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UNITED NATIONS INDUSTRIAL
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INSTITUTIONAL GROWTH STRATEGIES FOR INDUSTRIAL RESEARCH*

prepared for the

Joint UNDP/UNIDO Evaluation Study
of Industrial Research and Service Institutes

by

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CONTENTS

I PREAMBLE :

I.1 Research & Development and Scientific & Technical Services (R & D and S T S), comprise a support function essential for industrial growth. It would be aimed at new products, new processes and at production efficiency, cutting down costs, improving qualit and marketing, and overall an adequate financial return on investment. These are considerations for the very survival of an industry under modern competitive conditions.

I.2 The Industrial Research Services function is a tool of management at enterprise level, and of policy and planning at national level. Institutional machinery for the discharge of this function, can be conceived only in relation to Industrial Growth Strategies, which would vary from country to country and from industry to industry. Industrial Development Strategy, in turn cannot be separated from other development factors.

I.3 Developing countries, which for historical and other reasons confront a " technology gap ", need strategies to speed up the development process, particularly in the field of industry. However IRSI growth strategies which could catalyse industrialisation have generally eluded them.

I.4 Where a national Institute has been a notable success as for example in Korea, certain distinct elements, relating to its concept and functions, could be observed as contributory factors. The Korea Institute of Science & Technology (KIST), within the short space of a decade has ' catalysed ' the transformation of a ' primary agrarian ' economy and brought it to the threshold of a modern industrial society.

Elsewhere, constraints inhibiting the IRSI function, from fulfilling its purpose are noticeable. The subject has been amply documented on the basis of case studies, covering more than a decade of experience.

2 PRE-REQUISITES AND CONDITIONS FOR SUCCESS

2.1 Certain pre-requisites and conditions for success can be identified. The most fundamental of these is the Link with Industry. The absence of a vigorous demand for Research & Development (R&D) and Scientific & Technical Services (STS) from industry, is a characteristic of developing countries. This weakens IRSI growth as well as industry, and is in contrast to the situation in industrialised countries, where their mutual interaction reinforces both. Hence the strengthening of this and other links should be a crucial consideration of IRSI Growth Strategy, in a developing country. The other links are with Government, financing institutions, and educational institutions together with international relations.

2.2 These essential links are affected by :

(i) ' In house ' institutional factors comprising the concept, structure, organization, programmes, policies, management, financing etc.

and

(ii) By national development plans and perspectives particularly Industrial Policy, in relation to a National Science & Technology Policy. The 'climate' created by such circumstances will determine whether an IRSI will flourish, thrive, or languish.

Many tangible and intangible factors relating to historical, geographical, political, circumstances

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as well as mental attitudes, leadership, entrepreneurship and natural endowment would be relevant.

2.3 Reasons, why " intense " nations like Japan, Republic of Korea and Singapore are different from the others in Asia or for that matter why the West German economic miracle has not been repeated elsewhere in Europe, would include many considerations besides 'growth techniques'. For this reason caution needs to be exercised in applying to developing countries ' models ' derived on western industrial or similar experience. The ultimate strategy in any country has to be worked out by its own nationals, for IRSI growth, or for any other development activity.

2.4 The ' raison d'être ' for an IRSI is as a service function for industrial development. An IRSI would not merely be a machinery geared to and moving " in tandem " with industrial growth, but could also be an ' accelerator ' and a 'multiplier' . The IRSI link with industry has to be established structurally, within an operational network of planning, investment, management, production, marketing and man power development. " In house " organization, policies, & programmes need to conform to basic criteria essential for the efficient conduct of ' mission oriented ' Research and Development (R & D) and Scientific and Technical Services (STS) . They have to be devised and adapted to the specific conditions obtaining in a developing country.

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2.5 The IRSI function, would be discharged through a network of many units, located at various points in industrial planning development and operational systems. Individual IRSI units operate at various levels within individual enterprises, groups of enterprises, Government departments, or Ministries, or centralised as a national institution. In the case of the latter its title would invariably reflect a more broad based, cross sectorial function, even when substantially concerned with industrial growth.

Such institutions of Science & Technology, Applied Research, Scientific & Industrial Research etc. become the machinery of national Science & Technology Policy, within the purview of a Ministry of Science & Technology, rather than a industrial activity ' per se ' within the purview of a Ministry of Industry. Hence it is necessary to consider the IRSI as a function exercised at different levels both operationally and functionally. The inter-relationships of these functional and operational levels in a specific country context would be relevant to IRSI Growth Strategy. An IRSI needs strong links with

GOVERNMENT
OPERATIVE INDUSTRY
FINANCING INSTITUTIONS
EDUCATION & TRAINING INSTITUTIONS

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3 CLARIFYING POLICY OBJECTIVES :

3.1 Most developing countries would be concerned with up grading and amplifying IRSI facilities as appropriate. Such an exercise would involve an identification of present and future needs and priorities, within the frame work of well defined policies and organizing the coordinated functioning of an IRSI net work, distributed among functional and operational levels, so as to provide a dynamic thrust towards industrial growth. The waste of effort and resources in many countries are the result of confusion and conflict of objectives and absence of clear cut policies. Hence a clarification of policy objectives is essential.

