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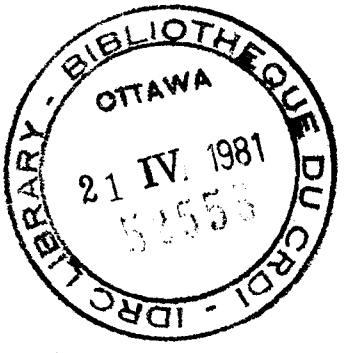
CONSULTING AND ENGINEERING DESIGN ORGANIZATIONS IN DEVELOPING COUNTRIES

Characteristics, role in development, promotion.
Analysis and research suggestions.

A report prepared for the International Development Research Centre



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1. INTRODUCTION

Consulting and engineering design activities are important for the conception and execution of investment projects, and therefore for the process of capital formation. If a country does not have the capacity to perform such activities, projects will be conceived, designed and carried out by foreign organizations, involving a loss of decision power and the danger of inappropriate technical solutions which do not correspond to the conditions and needs of the recipient country. In addition, important opportunities will be lost to favour purchases of domestic equipment, inputs and technical services, and to create effective links between research institutions and the productive sector.

Optimal investment projects and self-reliance on technological matters depend crucially on having consulting and engineering capabilities of one's own and employing them properly. Developing countries should have an interest in establishing their own consulting and engineering design organizations (CEDOs), developing them so they can efficiently carry out their activities, and utilizing them in the most appropriate manner. This is increasingly being understood by some countries which have formulated policies for such purposes. In other developing countries, however, such a need is not yet properly appreciated.

The present paper explores this subject on the basis of previous work by many authors, the results of studies sponsored by several developing agencies,[1/] the conclusions of a number of seminars on consulting and engineering that have taken place in the last few years, and the personnel experience of many people consulted by the present author. The purpose is to identify a number of aspects on which it would be desirable to conduct comparative research in a few developing countries, and to suggest how such research may be carried out. The results will be discussed at a meeting to be sponsored by the International Development Research Centre, in early 1979.

1/ See Annex 1.

The author has profited from the views of many persons, of which Anil Malhotra, Geoffrey Oldham and Mario Kamenetzky should be mentioned. He has had occasion to discuss some of the ideas here presented at meetings in the Centre for Social Research on State and Administration (CISEA) in Buenos Aires, and is grateful to the CISEA Director and staff members for their comments and advice.

2. NATURE OF CONSULTING AND ENGINEERING. DEFINITIONS

Modern industrial development, which implies the introduction of new technologies and the execution of complex investments, has brought about the appearance of intellectual and professional activities that take care of these tasks and specialise in them. We may refer to them as "consulting and engineering" (C & E) activities.

These activities organize and apply knowledge for purposes of investment and production. In the first case, they form an interface between the planning exercise (selection of projects, their economic evaluation, choice of the most appropriate product design and process technology) and the implementation of projects (which includes detailed design and engineering, procurement of plant, preparation of contract documents, supervision of construction and erection, commissioning and testing of plant and equipment and its initial start-up). In the area of production, they provide valuable services for the proper operation and maintenance of the plant, the solution of management problems, and the training of personnel. When backed by research and development, they provide the necessary support for adapting and improving imported technologies to render them appropriate to the "use environment", and also for creating and applying new technologies.

There seems to be no general consensus about what types of intellectual products should be included under the labels "consulting services" and "engineering services". The terms "consulting", "consultancy", "consulting engineering", "engineering", "project engineering", "detailed engineering", "technical advice", and other related terms, are used differently in various countries and by diverse national and international institutions. Table 1 at the end of this section shows a number of alternative definitions.

What is clear is that consulting and engineering (C & E) activities are characterised by certain methods of work, or methodologies, and by a multi-disciplinary approach. The services produced are not just of a technical nature: they refer to the general conception of a project, to its economic aspects, to the implementation of the general project, to the conception and organisation of a system, training programme, etc., and to inputs into management, training activities, economic studies. Hence there is an accent on professionalism and multidisciplinarity; the methodology is not strictly "technical"

but should also include economic, management and training aspects; and the purpose of the services is to conceive and implement investment projects, and to contribute in the efficient operation of the resulting installations.

