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UTILIZATION OF NATIONAL TECHNOLOGICAL INSTITUTIONS IN THE DEVELOPING COUNTRIES FOR INDUSTRIALIZATION

Report of an Expert Group Meeting

Port of Spain, Trinidad
14 - 19 February 1977

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Explanatory notes

References to dollars ($) are to United States dollars, unless otherwise stated.

References to "tons" are to metric tons, unless otherwise specified.

The following abbreviations are used in this document:

KIST	Korea Institute of Science and Technology
K-TAC	Korea Technology Advancement Corporation
FIIR	Federal Institute of Industrial Research, Oshodi (Nigeria)
CARIRI	Caribbean Industrial Research Institute (Trinidad and Tobago)
IDC	Industrial Development Corporation (Trinidad and Tobago)
CRI	Cement Research Institute (India)
R and D	Research and Development

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INTRODUCTION

Most developing countries place high priority on industrial development to facilitate the achievement of their social and economic goals. There is general recognition that the rate of economic growth in general and of industrial development in particular is greatly enhanced by the level of technology in the country and the rate at which technological research results and "know-how" are applied. Accordingly, there has been an increasing movement within the developing countries towards the development of their technological capacities through, inter alia, the establishment of national technological institutions as a means of aiding industrial development. Large sums of money have been invested in such institutions and their programmes with the expectation of some important returns on these investments.

Any agency or institution supplying the technological inputs in the sub-systems or linkages in which there is a technological content may be broadly defined as a "technological institution". These are focal points, in terms of the existing and future development of indigenous capability.

United Nations experience in assisting the developing countries in the development of technological supporting activities for industrialization covers a period of over 10 years, beginning in 1964 with the Centre for Industrial Development (CID) of the Department of Economic and Social Affairs of the United Nations Secretariat. During the period, assistance has been given to developing countries in building their technological capabilities in support of industrialization, particularly in training, and increasing the expertise of the staff of the national technological institutions.

In its technical assistance programmes, the United Nations Industrial Development Organization (UNIDO) has had the general objective of assisting the developing countries in the formulation and implementation of their industrial development policies and plans in accordance with national priorities and objectives. Within this context, UNIDO has provided assistance in establishing the institutions mentioned above, as well as in strengthening the structure and in improving the efficiency of existing ones so that they could become effective focal points for the introduction of technologies suitable for local needs; in adapting processes to meet these needs; and in supplying technological and related services to government agencies and to public and private industries of the developing countries. These institutions cover a wide variety of areas, such as multipurpose and specialized industrial research; standardization and quality control; industrial information; engineering design; training, management and consultancy; technology transfer; and identification, preparation and evaluation of projects.

In working towards these objectives, UNIDO has emphasized the need for maintaining continuous collaboration among these institutions and the agencies and enterprises directly concerned with industrialization. To build and develop such complex institutions in an orderly manner, the policies under which they operate, their fields of activities, and the resources that will be made available to them must be defined and care taken not to duplicate activities. The main objectives of UNIDO are to assist the developing countries:

To formulate, co-ordinate and apply sound technological policies

To establish an institutional framework to provide technological support to the national industrialization programme in accordance with the needs of the country

To restructure and consolidate similar or affiliated technical institutions and harmonize their programmes to avoid duplication and wastage

To plan and implement research and development and translate the results to industrial production

To strengthen the management of technological institutions concerned with industrialization

To train executives and other levels of professional workers in technological institutions

To link the institutions in developing countries with counterparts in both developing and industrialized countries for the exchange of experience and information

The involvement of these national institutions in the industrialization process has not been clearly understood and well defined. While a number of them play key roles in some countries, their involvement in most developing countries is still very limited, especially in such areas as industrial and technological planning, programming and forecasting; project identification, preparation and evaluation; and project and programme implementation. The full potential of these institutions as an instrument of industrialization has therefore not been fully utilized.

Consequently, UNIDO decided to undertake a closer examination of the contribution national technological organizations could make with respect to each facet of the industrialization process; to analyse the steps and actions required on the part of these institutions; and to identify the principles, key elements and guidelines that would enable them to perform these critical functions, recognizing that not all the institutions might be able to contribute at all points of the complex operations associated with industrialization. Their contribution would depend upon such factors as the level of development of the country and the institution; the expertise of staff of the institution; the competence of its director; national policies; and the attitudes of the decision makers in the country.

In carrying out the above-mentioned examination, UNIDO appointed five directors of selected industrial research institutions in developing countries to prepare case studies on the role of their institutions in the acquisition of foreign technology important to their countries and the commercialization and improvement of the technology. The elements common to all the institutions in their involvement in this technology transfer process were identified by UNIDO with the assistance of a sixth consultant and elaborated in a background paper that was to form the basis for discussions at an expert group meeting.

The Expert Group Meeting on the Utilization of National Technological Institutions in the Developing Countries for Industrial Development, organized by UNIDO, took place at Port of Spain, Trinidad and Tobago, from 14 to 19 February 1977. The purpose of the Meeting was to examine the major elements of industrialization to which national technological institutions could make a contribution.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

General

Industrialization, particularly in the developing countries, is an extremely complex process involving managerial, technological, economic, social and political considerations and parameters, dynamically composed, orchestrated and performed by a changing cast of players, participants and decision makers. It involves the building and management of enterprises that harmonize and integrate resources, technology and human effort for productive purposes. As such, it must be handled as a system, consisting of an organized combination of subsystems and elements linked together to form a whole.

The most desirable way for the Government of a developing country to achieve its industrial development aspirations is to develop its own technological capability to plan, initiate, implement and evaluate projects and to act as a "watch dog" to see that national objectives are achieved.

The stage of development of a country's institutions will determine the degree of utilization of local technological expertise in the industrialization process. The development and organization of a country's technical talent and institutions should, using a multidisciplinary approach, be tailored to the job to be done and not based upon some general model or formula.

Industrial planning and programming

In the industrialization process, the detailed methodology varies from country to country. The broad planning is usually co-ordinated by indigenous economists and planners within the country. The technical inputs to planning, however, are largely provided from external sources. In most developing countries, local technological institutions, where they exist, are generally not called upon nor do they actively seek to play an important role in national planning.

The level of achievement of national industrial goals would generally be enhanced if national indigenous technical capabilities, especially technological institutions, were intimately involved at all points of the industrialization process, especially at the planning stage.

One of the critical problems of the industrialization process is the lack of organized technical and planning data and the talent to analyse and interpret the data in terms of project, sectoral and national needs. Technological institutions are ideal organizations to carry out such functions.

Initiation and implementation of industrial projects and plans

The implementation of industrial projects by nationals becomes extremely difficult when the local technological institutions are not involved in the planning and formulation stages of such projects.

Technological institutions can help in initiating industrial projects and programmes by identifying, collecting, and preparing sectoral industrial surveys and technology plans. To do this effectively, special staff need to be trained and a national network or system established to ensure a smooth and constant flow of information to the planners.

One of the problems national technological institutions constantly face in initiating and implementing industrial projects, especially in preparing feasibility studies, is that the Government and local and foreign financial institutions lack confidence in them. To overcome this problem, technological institutions in the developing countries may establish links with more experienced ones to develop on a long-term basis their capabilities and thus to enable them to acquire the necessary confidence of their clients. They also, as a short-term measure, need to involve in varying degrees those consultants and/or technological institutions that already enjoy international recognition.