3.2 SCIENCE POLICY, TECHNOLOGY POLICY, INDUSTRIAL POLICY.

Those components of Science, which bring short term economic benefits cannot easily be separated from the overall implantation of Science in the cultural, social and economic life of a country. Science planning would be concerned with short term, medium term and long term objectives. The cost/benefit of the allocation of resources to science or for that matter to a function such as education cannot be evaluated in quantifiable terms. This however does not mean that the cost - effectiveness in " mission orientated " research cannot be improved.

The writer is aware of industrial research oriented " Science Complexes " in several Asian & African countries, of both the "council " and " institute " type, where basic factors of "mission orientation" have been ignored, thereby weakening

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the IRSI input, so essential for industrial growth. Many such institutions, whose usefulness in relation to resources allocations have been under question, have been set up under " technical assistance ". Invariably they have been staffed by specialists both foreign and domestic, who by their background have been entrenched in the same traditions of ' symbiotic ' relationships between Science, Technology and production. Their restructuring is a difficult and time consuming process.

3.3 On the other hand " mechanistic " models, based on the experience of industrialised countries, isolated from their environment, cannot easily be transplanted with similar end results in the different " climate " of developing countries, " Growth " itself is an ' organistic ' concept, and by analogy it is not possible to have a tree which gives only fruit, without leaves, roots, branches etc. A tree however could be made " high yielding " and that is " growth strategy ". This emphasises the relevance and importance of a Science & Technology Policy, as the ' back up ' support for industrial policy. The IRSI is a creature of such policies.

3.4 Science policy includes Technology Policy in a general sense, but the latter could be distinguished in an operational sense as the basis of Industrial Policy. Industrial strategy, would indicate the course of a Technology Policy, but cannot await its fulfilment as an ' off shoot ' of such a Policy. There would of course be continual interaction.

3.5 Conceived in this manner, an Industrial Policy, could be the forefunner of, a vigorous and operationally effective Technology Policy, with its far reaching implications on other development

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sectors, and of a general Science Policy. It would establish the demand for the IRSI function (R & D & STS) from industry and in a manner that will mutually reinforce the growth of research and of industry. The successful experience of at least one country, the Republic of Korea has demonstrated the effectiveness of such an approach.

3.6 Industrial policy is an arena where Technology as a basic factor will merge with other operational factors of a commercial, financial, and managerial nature. A Technology Policy, would require the IRSI function to be tailored to specific requirements. Thereby IRSI links with industry in an operational sense, will be strengthened, creating an environment for its growth, by its deepening influence on industrial strategy. A technological planning and operational capability, will emerge providing essential support for industrial growth.

3.7 A favourable climate for industrial and IRSI growth, could be created by a meaningful Technology Policy, which takes cognizance of :

(a) The principle of ' endogenous ' development, whereby economic growth and technological charge are oriented and sustained by the nation's own scientific & technological community.

(b) Human resources, as the most important element, requires strategies of technological man power development.

(c) The factors, influencing the transfer of technology.

The mere creation of a national Scientific & Technological capability comprising the country's stock of qualified Scientists and Technologists (QST) and of institutional facilities(R&D & STS)

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as a matter of basic Science Policy, is not enough. Such an inventory, if not fully utilised, would be a waste of resources. It is a contributory factor of " brain drain."

3.8 Within a meaningful Technology Policy, an IRSI linked with operative enterprise could have a positive role in the transfer of technology. It would enable a reduction generally of external dependence, and an enhancement of domestic capability for selection, procurement, installation, commissioning and sustained operation, the cumulative costs of which constitute the overall costs of transfered technology. These management functions, cannot be satisfactorily discharged without IRSI support. The services would include studies relating to raw materials, choice of process, plant location, layout, designs, economics of scale, water, energy, transport and market studies as well as technological man power training. The IRSI techno-economic services could be a safeguard against uneconomic processes, unproven devices or obsolete technology being transfered as could sometimes happen under 'persuasive salesmanship' or even under " technical assistance ". Such IRSI functions would assist investment analysis and generally strengthen a country's negotiating capability in industrial contracting.

