites will usually be to:

(a) identify the technological tasks and sub-tasks;

(b) identify the talents and facilities that are needed and available;

(c) identify areas that will be of mutual benefit and interest to the participants;

(d) determine clearly at the outset the sharing of the benefits that will accrue because of joint collaborative programmes and projects.

Such linkages would also help in achieving results quickly at less cost and attacking problems with a multi-disciplinary, multi-organizational, multi-national team effort.

14. In building effective linkages, organizations like WAITRO and other regional and international bodies may be fruitfully utilized. Other avenues for such cases are twinning and cooperative arrangements, and networking of institutions, viz. between the developing and developing, and developing and developed countries.

ISSUE III: Is there a potential and priority role and/or function IRSIs can or should be performing?

15. An IRSI has the potential for technology assessment, transfer, adaptation, and utilization and for opportunity or prefeasibility studies, problem-solving and extension services and industrial information service systems. However, each IRSI must set for itself certain priorities for building its own competence as it would be difficult to achieve a desired degree of competence in all these areas at the same time. In the actual practice the IRSI should attempt to participate actively and assist appropriate institutions that have the principal responsibility for techno-economic feasibility studies and technology transfer.

ISSUE IV: What kind of dissemination should be given to the staff report and what follow-up actions taken?

16. Dissemination and follow-up actions have particular importance to the joint UNDP/UNIDO evaluation of IRSIs. The requirements for industrial services including research and development differ from country to country but these functions play an essential role in the industrial-

ization process of developed and developing countries alike. Human and financial resources available to carry out the difficult and sometimes risky tasks of industrial research and development are limited. If past and future investments in institution building are to achieve their purpose, the experiences, prerequisites, forecasting and goal setting which have been among the subjects evaluated in the study and reviewed herein should be better understood by the governments, service institutions and industries affected.

17. Therefore, it is recommended that the Governments and the UN system give priority consideration to the following:

(a) to disseminate UNDP/UNIDO evaluation report, including an annex of this review group report, to interested governments, development agencies, IRSIs and other relevant groups.

(b) to develop a set of programme and project guidelines from the evaluation results and make them available to interested developing countries. In addition, the UNDP/UNIDO evaluation report, together with supplementary documents, should be distilled and summarized to inform a broad audience including the Group of 77, the UNCSTD secretariat, and other interested parties.

(c) Governments are encouraged to also make use of these documents and others already available that are related to IRSI problems and conduct seminars and workshops to consider the implication of the evaluation conclusions for the individual countries' situation.

(d) This evaluation study represents an innovative step in programme and project management. UNDP and UNIDO are urged to extract the methodology employed in the study to evaluate individual IRSIs. Such a document should be widely circulated to the IRSIs to help them in the task of self-evaluation. This may also be included as a part of project design in setting up new IRSIs. Steps should also be taken to determine, over time, the impact of the evaluation exercise, including its follow-up activities, on industrial research and service institutes in developing countries.

(e) Networks of IRSIs and other relevant institutions can serve a useful purpose in indigenous capacity building if the problem-focus, self-interest of participating institutions, and terms of cooperation are sharply defined and clearly specified. Emphasis should be placed on linkages between developing country institutions addressing problems of multi-country concern for which common action is practical.

(f) At the request of Governments, UNDP/UNIDO should develop methodologies for technology forecasting, assessment and self-evaluation and this be used in the design of technical co-operation projects with IRSIs. Also upon the request of governments the UNDP/UNIDO should develop and conduct management courses for IRSI staff in order to enhance their industrial skills and technology competence.

LIST OF OFFICIAL PARTICIPANTS

in

HIGH-LEVEL GROUP MEETING REVIEW ON RESULTS

of

THE JOINT UNDP/UNIDO EVALUATION STUDY OF IRSIs

28-30 March 1979, Vienna

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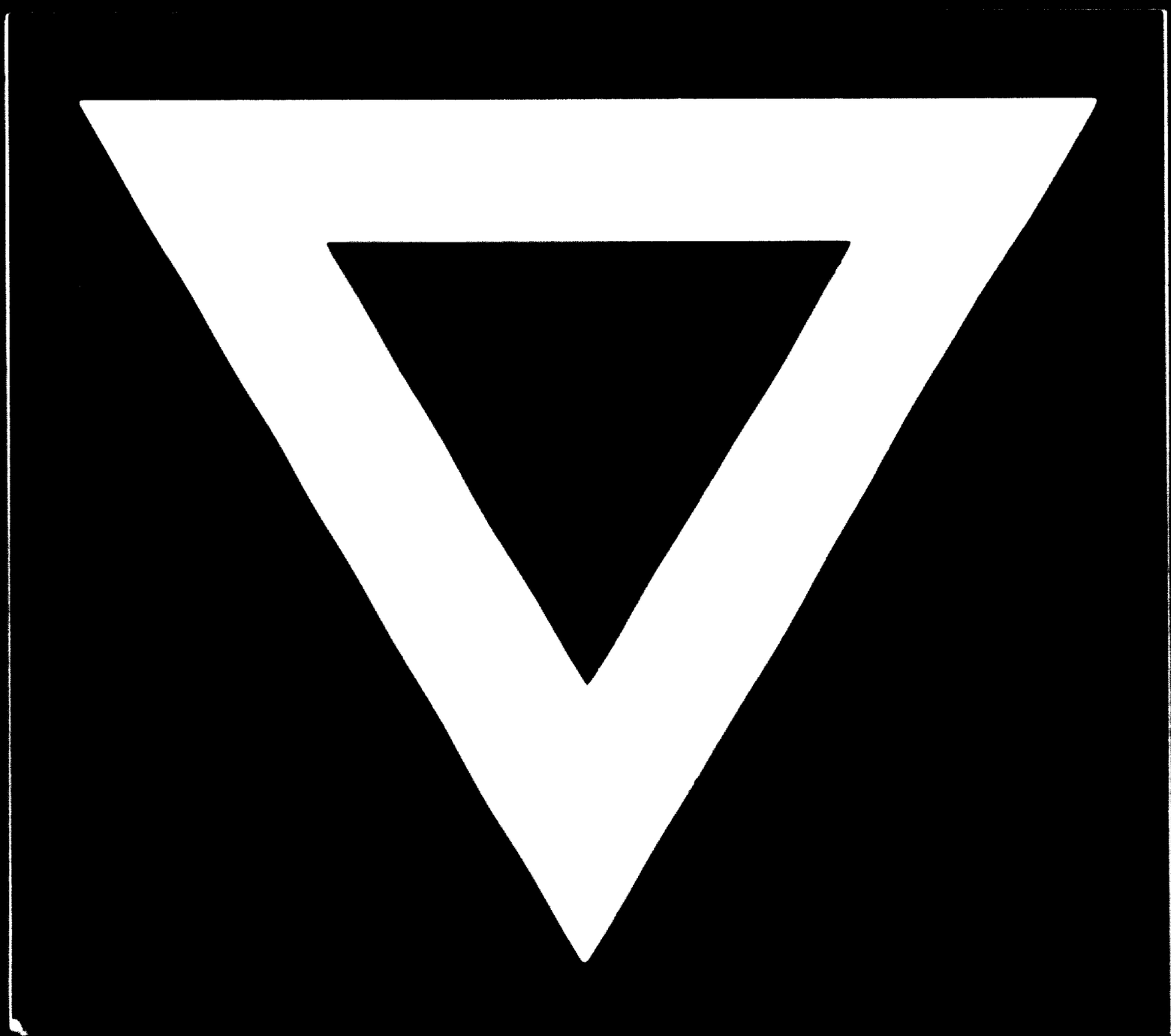

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