Acquisition of technology and commercialization of R and D results

The acquisition of foreign technology through importing or licensing arrangements etc. can play an important role in increasing technological capacity. The timing of such an action is extremely important and the institutions should recognize that. Technological institutions can advise on the key technologies that should be brought into the country and the status of the raw materials needed in processing and production.

A vital role of the institutions is to ensure that the imported technology shall be absorbed and rapidly diffused to other industries. In some countries technological institutions carry out the whole range of activities related to technology acquisition. In other countries they act as participants or part of a national team.

For large turn-key projects involving the purchase of off-the-shelf technology and know-how, which are quite different from those projects carried out from the test tube to pilot plant and to commercialization by a technological institution, some of the project funds should be invested in the development of capacities for the absorption and maintenance of the technology.

Role of technological institutions

For technological institutions to be effective, the policy under which they operate must be clearly defined and adequate financial and human resources and physical facilities provided. Depending upon the level of development of the country, a judicious choice needs to be made between the organization of the national technological inputs into industrial development through a single, multipurpose and multidisciplinary technological institution or through several multipurpose and/or specialized ones.

Technological institutions have differing types of roles to play in industrialization. In technological matters, they should be leaders. Where technological factors are not decisive but necessary, they should act as participants. In all other activities, they should keep themselves informed of what is happening in the other aspects of the industrialization process so that they can be prepared to respond to new needs.

Technological institutes should be agents of change and must accordingly have flexibility to adapt to changes in economic and technological environments, changes in national strategies and other changes that affect industrialization. Within the framework of such a dynamic life cycle, some technological institutions need to be strengthened, others phased out, and some combined. Before taking action to create new technological institutes, planners should exhaustively review existing institutions to ensure that the tasks to be accorded to the new institution cannot be undertaken by an existing one in its present or modified form.

Evaluation and monitoring of industrial projects and programmes

Once the project has been implemented and its products have entered the market, there is a continuing need for evaluation, monitoring and technical support. Further, there is a need for feedback to the policy makers for possible modification of national and sectoral plans, based upon the performance and the potential for growth of the plant. It may also be determined that the operation, or a phase of it, needs to be modified or improved.

Of major importance during this phase is the evaluation of on-going production; a continuing analysis of market and technological trends; identification of new opportunities arising from market changes and new technology; identification of changes arising from revised national and sectoral plans; provision of technical information and data required for assessing the short- and long-range industrial and economic trends of the country and the changing needs of industry.

An important responsibility of technological institutions is to see that industrial projects meet national goals. There is a general lack of evaluation systems in developing countries that would enable them to learn from past successes and failures. Technological institutions acting as watch dogs for Governments oould make suoh evaluations.

In many cases there are detailed contracts between enterprises in developing countries and foreign companies, but no one seems to be charged with the responsibility for seeing that agreed upon specifications are being maintained. Technological institutions could assume this responsibility.

Recommendations

General

1. To exercise total control over their industrialization, developing countries should attempt to reduce their dependence on foreign sources of technical inputs required for industrial development. Each developing country should establish national machinery, where this does not exist, for the effective development, interaction, and utilization of national indigenous capabilities with resources and management for planning, programming, implementing, monitoring and evaluating in its industrial development plans and programmes.

Development of national industrial and technological institutions

2. In implementing industrial development plans and programmes, Governments of developing countries should not only be concerned with the success of industrial projects in the short term, but also endeavour to develop a sound local basis for long-term industrial development by creating national indigenous technological capacities to develop and apply indigenous technologies, where appropriate, and to absorb and adapt foreign technology.

3. UNIDO should intensify its efforts to assist developing countries to improve their industrial and technological capacities, particularly at the management level. UNIDO should devote special attention to the exchange of experience between directors of technological institutions to broaden their perspectives.

4. UNIDO should also assist developing countries in identifying specific tasks in the industrialization process or project cycle that local technological institutions could undertake.

<u>Establishment and utilization of national technological institutions</u>

5. Each developing country should establish appropriate industrial development and technology policies and programmes to ensure a systematic and co-ordinated approach to the development and utilization of national industrial and technological capacities. To implement these policies and programmes, national technological institutions should be strengthened or new ones established to provide the necessary technological information and data required for industrial development.

6. When a new institution is to be established, a careful and exhaustive review of existing ones should be undertaken to ensure that the tasks proposed for the new institution could not be undertaken by the existing ones in their present or modified form.

7. Notwithstanding the establishment of the above-mentioned industrial and technological policies and programmes, existing technological institutions should endeavour to involve themselves, to the maximum extent possible, at all stages of the industrialization process, from planning through production.

8. These institutions should broaden their perspectives. Their responsibilities should be nationally oriented even though their capabilities may be limited initially. Using this guide they should recognize their role, in many cases, as a prime cont[illegible] draw upon other experts both within and outside the country to comp[illegible] their capability in carrying out their functions.

9. Technological institutions should endeavour to develop linkages with other complementary [illegible] foreign institutions to obtain assistance, training and technical exp[illegible] enable them to expand their scope and improve their contribution [illegible] industrialization. Great discretion should be exercised in the choice of partners to enhance the confidence of the decision makers and industrial enterprises in the ability of the institutions to provide useful short-term and long-term services.

Industrial statistical data and technological information

10. In furthering national industrial development capabilities, developing countries in general and technological institutions in particular should pay attention to developing skills in collecting, analysing, interpreting and providing technological information and industrial statistical data required for application at all stages of industrialization.

11. In this connexion, UNIDO should sponsor special training programmes for individuals and groups of technical personnel from the developing countries to enhance their capabilities and skills in carrying out the above-mentioned work.

Commercialization of R and D results

12. Each developing country should, where appropriate, establish a national policy and create machinery for the commercialization of R and D results. Such policies should include appropriate incentives to promote the development and commercialization of local technologies as well as the creation of the required capabilities for the maintenance of not only locally developed technologies but also imported ones.

13. UNIDO should carry out an analysis of specific on-going or completed projects in selected developing countries to identify the optimum conditions under which the commercialization of R and D results can be stimulated in other countries without undue duplication between national institutions. UNIDO should help finance the commercialization of selected R and D projects in developing countries.

Acquisition of technology

14. Each developing country should establish a national system and appropriate institution for the acquisition of technology. Its terms of reference should allow it to work closely with the national technological institutions but as an independent entity negotiate with the private sector the terms of acquiring technology, both locally developed and imported.

15. UNIDO should support actual technology transfer and development programmes so that case studies may be prepared from which models of the technology transfer can be developed. These models would identify the parameters to be examined when embarking on such ventures.

International and national follow-up meetings

16. To create greater awareness among decision makers, industrial enterprises and technological institutions in the developing countries of the contributions technological institutions could make to industrialization, UNIDO should organize international meetings on this subject.

17. UNIDO should also initiate and assist each developing country, upon request, in organizing such meetings nationally. Such conferences would help to develop the most appropriate methods of organizing the technological institutional infrastructure to obtain the most effective results from these organizations, to motivate greater use of these organizations and to stimulate the development of a greater local technological capacity.

I. ORGANIZATION OF THE MEETING

The Meeting was attended by six consultants from both developed and developing countries and eight experts from Trinidad and Tobago. S.N. Ndam, Industrial Development Officer in the Industrial Operations Division of UNIDO, served as Director. Some of the participants from Trinidad and Tobago served as chairmen of the discussion sessions; E. Glass was elected Rapporteur. He was assisted by D. Ali and G. Voss. Annex I contains the list of participants.