To clarify concepts it is important to use the approach of services and not of those who supply the service. The latter approach would only bring confusion, since in many cases a contractor provides C&E services and on doing so he is acting as a consulting engineer. On the other hand, if a consulting engineer constructs, he acts as a contractor. It is necessary therefore to arrive at an operational definition of consulting and engineering activities, and C&E services, and indicate that these services should be provided by capable organizations, which may be of different types, the "consulting and engineering design organizations" or CEDOs.

The concept we propose of consulting and engineering design services is simple. Such services are rendered at different stages of a project, as shown in the following table:[1/]

SERVICES	STAGE OF A PROJECT
Pre-investment services	1. Prefeasibility studies (Surveys, identification, evaluation).
	2. Project feasibility study.
Project execution services	3. Project engineering (Engineering surveys, detailed engineering, product engineering, organization and management, information systems).
	4. Project implementation (Procurement, construction-supervision).
	5. Commissioning and start-up (includes personnel training).
Services for operation and maintenance	6. Production and maintenance.

1/ This table emerged as a result of discussions at the STPI meeting on Consulting and Engineering Services, Caracas, 1975

Consulting services would comprise the "preinvestment services" as well as advisory services in the two other categories, the rest being "engineering services". Then:

- consulting services: include preinvestment services (prefeasibility and feasibility), as well as services rendered to a client related to the coordination, control and supervision of project execution, and to operation and maintenance of productive installations;

- engineering services (or engineering design services): those related to project engineering (basic engineering, detailed engineering), product design and engineering, and other design activities.1/

Consulting services at the preinvestment stage may involve various disciplines --engineering, architecture, economics, finance law, ecology, and occasionally even medical, psychological and educational sciences-- in order to conceive and appraise a project so that a sound decision may be made. The contributions of professionals from those disciplines must be integrated through multidisciplinary work. The result is based on estimates of various parameters which may change in value in the future --input costs may vary, an unexpected geological fault may appear, a new and better technology may be produced-- so that there is an uncertainty attached to it.

Engineering services come into the picture when the main characteristics of the project have been decided upon and a technology has been chosen. They are mainly performed by engineers and collaborating technicians and draftsmen. Uncertainty of the outcome is much lower than at the preinvestment stage, so that we may qualify consulting services as "probabilistic" and engineering services as "deterministic".

We may classify C&E services in different ways, such as the type of service, the branch of economic activity to which it is rendered, the type of client, etc. This allows a fine division that can be expressed in the form of a matrix, for instance by crossing type of service and economic branch,

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1/ Some people prefer to call "consulting engineering services" the services under the three categories, provided they are rendered by an organization apart from the client. Others prefer to speak of "design engineering services". The semantic problem will probably be very difficult to sort out to everyone's satisfaction since different terms are already in use in different countries and sometimes have a legal meaning; however, the conceptual scheme shown would seem to have general validity.

a classification that has been employed by UNIDO in surveys of C&E and by OECD in its research on the subject. A complete project can be subdivided in portions that can be performed by different agents, and this can be of help for programming purposes.

Consulting and engineering services are required by different types of users. Organizations in the public sector often need them to prepare and implement all kinds of investment projects, for instance, Ministries, planning commissions, regional development authorities (very numerous in the Latin American countries, where more than 30 such organizations are carrying out investment programmes that run into several billion dollars), public enterprises in mining, oil, petrochemicals, fertilizers, transport, power, etc., development banks, and institutions that have to do with the promotion of industrial development. Private industry is usually a less important client. Small and medium scale enterprises are potential clients of a wide variety of C&E services, particularly those that have to do with management, technical assistance and information problems.

The cost of preinvestment consulting services is only a very small fraction --1 to 3 per cent in most cases-- of the total cost of the investment, but such services are crucial to lay out good projects from the technical as well as the economic and social points of view. In a developing country the intervention of a local consulting organization may mean that the project is conceived with much more relevance to local needs and conditions than if a consultant from a central country is employed. Local engineering may contribute further in that sense, for instance, by maximizing the domestic inputs.