3.9 A technology policy is necessary to enable an IRSI to undertake such a role. Furthermore it is known that often there are " restriotive practioes " & " hidden factors " associated with technology transfers at international as well as domestic level, even though the latter are less publicised. Such practices could invariably act as demoralising constraints on an IRSI. Hence a Technology Policy, which involves monitoring ' technology transfer ' in national interest, is needed to strengthen and safeguard the IRSI, as a policy instrument, which

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could advance the technological, economic, social and ethical values of technology transfers. Confusion of policies and goals, have plagued IRSI'S in many developing countries and inhibited their growth. There may be other reasons why industrialists are reluctant to use the domestic IRSI. Among these is a lack of confidence, which could be related to the actual competence of the institute, not merely in terms of its specialisation in a scientific sense but its inability to translate and ' process ' research findings to a commercially usable stage. Alternatively especially in joint ventures the domestic partner would be supplied with IRSI services from its foreign counterpart . These problems are also associated with poor public relations. Whatever the reasons, the motivation behind the industrialists' wish or reluctance to use a domestic IRSI, will be primarily commercial.

3.10 It is possible & necessary to clarify policy, to ensure that IRSIs are given a positive direction, within a coherent pattern of development. Thereby an IRSI can be geared to the fulfilment of its own mission, while at the same time strengthening the overall national Scientific & Technological capability, through its interaction with other related sectors The policy support would also enable the IRSI to improve its ' credibility ' and ' image ', which are essential for winning the confidence of industrialists and the general public.

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4 STAGES OF INSTITUTIONAL DEVELOPMENT

4.1 The stages of institutional development could be considered in relation to functional and operational levels, as appropriate to phases of industrial development. The initial stage of industrialisation in a developing country is import substitution, for which technology is invariably obtained in " package form ". These could be considered into two phases of functional levels :

FIRST PHASE AND FUNCTIONAL LEVEL :

Routine Services :

Information and documentation , raw material surveys, analysis and testing of raw materials, intermediates and finished products, instrumentation, precision measurement and calibration.

General Technical Services :

Plant location, plant layout, ' trouble shooting ' in process or equipment.
Standards and specifications .
Quality control of products for import and export and consumer protection.
Quality Control and Standardisation as a production management technique.
Operational efficiency evaluation, energy balances etc.
Safety Standards
Equipment evaluation , selection and procurement.
Registration of patents.

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4.3 SECOND PHASE AND FUNCTIONAL LEVEL :

Comprises operations refered to in the first phase but at a more advanced level and particularly Techno-economic Services :

> Feasibility studies, for new projects or modernisation of existing ones. Long range forecasting for manufacturing expansion and resource utilisation. More advanced Management and production engineering services;commencement of contract research.

This second functional level constitutes a more advanced role and a closer involvement with technology transfer, as mentioned in para 3.8. In addition the IRSI would be providing advisory or consultancy services to entrepreneurs, financing institutions, Government policy makers and licensing authorities. Such functions will generally help to consolidate the IRSI links with operative industry, with financing institutions and with Government. The build up of professional skills will also open possibilities for collaboration with universities, as well as providing 'in house' training facilities for both research and industrial personel . . However the most important aspect of this second phase is the consolidation of the ground for the third phase, which could be a " take off " stage.

4.4 THIRD FUNCTIONAL LEVEL : would involve R & D for adaptive and innovative technology.

This includes translation of laboratory findings, through successive technological pilot and semi-commercial stages to commercial production. Each successive stage becomes more

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expensive than the previous one, with enhancement of risks. This is also the stage of expanding " Contract Research " activities. Such work would also be aimed at new products and processes and the generation of proprietory ' know how ' To accomplish this stage the IRSI facilities & operations should have provision for engineering design, plant fabrication, and " risk investment capital " support. It could be a stage when specialised R & D institutes begin to " spin off " as in Korea.

4.5 OPERATIONAL LEVELS OF IRSI

The three phases and functional levels, would in actual practice take place at several operational levels & to an extent overlap one another.

Enterprise Level :

It would be best, if at least the first and second level functions relevant to production be conducted at the enterprise level. Special " linking " efforts, would then not be necessary. However except in a large enterprise, this would not be possible. A substantial proportion of the work would have to be carried out " extra- murally ", and hence the need for institutionalisation. As a matter of principle it would be desirable to strengthen and encourage the IRSI function in Departments and Agencies, such as those dealing with Geological surveys, forest, land and marine resources etc, rather than ' externalising ' or centralising them, without a valid justification.

" Critical mass " and programme selectivity will be discussed in section 6.