To facilitate discussions, the role of technological institutions was considered in four broad areas (see annex II) as follows:

In national industrial planning
In the initiation of industrial projects
In the implementation of industrial projects
In the evaluation and monitoring of projects and programmes

Study tours were undertaken to the Trinidad and Tobago Oil Company (TRINTOC); the Pitch Lake; the Electrical Switchgears and Wire Manufacturing Plant of the Neal and Massy Company; the sorrel concentrate production plant; and the Caribbean Industrial Research Institute (CARIRI) to obtain on-the-spot understanding of some of the aspects discussed. These study tours also helped to impart a more practical orientation to the discussions, especially in the elaboration of the recommendations.

II. PRESENTATION OF CASE STUDIES

The following case studies were presented by their authors:

Production of ethambutol, by J.H. Yang

Industrial production of "Gari", by I. Akinrele

Israel Institute for Coastal Engineering, by H. Bernstein

Development and commercial production of sorrel concentrate, by G. Sammy and H. Charles

Improved packaging for cement and mini cement plants, by H.C. Visvesvaraya

A summary of the case studies is presented below.

Production of ethambutol (d-ethylenediamino-di-1-butanol dihydrochloride)

This case study concerned the work done by the Korea Institute of Technology (KIST) in developing and commercializing a local technology for the production of ethambutol.

Institutional background

KIST was established in February 1966 as a non-profit organization to perform applied research and provide technical services to industry and government. It is a multidisciplinary, independent and contract research organization, modelled after the Battelle Memorial Institute in the United States of America. It emphasizes the transfer of technology to local industry. It encompasses the full range of technological activities: industrial research, development, engineering, testing and analysis, production processes, and marketing. KIST has a total of 52 laboratories, 1,100 staff (700 professional) and an average annual project income of $7 million (70 per cent from private industry and 30 per cent from the Government).

As a result of delays in commercialization of R and D results, KIST set up a separate corporation in 1974, the Korea Technology Advancement Corporation (K-TAC), to facilitate the commercialization of R and D results from KIST. The business activities of K-TAC include: promotion of R and D results to be commercialized; sales of by-products of KIST research; sales of patents and know-how; sponsoring KIST R and D; and support of other related activities.

K-TAC helps local industries to launch new businesses based on the technology developed by KIST by arranging technology diffusion and rendering services. In return for its assistance, K-TAC receives payment in the form of equity participation, royalties and lump-sum cash payments.

The ethambutol case study illustrates several important points in the commercialization process. It requires a fairly sophisticated synthesis route along with high-level technology; the existing size and structure of the sales market is relatively complicated; the patent position involves complications; the process leading to commercialization is an integrated one involving bench-scale research, pilot plant testing and, finally, construction and operation of a commercial capacity plant; and close linkage not only with the project sponsor, but also with the Government throughout the life of the project.

Nature of the industry

Since 1950, when the Republic of Korea was completely dependent upon foreign sources for pharmaceuticals, the industry has developed a capability for tabletting and encapsulation, followed by a new stage where intermediate compounds are imported and carried chemically to the manufacture of final products. The industry has begun to process raw materials into final products. It was during this latter stage that the laboratory results on ethambutol were successfully completed by KIST.

Currently, there are some 270 pharmaceutical companies in the Republic of Korea with annual domestic sales of about $200 million. Raw material imports for the industry are about $60 million. The annual increase in demand for all pharmaceuticals is about 30 per cent per year. Only about 30 per cent of the total raw material needs are being met locally.

Government incentives for industry

To enhance the local development of technology and to promote establishment of domestic manufacturing chemical facilities, a series of incentives has been worked out. These include the protection of industries involved in synthesis instead of blending; discouragement of the development of the same item by competitors; and tax deduction for research expenses.

Market situation of ethambutol

The drug, developed in advanced countries about 15 years ago for the treatment of tuberculosis, was introduced into the Republic of Korea in 1968. The demand for the drug increased dramatically from $40,000 in 1968 to $5 million in sales for 1976. The client who took up the ethambutol production project in co-operation with KIST is a well-established manufacturer with about 900 employees. His total annual sales are valued at $20 million, based on the production of 60 drugs. The firm had a reasonable prospect of dominating the existing market if it could successfully synthesize the drug. The preliminary economic study also revealed that it could produce the drug at internationally competitive costs.

Patent dispute

KIST found a new route to synthesize the drug that would bypass the patents held by foreign firms in the country. Its yields were 10 per cent higher, which made it economically attractive. The development was held up for two years until the Government gave a favourable ruling over the protests of the foreign enterprises.

Monopoly on raw materials

Foreign suppliers of raw materials were reluctant to provide the required raw materials needed for synthesis, which compelled the KIST team to embark on a second stage of research to develop materials. After an additional year of research, a new, successful method was developed.

Pilot plant testing

A budgetary estimate indicated that the cost of pilot plant operations would be about 13 times the cost of bench-scale research. The scale at this stage was too large a risk for the client alone. In recognition of the importance of the project by the Government, a cost-sharing agreement was developed, with the client providing 50 per cent of the funds; KIST, 35 per cent; and the Ministry of Science and Technology (MOST), 15 per cent. A pilot plant of 10 tons (annual capacity) was initially constructed. A matrix type of structure was applied throughout the project. The pilot plant operation was successfully completed, and all engineering data and reasonable confidence for designing a more efficient and productive commercial plant were obtained.

Technology transfer to the client

It took nine months to complete the pilot plant. After initial start-up tests, steps were taken to transfer the technology to the client. Three professionals and 50 technicians were assigned to the project by the client to cover a three-shift operation. This was considered the best way to pass along the know-how to the client and to expose the client's personnel to the hazard of mistakes. In the latter stages, the pilot plant was running entirely on the client's work-force alone. The product of the test operation was involved in a marketing test to identify the general reactions of the consumers. The results were satisfactory.

Routine operations of the pilot plant were achieved in six months. At this point the client's engineers embarked on designing and building a 35-ton capacity plant on their own. It was completed successfully. The KIST team was, and still is, deeply involved through all stages of plant operations for the dual purpose of trouble-shooting and improving the yield.

Industrial production of gari

This case study described the work done by the Nigerian Federal Institute of Industrial Research, Oshodi (FIIR) on the development of a process for the industrial production of gari.

Gari is a semi-fermented, dried granular product made from cassava roots. It forms the staple food of much of the population of Nigeria and other West African countries. In Nigeria alone some 5 million tons per annum of cassava is used to produce gari, largely in villages.

Traditionally, gari is produced as follows: the cassava roots are peeled, then grated by hand into a pulp, which is allowed to ferment for a few days. The fermented and drained pulp is then screened and fried on hot clay or iron pots until it is dry and gelatinized ("garified").

This traditional method of production is of low output (about 75 kg per 8-hour day), and sanitation is poor. In view of the rapidly increasing demand for the product, several organizations in Nigeria have been attempting to develop a process yielding a higher and more consistent output, using so-called "intermediate technology". The most promising process was felt to be that of FIIR, with an output of 150 kg per 8-hour day. Another process has been proposed, with outputs of up to 1,500 kg per 8-hour day. This process was found to be more difficult to implement because of social problems; co-operative ventures rather than village units would be required.

It was, however, subsequently found that these intermediate technology processes were difficult to introduce, although certain features, such as mechanical grating of the cassava roots, were readily adopted. The greatest breakthrough came when, based on the R and D done at FIIR, an associated engineering firm produced a gari plant with an output of some 10,000 kg per 8-hour day. The first of these plants has recently been commissioned in the Gambia, and three others are currently under construction. Each requires a cultivation area of some 1,600 hectares. Thus a major change in cassava production is taking place; small-scale village plots are giving way to large plantations.