Consulting and engineering services may be supplied by different types of producers of such services, or CEDOs:

a) private individual consultants and C&E firms, which may go under the name of "consulting engineers", "engineering societies", etc., and which restrict themselves to rendering C&E services;

b) public C&E firms which are similar to private CEDOs except for being State-owned;

c) other public organizations that supply C&E services in addition to other services, for instance, industrial research institutes, industrial design organizations, vocational training institutions, productivity centres, technical information services;

d) captive or in-house organizations in public or private enterprises, which may be called engineering departments, project departments, etc., and may be temporary or permanent.

e) in-house organizations in contractors, capital goods producers and assemblers, which frequently use C&E services to sell their goods and services.

C&E activities in developing countries are in general not fully developed. Domestic CEDOs tend to be weak, and demand is geared to a varying but important extent towards foreign CEDOs or their local subsidiaries and joint ventures. At an early stage of development, C&E capabilities tend to be concentrated on construction and civil engineering, as well as on pre-investment services in general. CEDOs devoted to industrial investments make their appearance and gather strength as industrialization proceeds. The scope of activities becomes wider and in some cases basic engineering capabilities are achieved.

TABLE 1

Some definitions of "consulting" and "engineering"

1. Committee of Engineering of the Sixth French Plan: "Engineering is defined as the set of activities, essentially intellectual, which have the purpuse of optimizing investment, whatever the nature, in its choices, in the technical processes for implementation, and in its management".

2. Jacques Perrin ("Terminology and Economic Function of Engineering", OECD, Paris, 1976): "Engineering is a set of methods and of organizational structures which allow to master the interdependence of scientific, technical, economic and financial information necessary for the optimum conception or realization of investment in a coherent productive ensemble".

3. "Glossary" adapted at the CODELCA Meeting (México, 1975):
   - Consulting Services are the activities involved in the organization of technological knowledge, relating its possibilities and uses to the context and to the physical, economic and social requirements.
     (a) Pre-investment consulting services: those which take place before the materialization of an investment to identify, prepare and evaluate projects and to select appropriate technologies.
     (b) Consulting services for operation: those which constitute inputs for the materialization of an investment, or for the operating stage of an investment which has already materialized.
   - Engineering Services apply knowledge to develop data, documents and drawings with the purpose of implementing physical facilities for economic activities, and of optimizing and maintaining existing facilities. (This definition may be used to cover administrative, educational, health, and other systems which produce services).

4. E.Felices ("Development of Local Engineering Capabilities for Industry: Case Study of Peru", OECD, 1978): "Project engineering supplied by multi-disciplinary groups of consultants may be understood as the capacity that

TABLE 1 (cont.)

allows to convert ideas and initiatives into technical and economic concepts that can be appraised for the purpose of deciding about an investment; to transform such concepts into a design that can be efficiently built; and to complete the execution of projects within the delay, qualities, costs and operating yields which have been forecasted when the decision was taken to allocate resources to the project".

5. A.Malhotra ("Consulting and Engineering Design Organizations", paper prepared for IDRC, June 1976): "Consultancy and engineering services can be characterized on the basis of the output which is produced at each stage of a project as indicated in the table below:

Type of services	Output
i. Consulting services including economic management, etc.	Report
ii. Preliminary engineering	Bid document
iii. Design engineering	Drawing and blue prints, detailed specifications
iv. Procurement services	Purchase orders
v. Inspection services	Acceptance certificates
vi. Fabrication and construction supervision services	Installation/acceptance certificates
vii. Maintenance services	Operating manuals
viii. Training services	Training report."

6. Report of UNIDO Meeting on "Industrial Consultancy Services in Developing Countries", 1978: "Consultancy services may be of different types:
   - Pre-investment services: techno-economic, pre-feasibility, feasibility and evaluation studies, including market, location, technology, economic, commercial and financial aspects; preparation of terms of reference and invitations for tender; evaluation of bids.
   - Project implementation services: choice of technology and equipment; detailed engineering; specifications, tendering, bid evaluation and contracting; negotiation of agreements (financial, commercial, know-how, management); supervision of project execution (construction, procurement, installation, start-up, training); inspection and acceptance of goods, services and finished installations; design and implementation of management, production and marketing systems.

TABLE 1 (cont.)

- Services for management and production: technical assistance and trouble-shooting; production planning and control; cost control and cost reduction; product design and development; process improvement; quality control and maintenance systems; sales and inventory systems; expansion programmes; personnel training; management information and control systems, etc.