4.6 At enterprise level it is desirable that every medium and large scale industrial unit should have a design, development and research cell, with functions such as the following :

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Adaptation of imported designs to local conditions.
Use of indigenous materials
Quality control and strandardisation
Promotion of indigenous designs and local fabrication, initially of components and later of plant and equipment.
Continuing study and collection of latest available information relating to a particular industry.
Identification of problems faced by industry and future trends.
Maintaining internal and international contracts.

The function of a central IRSI would be to support and complement such activities.

4.7 GROUP OR SECTOR LEVEL OF ENTERPRISE OR INDUSTRIAL ASSOCIATION

To supplement efforts at enterprise level, particularly where individual units are too small.

Well known examples exist even in developing countries,particularly in export commodities, processed or semi processed.Sometimes institutionalisation covering a specific sector of research, is given corporate status, by special or general legislation. Such arrangements provide for the vital link with industry, assured source of funds, and consolidate the IRSI role as a service to an operative industrial sector. Among possible advantages of such arrangements, are the opportunity for specialist consultancy services emerging for sectors of industry, and the business enterpreneur being made " science conscious " of the commercial value of R & D & STS. Such Sectoral Institutes too would have

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close liason with a central IRSI. The latter could stimulate, support and complement such activities or else undertake them directly, until such a time, as the enterprises individually or as a grouping, were in a position to do so.

4.8 IRSI at MINISTRY LEVEL of INDUSTRY

By designation, this would be the operational level of an IRSI. Accordingly, IRSIs in many countries are under the purview of a Ministry of Industry, along with associated functions such as Standards, Instrumentation, Metrology, etc. Such an IRSI would serve the needs especially of small industrialists, who cannot afford facilities of their own and assist in the planning and establishment of new projects. The IRSI could be the principal institutional machinery of the Ministry for monitoring technology transfer, for controlling & licensing procedures. Such an IRSI would have opportunity for establishing links, with financing banks especially Government owned or those in which the Government has a vested interest, by doing feasility studies and by advisory services for industrial financing. The link with the Government, while operating under the purview of a Ministry of Industry, will also facilitate access to public sector enterprise. Government departmental IRSIs could have problems of administrative & financial procedures, not suited to Research administration.

Furthermore relations with the private sector could be weakened in some aspects, such as having to deal with problems of technology transfer, in the national, rather than specific project interest and ensuring confidentiality of services. Some of these problems could be overcome by giving a ' corporate ' or autonomons status, providing appropriate safeguards.

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4.9 A ' departmental ' IRSI could become an important machinery of Industrial Policy, if the Ministry treats it as its specialist consultative body, and would find it easier to fit into the administrative machinery but harder to be a service facility to operative industry. Hence special efforts would be necessary to maintain liaison and win the confidence particularly of private sector industry.

4.10 IRSI at NATIONAL LEVEL :

As already mentioned, at this level the institute tends rather to be a national Science & Technology machinery, with cross-sectorial functions rather than an IRSI ' per se ', even if its operations are substantially aimed at industrial development. In a country, which accords to National Science Policy, an important development role, with a Ministerial portfolio of Science & Technology, such an institution could provide a major thrust toward industrial growth, and related technological development in other sectors.

4.11 The institution itself could be a network of individual units. It could be of the ' Council ' type or ' Institute ' type. ' Councils ' of Scientific & Industrial Research patterned on the original British prototype, and found in many Commonwealth countries tended traditionally to be more academic oriented with strong University links. This bias is also attributable to the fact that such councils were placed under a Ministry of Education & Science. Ministries of Technology are of relatively recent origin. In contrast the ' institute ' types, particularly those influenced by American attitudes, tended to be more inclined towards commercial objectives, and less mindful of the role of Universities and of the appropriate relevance of fundamental or basic applied research. The coordination of these composite factors requires a Science and Technology Policy.

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During the last decade the relative merits and disadvantages of such systems have been the subject of study. The subject is well documented.

4.12 Imitative institutional patterns, taken from industrialised countries, have not been effective, without substantial adaptation. A basic factor, which had been overlooked was that in the industrialised countries, irrespective of political system, industrial research was carried out substantially within industry, whereas centralised institutional arrangement were invariably concerned with long term fundamental work on strategic areas. Developing countries, in their initial phase of industrialisation have been constrained to adopt centralised research institutional machinery, for . . purposes such as food processing, building materials, leather, ceramics, paper, pulp, textiles, etc. On the other hand, where commodity processing research facilities existed . " within industry ", they were invariably of the ' enclave ' type associated with traditional colonial patterns, multinational or joint venture arrangements, from which there was little ' horizontal ' spin off to other areas of industrial growth. Hence there appears to be a justification for the establishment of the centralised institution, of an appropriate form and content, which could stimulate industrial and associated technologioal growth. This will be further discussed in section 6.