While the original thrust of the work at FIIR was to produce a process based on "appropriate technology" with a slightly higher output than traditional methods, the end result was a large industrial process that proved to be more appropriate to the increasing needs of the country, especially in the urban areas.

The Institute for Coastal Engineering

This case study described the work carried out by the Technion Research and Development Foundation, a member of the World Association of Industrial and Technological Research Organizations (WAITRO) to establish the Institute for Coastal Engineering, Ltd, as a means of implementing a locally developed coastal engineering technology.

Technion is responsible for sponsored research, requested by the public or private sectors, carried out at the Technion - Israel Institute of Technology by faculty members. Contracts for such research are signed by the Foundation and the sponsor and are administered by the Foundation. The problem is that the Foundation has no direct jurisdiction over the project leader, who is a faculty member, but the responsibility for the proper execution of the project rests with the Foundation. Pressure can be brought to bear on errant project leaders through their deans, but such occasions have been rare.

The Foundation also owns and operates its own specialized service laboratories, such functions being carried out if no other group in Israel can render them. The Institute for Coastal Engineering was established as the ninth of such specialized laboratories, following the realization that the development of Israel's long coastline was important to the country.

The initial idea grew out of a teaching laboratory established for the study of special techniques for the development of harbours. To transform the idea into an R and D tool meant that the traditional problems of finding human and financial resources had to be overcome; various model studies were required that could be carried out only overseas, which entailed foreign exchange.

A faculty member with interest in the field became involved in putting the project together, and he initially spent some time doing studies in Europe. The multiplicity of authorities in the Government of Israel responsible for coastal development presented a major organizational and financial problem, since it was not clear as to which agency or agencies should be approached for collaboration and financing. Since the Harbours Authority of the Ministry of Transportation was charged with the development and operation of the three main ports and since they were interested in developing indigenous capacity for coastal engineering, it became obvious that they should be one of the major clients of the new service.

However, since the Foundation and the Harbours Authority had entirely different terms of reference, the negotiations between them for the establishment of the joint venture were long and drawn out. During these negotiations, work was accepted by the fledging laboratory on a commercial basis, which enabled competence and skills to be built up. For instance, a major research project involving a coastal development programme for Tel Aviv was carried out for a company who used the Foundation as an alternative to going overseas. The complex project was successfully realized, with UNIDO providing certain back-up services in project evaluation and training.

The negotiations between the Foundation and the Harbours Authority led to the creation of a limited liability company, the Institute of Coastal Engineering Ltd, with both parties as equal participants in management and financing but with actual operations in the hands of the Foundation. The Dean of the Faculty of Engineering is an ex-officio member representing Technion and ensuring participation of the faculty as well as a high level of technical inputs. Total capital investment in the project is $430,000.

The first year of operations involved projects for the Harbour Authority totalling $300,000 in project income. This income is to be increased to $1 million. It is intended to combine the knowledge and facilities of the

Institute with the newly created Oceanographic and Limnological Research Institute and thus extend its expertise for local and overseas consulting. It is the aim of the Institute to derive all operational expenses from project income.

Development and commercialization of sorrel concentrate

Two case studies were presented concerning the development and commercial production of a popular food drink from the tropical plant Hibiscus sabdariffa var. Sabdariffa. This plant is known in the Caribbean as sorrel. The first case study, presented by G.M. Sammy, gave a short historical sketch of how the project developed from conception to a semi-commercial plant. The second case study, presented by Hollis Charles, dealt with the experience of CARIRI in developing the semi-commercial unit from the laboratory scale work done by G. Sammy. A number of points arising from these case studies are worth special mention.

First, the project was conceived and initiated by G. Sammy, a faculty member of the university, the selection being made solely on a personal basis. The development from laboratory scale to semi-commercial operation was done by CARIRI, and funding for the project was provided by the Industrial Development Corporation of Trinidad and Tobago (IDC). Secondly, the interaction between the university, CARIRI and IDC was a very good example of co-operation between such institutions in the developing countries. Since only very few other examples of this kind of co-operation are known in developing countries, one is tempted to conclude that personalities rather than policy contribute more to the success of this kind of project. A third point to note is that both CARIRI and IDC experienced rapid turnover of staff responsible for implementing the project. The presence of G. Sammy as a continuing co-ordinator throughout the life of the project was therefore crucial to its success.

The size of the semi-commercial plant chosen for the development work was an attempt to strike a balance between a pilot plant and a commercially viable plant. With scarce expertise, it was felt that the orthodox sequence of scaling up could not be afforded. There was also the constraint that the agricultural resources had to be developed in parallel to avoid the traditional problem of mistrust between farmers and processors. Farmers who were encouraged to grow the raw material for the processing plant, in the absence of binding contracts, preferred to sell their produce on the fresh market when the prices were high, which disrupted the plant schedule. The reaping of the raw material was highly labour intensive and hence costly, which would have had an effect on the availability of raw material for large-scale operation and made the exploitation of the export market difficult. A spin-off project to develop a mechanical harvester has therefore been proposed, together with the agronomical project of growing a variety of sorrel amenable to mechanical harvesting.

It was also discovered during the project that the local suppliers of stainless steel were unable to differentiate the grades of stainless steel they imported and sold all grades as one material. As a result, the highly acidic sorrel extract corroded lower-grade stainless steel.

Both the time and cost estimates for the project were usually underestimated by about 20-30 per cent. In the course of implementation, it became apparent that there was no local expertise with responsibility for the commercialization of the successful results of R and D. The project engineering and management for the setting up of commercial operations therefore had to be carried out by CARIRI, which absorbed some of the costs of development under a policy formulated to that effect. A policy therefore needs to be worked out for the commercialization of technology developed with public-sector funds. In this context the adaptation of foreign technology to local conditions is to be regarded as the development of indigenous technology.

Improved packaging for cement and mini cement plants

The two case studies visualized industrial R and D as a closed circuit, the several loops of which were technology already available, technology generated by an R and D institution, and any basic studies related to the R and D project. The case studies concerned the results of R and D successfully transferred by the Cement Research Institute of India (CRI) to industry and the sequences and means of transfer.

The first case study related to the development of an improved packaging technique for the bagged delivery of cement in India to replace the currently used porous jute bags, from which cement is lost through seepage, which causes dust. The methodology used involved a preliminary joint exercise with industry to spell out the requirements to be met by the improved packaging technique:

the bags should be proofed against seepage and ingress of moisture; should develop adequate friction; and should be capable of being filled at a temperature ranging between 90° and 110°C by using already installed expensive equipment. Ensuring continuity of supply of the raw material required for the manufacture of the bags is also important. The techno-economics of jute, paper and plastic bags, which are widely used all over the world, was critically studied.

Later research led to the development of a composite packaging material. Some of the designs evolved were equipped with air vents. The bags designed by CRI were produced in the premises of a laminator-cum-bag manufacturer who was brought into the picture when the project was conceived. After satisfactory laboratory trials, a bundle of 41 bags was sent to 58 cement plants for trial in their premises. On the basis of the trial results and responses received from the factories, it was concluded that the new bags provided a feasible and better alternative. Feasibility thus established, a cost-benefit analysis was undertaken to see whether the extra cost of packaging would be offset by the savings realized in arresting seepage and damage caused by the ingress of moisture.