Consultancy services may be offered to many different branches of industry, and to supporting institutions such as Ministries and R&D centres. Some consultancy organizations will specialize in one or two specific branches, as happens for instance in iron and steel, hidroelectric generation, petro-chemicals, etc."

3. ROLE OF CONSULTING AND ENGINEERING

Consulting and engineering design activities are very important to conceive and implement investment projects, including the expansion of existing installations, and to improve production and management activities.

If a country does not have the capacity to produce these services, particularly in the case of pre-investment consultancy, projects will be conceived, designed and executed by foreign-based CEDOs. This is the situation in many developing countries, and it implies a number of draw-backs, principally the use of inadequate technological solutions, the need to import capital goods and production inputs that might have been supplied locally, and the continuing dependence on foreign know-how and foreign skills.

CEDOs in developing countries have a wider and deeper role than those in industrialized countries. This is due partly to the different conditions under which they operate - cultural and technical environments, lack of readily available information, need to undertake lengthy training of their human resources, the relative ignorance and unfavourable attitudes of their clients, etc. The principal difference, however, lies in the important socio-economic role they may fulfill, through the carrying out of projects which are more appropriate to local conditions and through putting in motion a complex process that may have significant impacts on development beyond the contribution of the project in question.

When C&E activities are carried out by domestic CEDOs, there may be in the first place a number of positive consequences on the projects on which work is done, from which will benefit the project-owners and ultimately the whole economy. Better projects may be prepared and better decisions may be adopted than if a foreign consultant is engaged, through having a better knowledge of local conditions, choosing more adequate technological solutions, disaggregating investment "packages", absorbing foreign technology more efficiently, and using foreign consultancy inputs in a way that will maximize their benefits and reduce their draw-backs. A local CEDO may choose appropriate technologies which a foreign CEDO might not even consider.[1/] There may even

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1/ For instance, small paper plants which may be justified by reasons of transport costs, seasonal production and other local factors. Such a solution would probably not be envisaged by a foreign CEDO accustomed to large, "efficient" paper plants.

be a reduction in the cost of projects and their foreign exchange component, since local consultancy services are often much cheaper and there is a higher proportion of local inputs.

Perhaps more significant in the long run are the consequences that may trascend the limits of the project itself. Locally conceived and designed projects tend to make a more intensive use of local inputs, thus increasing the demand for local capital goods, materials and components, technology, technical services and highly skilled technical and professional manpower. Positive effects take place on the diffusion of knowledge, which may be circulated among enterprises and from R&D to production. New skills, attitudes and capabilities are introduced throughout the industrial spectrum, principally problem-solving capacities, bargaining power vis-a-vis foreign investors and foreign suppliers of technology and equipment, local expertise for the maintenance of plant (thus decreasing technical vulnerability), etc. CEDOs may link up local R&D institutions with the productive sector, taking charge of the engineering aspects of new technical solutions and carrying out technical assistance tasks once industrial production has started.

These are significant positive impacts on development, and on the attainment of self-reliance, as the management of knowledge by nationals is strengthened and autonomy in technical matters increases.[1/]

Some authors --of which Perrin has been the most persuasive-- feel that consulting and engineering play a unique and very crucial role in industrial development because of their being at the crossroads of a flow of information and decisions between productive units, capital goods manufacture and research and development. C&E link these three parts of the economic system, and also provide links with the financial system. Through the projects carried out by domestic CEDOs it is possible to maximize impacts from the productive units to the other two activities, thus promoting the development of an integrated industrial system. Industrial development without employing domestic C&E capabilities would rely indefinitely on imported technical solutions and imported capital goods.

1/ Annex 2 examines in detail the role that domestic CEDOs may play in the transfer of technology. Annex 3 describes the different tasks and decisions that take place in an investment project.

C&E activities may achieve therefore a high social utility in terms of their impacts on development. Two important national objectives would then be the increase of domestic C&E capabilities and their proper utilization so that a high social efficiency will result from the resources allocated to investment.