5 IMPORTANCE OF STAFF DEVELOPMENT

5.1 In the section of Policy objectives, it was stated that a Technology policy favouring IRSI growth, needs to consider human resources as the most important element requiring strategies of technological man power development (para 3.7). Evidence of this is the fact that such a policy has enabled nations to overcome deficiencies of natural endowment.

5.2 Subject to the availability of financial resources, it should be possible to set up IRSI facilities, building and equipment within a short time. This applies also to the establishment of industrial plants. Staff development is however the slowest and the most difficult, whether in operative industry or research. It is often the principal constraint, whose importance is often underestimated on the assumption that like plant and equipment, personel too can be imported at will. Man power development, a basic consideration of Science & Technology policy, comprises training at all levels from top Scientific specialists to middle & lower level technicians of the various skills that are needed for Research and Industry. ' Formal ' education requires to be supplemented by training within Industry or the Research Institution.

5.3 PERSONEL MANAGEMENT and development is difficult enough for the purposes of operative industry. It is much more selective and difficult, in practical terms, for the purposes of Research. Staff training and development have to be conceived in terms of incentives, the maintenance of high level of ' morale ', and the fostering of creative abilities, individually as well as in groups.

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This critical aspect of research management (along with other aspects of management) is one which is often negleted in most developing countries, where the complaint is invariably of shortage of skills and of " brain.drain ".

5.4 LEADERSHIP is the first and most important requirement. The Director or Chief Executive of an Institute is a oritical ohoioe. On his professional and academic stature, proven oompetence, personality, individuality, dynamic qualities of leadership, intergrity, impartiality, strength of character and ability to maintain a high staff ' morale ' would depend the suocess of an IRSI more than anything else. It is not only the oorrect choice of a ' head ' that matters but it is essential that he and his staff are safeguarded from ' external interferenoe ' in the discharge of their functions, through adequate provisions in the charter of an institute.

5.5 One of the most secoessful strategies, has been the Korean experiment of inducing qualified nationals working abroad (reversal of ' brain drain ') to return, by offering suitable oonditions of servioe. Reasonable emoluments is only one of the oonsiderations. Equally important is the oongenial working environment of a Scientific Community and oppertunity for rewarding and oreative work, and reoognition of achievement.

5.6 Subjeot to basic pre requisites, such as those referred to in the foregoing, the staff development function of an IRSI would include the following :

(i) Seleotion of personel

(ii) Training within the institute, of the methodology of research, of team work, of speoialisations, of adaptation to looal oonditions, of identifying needs and priorities,

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of taking cognizance of local cultural and social conditions, particular attitudes, of the art of communication in extension work, and successful public relations.

(iii) Supplementary specialist training abroad as appropriate

(iv) Periodical or ' sabbatical ' leave for working abroad.

(v) Special training needs of middle level technicions.

(vi) Anticipating personel requirements well in advance of the actual needs.

(vii) Recruitment of specialists, nationals of the country or expatriates.

(viii) The institute's function as a staff training facility for industry and also the provision of training programmes for persons employed in industry.

(ix) Promoting exchange of staff between Universities, industry and institutes.

(x) Providing liberal opportunities for international contacts.

5.7 Apart from the general complaint about ' brain drain ' from developing countries, many research institutes complain about their inability to retain certain categories of staff, on account of the demand from local industry. If an IRSI is providing trained staff for domestic industry, it is indeed doing a national service. In fact if certain categories, including skilled middle level personnel are difficult to retain, this in fact is a case for stepping up cadres and training facilities in those categories. The IRSI in a developing country should also be regarded as a source of trained personel for industry.

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6 OPERATIONAL STRATEGIES AND ANNUAL WORK PROGRAMMES

6.1 Under this heading, it would be appropriate to consider organizational structure, programmes, policies and management. Research & Development (R & D) and Scientific & Technical Services (STS) for industry requires to be carried out at several functional and operational levels (Section 4). Institutional development for this purpose needs to conform to certain basic criteria :

Firstly, ' mission oriented ' or ' problem oriented ' work should be carried out as far as possible within their respective operative sectors. (paras 4.5 - 4.7). Over centralisation could weaken the links with production as has happened in many developing countries. Large and medium scale industries should undertake certain IRSI functions within the enterprise (para 4.6).

Secondly, Research Units need to have a minimum concentration of personel and facilities to be effective. Proliferation of units, as might appear desirable, for purposes of decentralisation into the heart of operations, could result in a wasteful dispersal of resources if carried out regardless of the " critical mass ". Furthermore there would be essential facilities, beyond the means of smaller enterprises. Hence a grouping of programmes, personel and facilities would be necessary, to supplement ' in house ' operations at enterprise level.