The balance of advantages was found to be in favour of the improved packaging. Trials on a commercial scale were undertaken, and 35,000 bags were supplied to 5 cement companies. The feedback from the cement plants and consumers, analysed by means of a questionaire to assess acceptability of the new design, was extremely favourable. As a consequence, the improved bags are now increasingly being used for distributing cement in India and abroad.

The second case study concerned the successful transfer of know-how for setting up mini cement plants, which often provide appropriate technology for remote locations with limited deposits of raw materials. They offer the advantages of low capital investment and shorter gestation periods. A malfunctioning mini cement plant made available by the Government of Tamil Nadu for research purposes enabled CRI to prove its technology on a prototype scale. The vertical-shaft kiln and accessories were redesigned. The cement and clinker produced in the mini plant were found comparable to those produced in conventional vertical kiln shafts. The plant successfully commissioned in July 1976 has been in continuous operation, and the cement produced is being supplied to consumers.

CRI decided to transfer the technology direct to entrepreneurs intending to use it, for several reasons. It was essential to establish confidence in the new technology by successfully setting up the first few entrepreneurs in business. Some of the design features being new, machinery manufacturers were likely to quote unreasonably high fabrication costs if CRI did not assume the responsibility of supplying the equipment items by fabricating them, if necessary, in its own workshops. CRI now provides, for a fee, a package service to entrepreneurs for setting up these mini cement plants. The range of services offered include feasibility studies, design, engineering construction and commissioning of the plant and training programmes for operators.

Thus, the successful generation and transfer of technology by an institution requires a careful selection of projects, user involvement from the very initial stages and the hiring from outside of expertise not found under its own roof. Pilot plants involve time and money and are not always necessary if large-scale trials can be carried out on the premises of indentified end-users of R and D. The institution that generates the technology can often ensure its successful application by transferring it direct to the first one or two entrepreneurs so that teething problems may be successfully overcome.

III. SUMMARY OF DISCUSSIONS

General

Any country aspiring to become more industrialized must endeavour to create the industrial capabilities it requires for development. There needs to be a well-defined decision-making process with respect to industrialization and its various components. In addition to political and economic considerations, technological implications must be taken into account in the development of industrial policies, plans and programmes. There also needs to be a clear technology policy that will determine: the degree of technology development needed; the extent of involvement of various institutions; the mechanism and mode of transferring technology; and the extent of utilization of foreign versus local sources of expertise.

An important approach to the development of the national industrial capacity is to involve indigenous technical personnel in the entire industrialization process. A national system and machinery must be developed to ensure the proper co-ordination and effective use of local technical expertise in industrial development. An important aspect of such a national system and machinery is the establishment of technological institutions to cater for the technological inputs at each point of the industrialization process.

Experience indicates that, at the early stages of development, preference should be accorded to the single, multipurpose institution in order to maximize the use of the limited national technological expertise and financial resources. Close working relationships need to be maintained between these institutes and the universities to promote the tapping of the appropriate manpower resources of the universities and scientific expertise for industrial development.

For the technological institutions to make a more effective contribution to industrial development, they should act in the dual capacity of catalysts and performers in industrial development. They may, under certain complex situations, act as "system manager" of a total package, not necessarily doing all of the required work itself, but utilizing competence wherever it exists, within or even outside of the country, in universities, industry and other institutions.

Technological institutions should endeavour to act as the "honest broker" with no axes to grind. Their findings and recommendations must be honest and objective in attempting to find reasonable solutions to problems. They must develop a rapport with industry and must convince industry that the results of their actions will be to its benefit. At the same time, they must also develop close working relationships with the decision-making and implementing bodies of government. Thus they must develop the confidence of both industry and the government.

Industrial planning and programming

The rate of industrial development of a country is influenced, inter alia, by economic, political and social conditions. The deep-rooted rigidities and other obstacles faced by many developing countries cannot be overcome by market forces alone. Planning is an essential feature of industrial development in these countries. The extent of planning and the roles of the public and private sectors may differ from country to country, but no country can hope to achieve meaningful industrial progress without sound planning, goal setting, programming and evaluation.

Planning is based, among other considerations, on two fundamental propositions: (a) that economic progress results, in large part, from human action based on systematic analysis and reasoning and not as a consequence of change; and (b) that by harmonizing policies, investment and natural material and human resources into an integrated whole, the efficiency of the total economy can be improved.

A development plan should incorporate an explicit strategy for industrialization. It provides the basis for planning sectoral programmes and specific projects. A plan should be formulated to achieve a reasonable balance between available resources and economic technological targets; encourage the policy makers, investors and those who will implement the plan to think along similar lines; and decrease economic uncertainties. The major steps in the industrial planning process, the primary co-ordinating and decision-making authorities, as well as other organizations which could contribute in the decision-making process are outlined in annex III (A).

Planners should set targets and work out schedules for achieving them not only for the next year but for the long term. Although planning units exist within the government, their staff hardly have the time for planning. Their energies are directed towards the solution of the day-to-day problems of the ministry. For this reason, as much as possible of the planning should be delegated to institutions outside the ministries and the general bureaucracy. Technological institutions could be useful in carrying out specific planning activities under the direction of the responsible government department.

Technological institutions are constantly involved with a stream of new ideas. To make the best use of this local resource in planning and creating proper organizational linkages is an important responsibility of the government. The capacity of the country to absorb new technology and to put it to work needs to be built up and should be based upon sound integrated planning involving both economic and technological inputs.

Governments of most developing countries depend largely on foreign expertise for the technological inputs required for industrial planning and programming. National technological institutions should participate in national industrial planning by helping to, within the scope of their expertise, provide the technological inputs needed by Governments for establishing the country's industrial development strategy, policy and planning.

In the developing countries, industrial data and statistics, without which planning and forecasting are impossible, are lacking. Technological institutions should act as catalysts and performers in carrying out surveys designed to collect technical information, data and statistics required for the development of relevant sectoral and national targets. Economic and marketing services are important inputs to industrial planning to ensure that the processes and products are developed and applied and to ensure that the resulting productive capacity shall be fully utilized.

Technological institutions in most developing countries tend to respond only when asked to participate in national planning. They usually provide *ad hoc* services upon request. They tend to shy away from participating in the identification of industrial projects that could have real national impact. They could take the initiative in bringing experts together to discuss new ideas using the competence that exists within the country.

Assignments to technological institutions are generally based upon the "track record" and the measure of the past success of these institutions. This sytem does not usually give an institution a chance to show its merit on important projects because of lack of confidence. Its opportunity to participate, learn and grow is therefore very limited.

Initiation of industrial projects and plans

Planners in any developing country could conceive of literally thousands of projects that the country might undertake. However, the possibility of undertaking them may not exist. Thus it is essential to determine objectively whether a particular project is feasible under the conditions prevailing in the particular country. The project should not only be feasible, and consistent with the country's industrial programme, but should also relate to other development projects.

The project initiation phase, from preliminary idea to decision-to-invest, provides a great scope for contributors from technological institutions as outlined in annex III (B). Technological institutions can take certain actions, such as the development of project ideas or project profiles, even before a decision is made who should be invited to submit bids. A technological institution could provide the leadership with foreign assistance to help the Government clarify its thinking on industrial projects. During the technological feasibility phase, inputs could be handled by local technological institutes, with the assistance of foreign firms as necessary. Successful performance in such an arrangement could enhance the credibility of the technological institutions of a developing country.