The public sector may play an important role in this regard. In many developing countries the State has taken up growing responsibilities in dynamic activities such as petroleum, energy, transport, iron and steel, shipbuilding, heavy chemicals, pulp and paper, cement, etc., and public enterprises have become the main --if not the only-- concentrations of economic power under national control able to face foreign-owned firms. They constitute very important decision centres with the power to affect profoundly different sectors of national activity. Investment projects in those branches, however, have often been bought from foreign suppliers through "turnkey" purchases, and the participation of domestic C&E and industry has tended to be limited. A change in traditional patterns of behaviour would have important effects on industrial development. This may also be true for private enterprise too. There should be an effort to open up investment "packages", which often combine financing, technology, capital goods, construction and various technical services. By doing so, it may be possible to obtain maximum local participation in the supply of goods and services for the investment.

A turnkey plant may be said to constitute a "black box". The investor should eventually be able to carry out its investments in a disaggregated manner, or "white box", in order to have control of the technology, put the package together in accordance with the real national needs and utilize fully intellectual and physical domestic inputs. To go from a "black box" situation to the domestic control of technology and inputs, or "white box", it is necessary to undergo a learning process which can rarely be accomplished in one step, so that it is necessary to proceed through a series of "grey boxes", gradually "whitening" the box in successive investment projects. A process of this nature, which implies a growing mastery of technology, is supported by the development of domestic C&E capabilities and their adequate utilization.

There are costs in developing the country's capabilities and in accepting for a period some relative inefficiency, as happens with "infant industries". Of those elements of cost that which has most deterred policy makers has been the risk to be assumed in entrusting national organizations with complex and exacting tasks. This element however has generally been exaggerated in the past on account of poor knowledge and underestimation of national capabilities as compared to foreign capabilities that have been assumed to be unexcelled.[1/] To this is added the frequent attitude of decision makers in developing countries to look for an immediate effect of their decision and purchases. They just want to obtain what they urgently need, to "get the job done". On adopting such a short-sighted approach they may lose important opportunities to improve the efficiency of their own organizations in future years and to produce significant long-run effects on development.

There is therefore a good deal to be done in educating project-owners, banks, and governments regarding the key role of consulting and engineering for self-reliant development, and the need to support and promote this activity through national policies. Ways and means have to be found in every country to transmit this message to decision makers, planners and politicians, to industry, and often to the consultants themselves.

1/ Foreign consultants have not infrequently made costly mistakes or recommended inadequate solutions which would have been easily perceived by a local consultant familiar with local conditions. On the other hand a local firm may contract foreign expertise as and when needed. A more balanced assessment of the worth of local consultancy and a change in risk-avoiding attitudes would be needed.

4. DEMAND FOR C&E SERVICES

Consulting and engineering services are not products that feed final consumption in a society; they are inputs to other activities --investment principally-- and as such their demand largely dependes on the volume of those activities, which are themselves related to the extent of actual or planned changes in the country.

One may make a distinction between "requirements" and "demand", meaning by the first term the volume that should ideally be demanded and by the second the actual volume demanded, which may be different and in a developing country would tend to be lower, since project preparation and design are often made with less depth than would be desirable. In the case of preinvestment services, this gap between demand and requirements would seem to become more acute. If such tendencies were verified, there would be reasons for adopting policies for increasing the demand for C&E services to an adequate level, through persuasion, a decrease in the price of C&E services, or other means.

4.1. Sources of demand

The principal sources of demand for C&E services in a developing country are:

(a) large public sector investment projects carried out by ministries, public enterprises, development corporations, and other agencies. Such projects are usually included in national development plans.

(b) Tasks required by financial institutions such as development banks, industrial banks, investment funds, institutions for the development of small and medium enterprises, etc.;

(c) Industrial investment projects launched by private firms, local or foreign, for the installation of new production plants. The origin of the capital would determine in most cases the nationality of the consultant to be used; subsidiaries and joint ventures of foreign corporations would tend to employ consultants from their home country.

(d) Smaller investment projects for extensions in existing enterprises. They would be directed to achieving a higher output, or adding on new product lines.

(e) Introduction of new products, new process technology, or new manufacturing techniques in an existing company.

(f) Rendering of services to small and medium enterprises, on the acquisition of machinery, the improvement of management practices, and numerous technical problems.