Thirdly, there should be a selective programme strategy. For any country and particularly for a smaller country it is important to select a few development areas of high priority and go all out in these as far as innovative R & D is concerned, in order to avoid wasteful dispersal of scarce resources. General STS however should be maintained to cover the widest area practicable.

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Fourthly, the efficiency of factor combination is a crucial organizational consideration. Several factors are involved in " mission oriented " research for industrial purposes. These include physical resources, management, investment, marketing (domestic or export), man power development, employment, regional development and many other elements.

6.2 As a development strategy, a strong case could be made out for the establishment of an IRSI at the highest national level, as a National Technological Research & Development Institute, preferably under a Ministry of Science & Technology, and backed by a meaningful Science & Teohnology Policy, to provide an effective thrust for the growth of the industrial sector and other activities requiring technological inputs.

6.3 Such an Institute would enable a concentration of professional skills and facilities of critical strength. Where R & D already exist at enterprise levels, it would complement and support such activities. Alternately, it would handle such activities until enterprise could take them over. The Institute would also concentrate on cross-sectorial activities not coming within the exclusive purview of a specific enterprise or sector and conduct original research and development, and render technical advisory services to the Government, financing institutions, enterprises and investors, both domestic and foreign.

6.4 The Institute could also serve as a National Technology Transfer Centre, by assisting in the choice of appropriate technology, as well as adaptation and innovation through R & D in specific areas. It would assist in minimising costs of technology transfer and maximising productivity in capital intensive sectors, e.g. in the selection, procurement, installation and operation of plant, required by mechanical, chemical, electrical, mining and metallurgical industries.

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It would also service small and medium industry and have a special role in agro-based industry, product and process development.

6.5 An Institute of this level, could provide the technological capability, needed to provide an effective impact much needed in many developing countries, where entrepreneurship and innovation have been stagnating even after years of import subtitution policies, and operation of IRSIs in one form or another. The establishment of such an institute and its progress would require both political will and leadership.

6.6 The first step is the Selective programme Strategy, for achieving " critical mass " and specialisation, as appropriate to the country's economy. A thorough and exhausive survey requires to be carried out, in order to determine the present and potential needs of industry, on the basis of which a few high priority areas should be selected for specialisation and concentration of effort. It certainly does not mean setting up a ' prestige ' institute and waiting for programmes to come to it.

6.7 OPERATIONS : The operational strategy , based on such surveys and policies,need to be expressed in programmes, annual or longer for practical administrative convenience and budgeting purposes. There would be the continual in flow of work, based on demands from industry, and which is likely to increase steadily.Where the work demand exceeds available resources,selection on the basis of priority will have to be considered, simultaneously with provisions for expansion of facilities. It is essential to ensure that long term R&D work which is likely to have far reaching implications on national development is not overlooked in favour of short term programmes.

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6.8 To meet the specific needs of technological development in a tropical developing country, facilities such as the following would be desirable, enabling a combined effort of specialists in various disciplines .

A PROCESS DIVISION

The process division would concentrate on developing process know-how supported by necessary basic research :

(i) Applied chemistry and chemical engineering unit.
(ii) Applied physics,material science and metallurgy unit.
(iii) Microbiology unit relevant to natural products and food technology.
(iv) Data processing unit.

The Applied Chemistry and Chemical Engineering Unit

would work on natural products and agricultural commodities including wood, cellulose, pulp, paper essential oils, coconut, tea, coffee, cocoa, palm oil, sugar, cotton, natural rubber,etc. The unit should be equipped with modern physico-chemical analytical techniques.

The Applied Physics, Material Science and Metallurgy Unit.

would work on electronic materials and mineral benefication process of indigenous ores supported by basic research in solid state physics and physical metallurgy.

The Microbiology and Food Technology Unit would work on food processing, storage, post-harvest technology, and transport. Dairy produots and fruit preservation with export possibilities are important areas. This work might involve basic research in microbiology.

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The Data Processing Unit would advise in the design of experimental procedures and interpretation of results where statistical procedures are deemed necessary. The unit could also serve as the nucleus of a national computer centre for research and development and render general data processing services.

B TECHNICAL SERVICES DIVISION

The technical services division would be an active component of the organization, and comprise units for :

(i) Science and technology information
(ii) Techno-economic data and information
(iii) Standardization and specifications
(iv) Instrumentation and precision measurement

The Science and Technology Information Unit would be manned and equipped for collecting, classifying, abstracting and disseminating of technical information. This unit would avail itself of help from the scientists and technologists in other units. It would have translation facilities. The unit would also disseminate information on organization, projects undertaken and completed with special emphasis on economic benefits achieved.