Technological institutions can contribute to the initiation of industrial projects and programmes by preparing sectoral industrial surveys and technology plans. To do this effectively, special staff need to be trained and a national network or system established to ensure a smooth and constant flow of information to the planners.

Industrial project and programme implementation

In project implementation, the principal goal is the efficient accomplishment of an objective. In an industrial project, this objective is usually to establish a plant, whose performance meets specified standards, within the time and budget allotted. To achieve this objective, where time and money are important, various groups that are organizationally and physically dispersed have to work together. For such an arrangement, the traditional management methods and philosophies used in operations are usually inadequate. For industrial projects, a different management philosophy is required. The individuals and organizations who contribute to and participate in the project must be motivated so that they are primarily oriented to goals or products.

In many respects, technological institutions can perform the functions normally associated with management and technical consultants. Typical contributions that technological institutions can make include assistance in shortening the time needed for implementing projects; providing specialized skills and know-how; finding fresh approaches to established practices; and providing independent evaluation and recommendations. More specifically, technological institutions (particularly multipurpose industrial research institutes) can provide a variety of services as industrial consultants. These can range from direct assistance to the government in establishing the criteria, objectives, priorities and procedures for an integrated industrial design plan to specific assistance to an industrial enterprise within the country. Examples of the possible contributions of technological institutions to the implementation of industrial projects are presented in annex III (C). There are only very few examples in the developing countries where a technological institution can act directly as a project manager. The institution's involvement has been found to be greater where it had participated in the initiation, formulation and development of the project.

Acquisition of technology and commercialization of R and D

An important function of technological institutions is to acquire foreign technology, although the need to develop a local technological capacity should be kept in mind. In some cases, the technological institutions should approach the government with advice about technological development, but in many cases it is the government that should seek out their advice. It is basically a matter of capability and individual rapport.

While developing countries may for some time continue to import foreign technology, efforts should be made to develop national machinery to ensure that the project, the specifications and the equipment being purchased meet national needs. In the long term, the policy of the Governments of developing countries should be to develop a higher degree of technological independence or at least interdependence. Another important role of technological institutions is to approve and monitor licensing of foreign technology. Monitoring will not only help to ensure that the technology imported shall be in the best interest of the country concerned but will also provide important inputs to the technological institutions that they can use in their work in support of industry.

As far as commercialization is concerned, technological institutions can either concentrate on research and development, and thus play a limited role, or they can be involved in the full cycle of a project, including not only R and D but also pilot plant development, marketing studies, economic surveys and other activities such as technical consultancy required for project implementation. The decision concerning the scope of an industrial research institute must depend upon its own development and the level of development of the country.

In the commercialization of R and D results, social aspects may sometimes override economic considerations and affect the outcome of the project. This extremely complex question can be resolved only through a well-defined national policy, which must relate all commercialization activities with the national industrial plan and objectives to ensure that successful commercialization of R and D results fulfils the social objectives of the country.

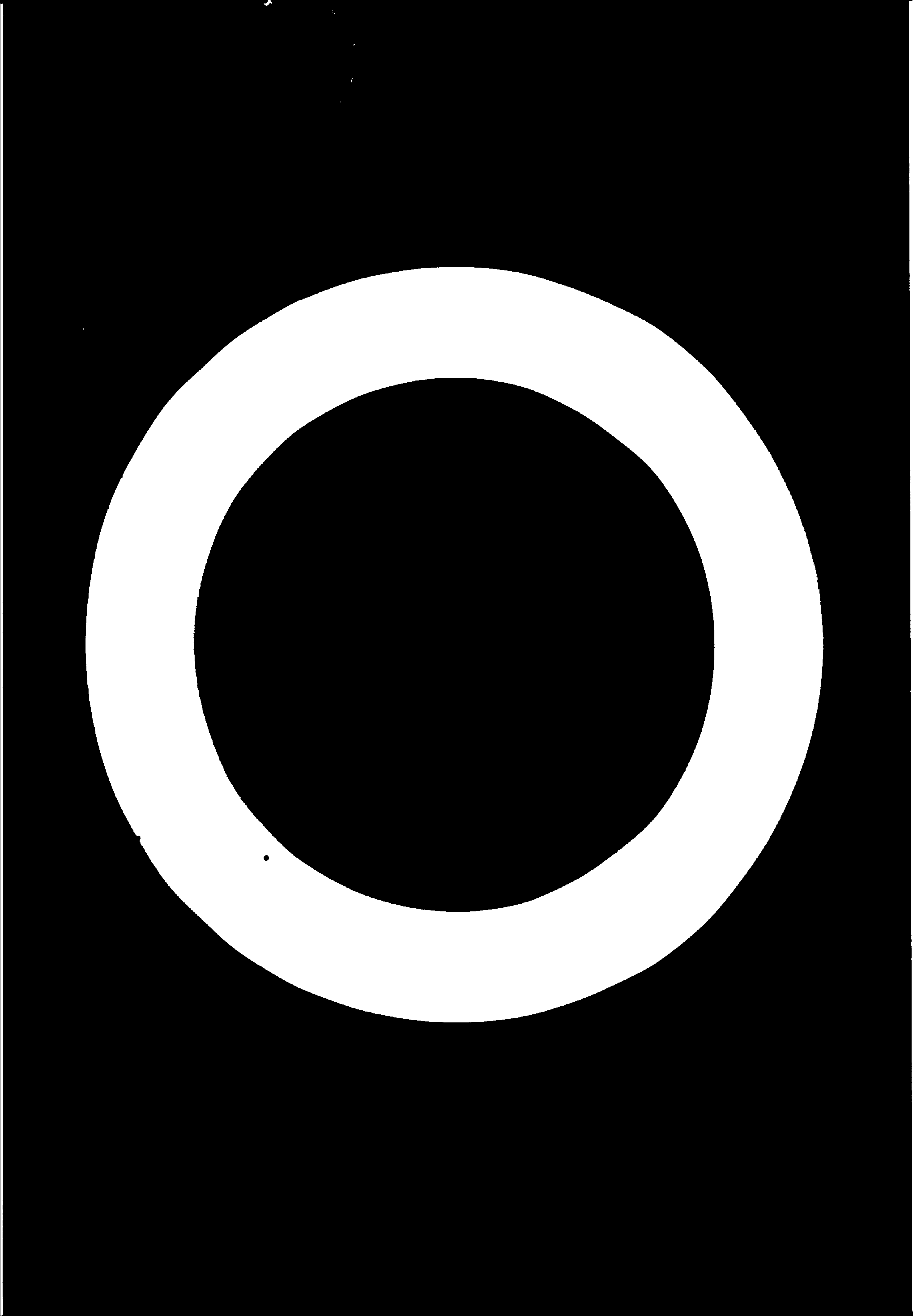
<u>Evaluation and monitoring of industrial projects and programmes</u>

The necessary evaluation and monitoring of industrial projects can be performed by the "captive" engineering staff of the company or its R and D organization. What is more likely in developing countries is to call upon outside consultants or technological institutions. Part of this function has been performed to a greater or lesser degree by indigenous, specialized or multipurpose technological institutions. It is in this phase that most technological institutions have performed most broadly. The possible contributions of the technological institutions to the evaluation and monitoring of projects and programmes are outlined in annex III (D).

In general, the monitoring of industrial projects must be done with the close collaboration of the industries concerned. Industry tends to be secretive both on technological as well as economic grounds. Monitoring must be cautiously exercised so as not to undermine the feeling of self-sufficiency in industry.

The function of project monitoring is to determine whether the project was well conceived and well established, what information must continue to be developed to keep it going according to plan and whether it is necessary to add to the production capability. A system should be established to ensure that new projects shall not falter. Technological institutions can play an important role in keeping high-investment industries alive. Through involvement in the monitoring stage the technological institutions could develop the kind of information needed to feed back to the planners to improve their future performance. Also the technological institutions should be able to have a total picture of the various industrial sectors, such as the textile or metallurgical industries.

An important function of technological institutions in most developing countries is to collect and analyse production, economic and technological information. In addition, these activities provide the institutions with a basis for interpreting the technological implications of the national plans and assisting those concerned with planning and forecasting.



Annex I

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Annex II

MAJOR ASPECTS OF THE INDUSTRIALIZATION PROCESS

A. Establishment of industrialization strategy

1. Strategies

Orientation

Intersectoral priority setting

Decentralization

State or private

Capital ventures

Labour intensive

Strategies are often set by the highest authority in the country, such as the Supreme Council, the cabinet or equivalent, with participation of the central planning and substantive ministries, enterprises, technological institutions etc.

2. Planning stages

Macro-stage

Basic development aims of the country

Collection of statistics on supply and demand

Macro-forecast

Forecast vs development aims

Formulation of macro-economic plan

Institutional framework

The main responsibility is usually accorded to the Ministry of Planning or equivalent, with participation of the substantive ministries, technological institutions and enterprises, and approved by the cabinet or equivalent.

Sectoral stage

Collection of estimates on income elasticities of demand

Collection of sectoral data on resources and evaluation of over-all technical possibilities

Translation of macro-economic targets into sectoral targets

Sectoral targets vs sectoral demand and supply estimates and forecasts

Formulation of sectoral plans

Institutional framework

These functions are usually performed by the technical ministries (Ministry of Industry for the industrial sector) with inputs from associated or related ministries and the Office of Economic Development, technical institutions and enterprises. The activities are reviewed and co-ordinated by the Ministry of Planning or equivalent.

Project stage

The project stage is often the main responsibility of the substantive ministries with the participation of other relevant ministries, institutions and enterprises.

The major problems at this stage are:

Absence of a properly qualified entrepreneurial class prepared to take initiatives and assume risks

Inadequate government policies

Lack of consistency between projects and programmes

Lack of industrial policies

B. Project initiation

1. Project identification (project profiles)

Once the project authorities in the government have decided that a specific project should be initiated, it is necessary to prepare a project profile with a view to: (a) confirming the initial need for the project and analysing the need; and (b) stating the requirements of the project in the following terms:

Political and social implications

Marketing

Infrastructure and power

Specification of production plans (types of products, number of units, production rate, price, manufacturing cost)

Raw materials and manpower

Formulation of the manufacturing processes (flow diagrams, charts)

Finance (funds required, sources, terms)

Technical and economic

Resources (skills, materials)

Schedules

The profiles are usually prepared by the Ministry of Industry or equivalent in collaboration with other relevant ministries, industrial enterprises and technical institutions.

2. Preliminary selection

A project committee or an equivalent arrangement then considers the results of the preliminary analysis on the basis of which it develops alternatives. The advantages and the disadvantages of each alternative are analysed. Some of these considerations are given below in the form of possible advantages and disadvantages:

Advantages

Effective use of existing organization and facilities

Promotion of regional development

Larger labour supply to draw upon and use of present local personnel to train new manufacturing operators

Less population, less traffic, fewer housing problems

Easy transportation of raw materials, components and finished products from and to market

New jobs for a growing population

Lesser energy and pollution problems

Backward integration

Easy introduction of new manufacturing techniques, methods, processes etc. and labour practices

Disadvantages

Over-concentration of industry in an already congested area

Separation from a related plant, communications and transportation problems; increased overhead cost

Further aggravation of local traffic and housing problems

High investment cost and shortage of experienced labour

Pollution and environmental problems

3. Feasibility studies

In the feasibility stage, the alternative approaches are analysed in sufficient detail to permit a sound selection of one of the alternatives during the next stage. This should constitute a techno-economic feasibility study, including implications such as social, political, economic, infrastructural, energy, manpower, raw materials and technology assessment. Some additional elements of analysis include the following items:

Siting

Adequacy of resources and facilities in various locations
Availability
Quality

Accessibility of inputs

Raw materials
Fuel and power
Transportation
Manpower requirements
Intermediate products

Technical feasibility

Technology
Infrastructure
Know-how
Licensing, joint ventures etc.

Economic feasibility

Present and potential market
Export possibilities
Trends in demand

Domestic
World

Cost implications

Raw materials
Transportation

Production implications

Scale of production

Efficiency required

Need for subcontracting

Cost of production

Analysis of alternative technology, raw materials, fuel and power, labour, plant and equipment, management, marketing, interest charges depreciation and taxes

Financial implications

Financial costs and working capital

Incentives policies

Duties on imported materials and machinery

Construction time

Consultants' costs

Long-term, short-term loans

Estimates of earning and profitability of the project

Estimation of break-even points

Foreign exchange required

Maximization of savings

Infrastructure

Communications

Housing

Health services

Social services

Feasibility studies are usually the main responsibility of the Ministry of Industry for industrial projects, with the participation of the other relevant ministries, financial and technological institutions, industry and enterprises. Consulting organizations are brought in many times to assist.

4. Project evaluation

Although an industrial project is feasible, it does not mean that it is desirable in terms of the country's national objectives.

Technical evaluation

Appropriateness of the technology

Optimum utilisation of indigenous inputs

Minimal technological complexity

Economic evaluation

Ratio of capital to output

Maximization of savings

High capital-labour ratio

High labour-capital ratio

Criterion of factor proportions

Maximization of employment opportunities

Foreign exchange needs related to prospective earnings

Commercial profitability

Payback period

Rate of return on investment

Project evaluation is a major responsibility of the Ministry of Industry, with the participation of the other relevant ministries, institutions and enterprises. Consulting organizations are brought in many times to assist.

The economic and financial implications of major investment decisions are also reviewed by the top levels of government and by the Plan and Budget Organization, the Office of Economic Development and the Treasury Department or Ministry of Finance before a final decision is made.

5. Investment promotion

To support the financing of projects, developing countries need to approach systematically the problem of attracting domestic as well as foreign investment. The following types of activities should be pursued:

Disseminating information about the host country in capital-exporting countries, particularly as regards the conditions, laws, policies, procedures and opportunities for foreign investment

Advising and assisting local businessmen and the government on all matters involving attracting and holding foreign, private capital and industrial know-how

Informing and advising individual foreign businessmen, industrialists and financial institutions about the country's investment climate and the opportunities for profit that the country offers to foreign capital

Disseminating comparable information to local industrialists and entrepreneurs

Establishing an atmosphere conducive to private investment

6. <u>Acquisition of technology</u>

The acquisition of the required technology will have to come from the commercialization of research results from indigenous organizations or from foreign sources. Once the project is found feasible, the next important stage is the "negotiation of the acquisition and transfer of the technology", particularly foreign technology, in the most conducive and advantageous manner for both parties. This involves:

Negotiation of joint ventures
Preparation of tenders for joint ventures
Evaluation of these tenders
Negotiation of licence agreements

C. Project implementation

When the decision is made to proceed with implementation, a project organization must be established under the direction of a project manager. This organization must be related to all appropriate agencies of the government and to all participants in the process.