The Techno Economic Unit would conduct surveys, market studies and feasibility studies for projects to be undertaken taking cognizance of socio-economic aspects as appropriate. It would provide specialist services to industrial entrepreneurs. Working in collaboration with other units, it would enable the institute to be a principal advisor, to development financing banks, and to investors and entrepreneurs both foreign and domestic.

The Standardization and Specifications Unit would assist in establishing and maintaining standards guaranteeing quality.

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This unit would maintain contact with the National Patents Office to ensure that no infringement would take place.

The instrumentation and metrology unit would be concerned with fine mechanics, electronics, optics, and calibration. Its function would include servicing and maintenance of instruments. This unit would require to be equipped with primary and secondary standards equipment for precision measurements and calibration.

C Projects Division

This division would be the main channel for the translation of laboratory work into industrial production and would therefore be of major significance. It would comprise :

(i) Project teams
(ii) Fabrication facilities
(iii) Tools, jigs and fixtures.

The project division would have on its staff qualified design engineers, technologists, design draftsmen and adequate fabrication facilities. Project teams would be formed according to requests from industry, comprising staff from this division and from other units. The project leader would be designated by the head of the organization for the implementation of a project. He would have the necessary freedom and authority to use the services of any facilities and personnel of the Institute . The Projects Division would not only give manufacturing drawings, specifications and prototypes but also supply know-how in the form of technological documentation, tools, jigs, and fixtures. In some cases, complete layouts of plant and machinery might have to be supplied.

D Industrial Extension Services Division

This Division would hold the key to the success of the Institute

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as a service to industry and would comprise :

(i) Extension Services Unit

(ii) Small Industries Services Unit

The Extension Services Unit would need to post its staff in the principal industrial areas of the country. They would be in continuous contact with industry and their R & D cells, identify their problems, communicate them to the organization and establish contacts between the organization and industry. They would be responsible for promoting R & D contracts for the Institute

The Small Industries Services Unit would cater for the needs of enterprises which cannot afford to have either design or R & D cells of their own. They are often not in a position to acquire services of consulting firms. In view of the importance of this sector, especially on account of its employment potential, the organization should render services at nominal charge or even free in certain cases. The services might include improvement of product or process, product design, technological know-how, supply of tools, jigs and fixtures, etc. This unit would also post its staff in the areas where small industries are located.

6.9 MANAGEMENT

It is necessary to mention the need for providing appropriate administrative support in respect of personnel, financial, procurement, supplies stocks and inventory control, legal matters, etc. Inadequacy in these functions would have a prejudicial effect by detracting the senior staff, particularly the Head of the Institute from their professional tasks. It is in a situation that can be easily avoided by ensuring that scientific persons who are required to undertake administrative responsibilities, are trained for this function well in advance. Research management involves specific skills. Cadres as well as organization & Methods have to be developed for the purpose.

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6.10 Among the General Service Function that an Institute such as this oould perform are :

(1) A technical information service

(2) Reporting on the state of technology in various sectors of industry.

(3) Technological forecasting

(4) Organising basic long term research and studies of relevance to national economy.

(5) Sponsoring joint technological research programmes with other institutions.

(6) International relations

6.11 ORGANIZATION

It is generally admitted that normal civil service procedures are unsuited for a Research Institute. Hence it is customary to establish a national Research Institute, as a corporate or a juridical body by special legislative enactment, providing for internal 'autonomy' an assured source of funds and of course provisions for 'accountability'. A Governing Board of a Research Institute would be different in many respects from a Board of Directors of a manufacturing and trading activity. It would be desirable if the Institute Director's functions and responsibilities as well as those of the Governing Board are clearly defined. Such provisions are necessary to facilitate ' internal autonomy ' of the Director & Research Staff as far as the conduct of scientific research work is concerned, and also to cover special requirements such as safeguarding clients' confidentiality as appropriate and proprietory rights over ' patents ' etc. etc.

An important provision of ' accountability ', other than financial auditing would be periodical evaluation of work. Sometimes

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would be advantageous to conduct such evaluation by a special body, which includes outside specialists.

6.12 'Factor combination ' in the case of an IRSI would relate principally to industrial policy, investment, domestic and export marketability employment, regional development, technological training. The composition of a Governing Board or alternatively an Advisory Board provides an opportunity for the representation of such sectoral interest. An important ' Strategy ' in a developing country is securing a link with financing institutions, through Board representation. Such a link could be further strengthened if the financing institution would concede a reciprocal position to the Institute Head on its own directorate. Thereby the Institute could function as a technical advisory body, The bank's clients will also turn to the Institute for advice and assistance. There have been instances where this arrangement has been successful.

6.13 An assured source of funds is an essential requirement. An institute of this nature will have to be supported substantially with public funds, although it will have some income of its own. Putting too much pressure on an Institute to be financially self supporting would act as a constraint on its growth in the service of the national economy of a country.

PS The conclusions and recommendations in this paper are based on the writer's own experience as a research director, as well as his contacts with many IRSIs of developing countries in Asia, Africa, and Carribean. References to IRSIs by name have been avoided. Detailed information on individual IRSIs, are to be found in Prof. Blackledge's Comparative Study on the IRSI in a developing country,(USAID, Washington DC, 1975) to which reference has been made.

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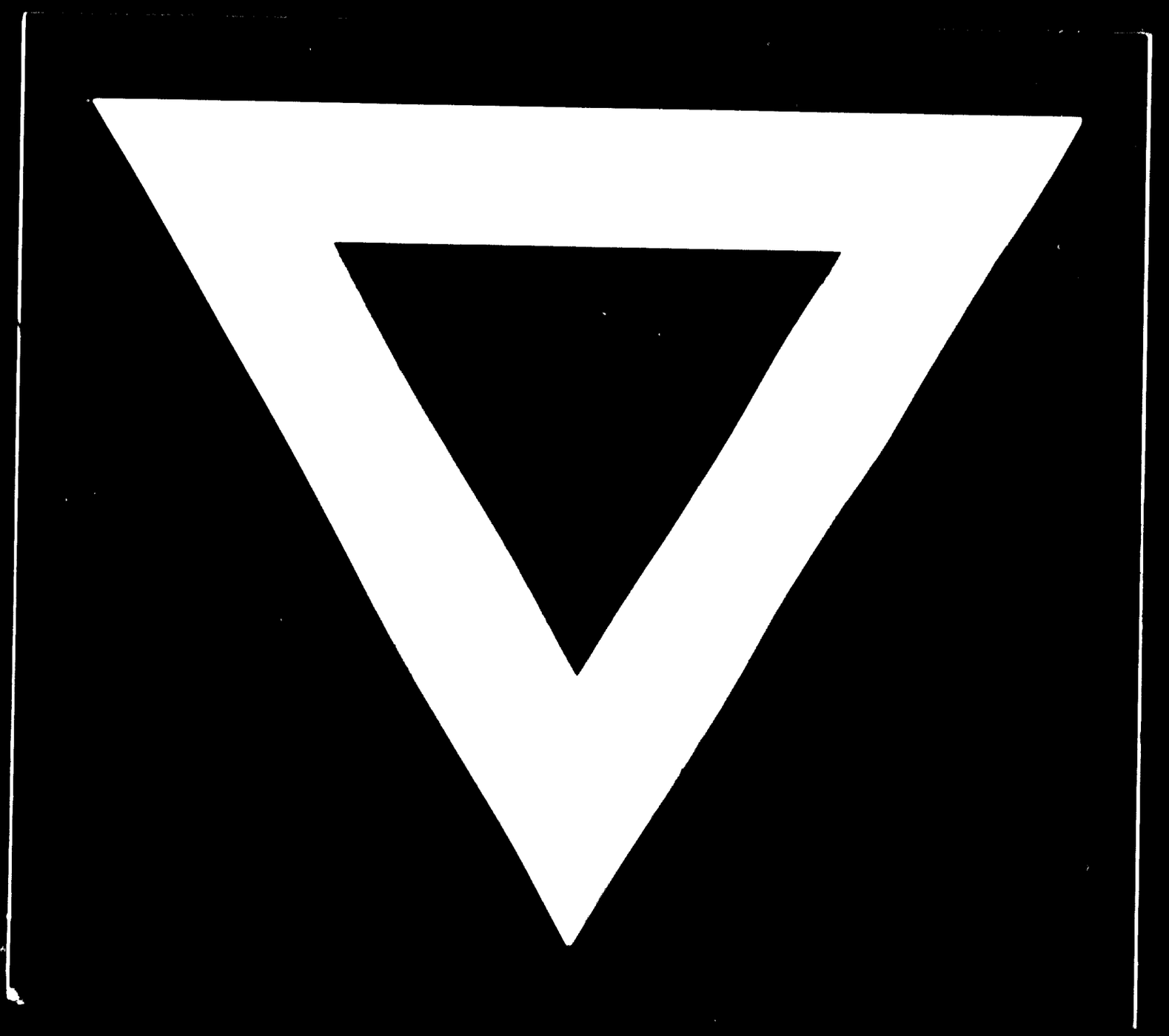

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