The kinds of information required to implement an industrial project are given below:

<u>Project financing information</u>

Financial plan
Financial progress reporting and document control

<u>Information defining project structure and scope</u>

Project structure and scope
Responsible and performing organizations

<u>Project action planning and control information</u>

Master plan and schedule
Task work statements and action plans
Task schedules
Progress reporting

Resource planning and budgeting information

Manpower and cost estimates

Manpower and cost budgets

Contracting, work authorization and resource control information

Work orders and contracts

Expenditure records

Work and resource (funds, manpower) control information

Product information

Descriptions, drawings and specifications

Product control information

Environmental information

Many organizations are involved in implementing the project. A systematic way of showing how all these organizations are related to the various elements of the project is given in the table below.

Decision-making bodies involved in project implementation

Stage of industrial development project	Project authority (Ministry of Industry or equivalent)	Project committee	Project implementation organization	Project manager or prime contractor	Contractor or project co-ordinator	Subcontractors	Suppliers
Decision to invest	a	b	c				
Securing the investment	a		b				
Acquisition of technology	a	b	b	b			
Initial project implementation, scheduling and detail project design and engineering		c	a	b	b/c	c	c
Contracting and purchase			a/b	a	b	b	c
Facility construction and pre-operations (system implementation, start-up)			b	a	b	b	b

__Note__: Involvement: a = ultimate responsibility; b = assigned to the project; c = peripheral activities.

D. Monitoring and evaluation of development plan and programme

During the phase of monitoring and evaluating the development plan, in addition to the technological support and technical services, there is a need for commercial-type services in supporting industry and government. These include:

Diagnosing companies' problems; arranging for assistance to them; and acting as a contract research organization

Assessing periodically the short- and long-range industrial and economic trends of the country and the changing needs of industry

Undertaking market research and techno-economic feasibility studies

Providing industry with technical management consultation in such areas as market studies, cost accounting, efficiency and productivity studies, industrial engineering, plant layout and management

Providing technological advice to entrepreneurs on joint ventures, licensing agreements, transfer of technology agreements, and new industrial projects

1. Evaluation

Evaluation of the macro-plan

Evaluation of the sectoral plan

Evaluation of sectoral programmes

2. Monitoring

Monitoring of the implementation and the macro- and sectoral plans and programmes, as well as individual projects

Annex III

POSSIBLE CONTRIBUTIONS OF TECHNOLOGICAL INSTITUTIONS TO INDUSTRIALIZATION

A. To national industrial planning, programming and evaluation

1. Macro-planning stage

Technological forecasting

Techno-economic analysis

Provision of technical information and data required for:

The preparation of national development strategy and plan

The establishment of the required institutional framework

Decisions on decentralization (industrial parks and estates)

Development of small-scale industry

Exports and import-substitution considerations

The establishment of infrastructure and power requirements

Manpower development

Other technical inputs to the development plan

2. Sectoral planning stage

Identifioation of technical possibilities

Technology plan

Translation of macro-stage targets into sectoral targets

Provision of technical information and data required for:

Establishment of sectoral priorities

Development of a strategy for sectoral development

Analysis of intersectoral relationships

Development of sources of information and data

Proposals of goals and programmes

Manpower requirements

3. Project planning stage

Provision of technical information and data required for:

Identification of project options

Selection of appropriate technology

Decisions on new projects vs expansion of existing productive capability

Selection of indigenous vs foreign technology

Development of industrial priorities

Manpower development

4. Specific considerations for planning

Assessment of availability and adequacy of project site

Assessment of inputs, such as raw materials, fuel and power, trained labour, managerial talent

Analysis of the social and economic appropriateness of technologies

Analysis of employment opportunities, marketing, industrial production and financial implications

Assessing a number of auxiliary factors such as housing and health services

5. Project evaluation

Development of evaluation criteria

Assessment of the relationship of the project plan to the sectoral and national development plans

B. To the initiation of industrial projects

1. Identification of project concept (preliminary analysis) stage - project profile

Formation and technical analysis of project concepts (project profile)

Identification of:

Processes and products suitable for commercialization (indigenous and foreign sources)

Technical requirements

Functional and operational performance requirements

Technical approaches

Techno-economic analysis

Operational concepts

Market analysis

Manpower and materials requirements

Possible subcontracting arrangements

Financial requirements

2. Preliminary selection stage

Provision of technical information and data required for:

Deciding on alternative approaches

Developing a systematic basis for identifying benefits and penalties of alternative approaches

Minimizing disadvantages of alternative approaches

3. Feasibility (formulation) stage

Establishing evaluation and effectiveness criteria and weighing factors (e.g. environmental, technical, economic and social)

Performing cost-benefit analysis

Conducting siting studies

Assessing alternative technologies

Developing or adapting network planning techniques and, where necessary, providing computer support

Performing operations research studies, where necessary

Verifying the suitability of alternative technical approaches

Developing practical schedules

Developing preliminary cost plans

Evaluating and assessing the alternative approaches based on established criteria

Assessing manpower and training requirements

Studying backward integration

Identifying potential problems

Determining the need for standardization and quality control

Defining future R and D needs

4. Evaluation (post-feasibility evaluation) and decision to invest

Acting as consultant to decision maker and assisting him in the technical analysis and evaluation of the findings of feasibility studies

5. Acquisition of technology

Provisions of technical information and data required for:

Negotiating joint ventures

Negotiating technology transfer

Preparing tenders and bids for joint ventures

Evaluating the tenders for joint ventures

Negotiating licence agreements

C. To project implementation

Defining performance of systems engineering on industrial projects

Defining detailed project structure and scope

Providing technical inputs from indigenous and foreign sources

Planning in detail and controlling project implementation

Selecting raw materials and parts (indigenous or foreign sources)

Determining level of subcontracting

Factory siting

- Carrying out geologic surveys
- Acquiring land
- Making detailed utility plan

Preparing a detailed manufacturing plan

Finalizing process and product

Selecting factory equipment

Establishing procurement specifications and data

Constructing factory building(s)

Production and plant layout

Installing and checking-out equipment

Preparing detailed process and product specifications

Commissioning plant

Recruiting and training personnel

Developing factory management skills, organization and procedures

Providing testing and analytical services

Trouble shooting and solving problems during the life of the project

Watching over the implementation of licensing and/or joint-venture agreements

D. To the evaluation and monitoring of projects and programmes

Technical evaluation and monitoring

Technical evaluation of on-going production

A continuing analysis of market and technological trends

Identification of new opportunities arising from market changes and new technology

Identification of changes arising from revised national and sectoral plans

Providing technical information and data required for assessing the short- and long-range industrial and economic trends of the country and the changing needs of industry

Technical services to industrial plants

Testing, analysing and evaluating raw materials and intermediate products

Testing and analysing finished products for standardization, quality control and certification

Providing specific information on the current state of world knowledge on industrial, technological and techno-commercial fields

Carrying out instrument repair, maintenance and calibration

Designing specialized equipment, where possible

Trouble shooting in industrial plants

Carrying out technical and management consultancy in such areas as market studies, cost accounting, efficiency and productivity studies, industrial engineering, plan layout and management

Carrying out technical investigations designed to improve the quality of finished products and increase process efficiency

Developing new processes for current or new products, at both the laboratory and pilot plant levels

Carrying the results of technical investigations on products and processes into the commercialization stage

Carrying out techno-economic studies and market analysis

Undertaking engineering design and service work

Training technical staff

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