In addition, CEDOs from a developing country may attend foreign demand originating in other countries (which would in general be developing countries), international financial institutions (World Bank, Inter-American Development Bank, Arab Funds, Asian Development Bank, etc.), international and regional agencies (UNDP, Organization of American States, Andean Pact, Organization of African Unity, etc.), and occasionally agencies of developed countries that extend bilateral aid usually preceded by extensive preparation work.

The sources of demand may be classified according to the branch (civil works, mining, food industry, etc.), the type of technical service (building, power and light, water and gas, ventilation and air conditioning, drainage and sanitary, topography, etc.) and the stages of consulting and engineering services for projects (pre-feasibility, feasibility, techno-economic work, process design, detailed engineering, procurement, product design, project start up, project management, etc.). A series of matrices may be built according to these classifications in order to give a detailed idea of the structure of demand.

This demand may be attended partly by in-house capacity and partly by outside CEDOs, and the complexity of demand --to a large extent depending on the country's level of development-- will call for more or less complexity in the structure of supply. The main interest in the case of semi-industrialized countries are multi-purpose CEDOs that may attend the needs in items (a), (b) and (c) above. In countries of incipient industrialization, or in those with a very large traditional sector, CEDOs attending the demand in (f) would be of prime importance.[1/]

1/ A network of consultancy institutions for small and medium enterprise has been established in India, in close liaison with financial institutions for the same sector.

Most of the demand for C&E services related to investment projects in the developing countries originates in the public sector. Any policy in favour of building up C&E capabilities and utilizing them adequately would therefore have to rely to a large extent on the behaviour of State investors, which should be influenced to adopt enlightened procedures in their investment operations.

4.2. Demand estimations

It is not easy to estimate the demand for C&E services. It is probably better to employ as an indicator the volume of business (sales of C&E services) rather than physical indicators such as the number of drawings, manpower by categories of personnel, etc.; though estimations of the latter are always made in the case of specific jobs, they are not appropriate for overall estimates.

The volume of C&E services may be roughly estimated as a percentage of the expected cost of investment. There is little data on this, but rules of thumb would indicate that the cost of preinvestment studies (consulting) would be around 3 per cent of the total project cost in large industry projects, and 1 to 1.5 per cent in large infrastructural investments. The cost of detailed engineering would be between 5 and 9 per cent according to the complexity of the project. This is much too rough for making reasonably accurate plans for the development and utilization of C&E capabilities, and a first research need comes out clearly, to find out from experience the value of such coefficients for different types and locations of investment projects. If information of this nature could be developed it would be possible for a country to estimate the requirements for C&E for its main sectors and hence to plan the expansion and use of its C&E capacity.

Let us remark that in the case of preinvestment services it is probably more difficult to arrive at satisfactory estimates than in the case of engineering and project implementation services. In practice, investment decisions by the State in a developing country are often taken on political grounds, using a few a-priori elements, and the feasibility study may then become a formal requisite to justify decisions already taken. In other cases,

investment decisions respond to one main factor, the availability of finance, and the study once again justifies a decision already taken. Preinvestment studies then largely become window-dressing. A similar thing may happen in the private sector. On the other hand, banking institutions and planning agencies are insisting more and more on the need to carry out careful feasibility assessments as a way to guarantee that good investment decisions will result. These two contending forces will define how complete and detailed a preinvestment study will result in practice.

Estimates of demand for C&E services should contemplate areas in which such services are bound to be required in the future, and in which there is as yet little or no national C&E capacity. Long term projections should be useful for identifying such areas. The formation of C&E capacity in them should be undertaken early enough if complete dependence on foreign CEDOs is to be avoided. Estimates may be made by an official organ, such as the Planning Authority, or by institutions like the National Association of Consultants which can also study supply aspects in great detail.

There have been a number of experiences in demand estimation which have underlined the difficulties of the exercise. Demand projections were carried out in Canada but the experience was not altogether favourable, it being concluded that only short-range predictions could be made since C&E activity is very much affected by the ups and downs of the economy to permit any reliable estimations in the medium or long term. This conclusion applies to a market economy, without explicit national planning; in a mixed economy with central planning, as is the case in many developing countries, it probably makes sense to devote efforts to estimate the future demand of C&E services several years ahead as a basis for programming the development of C&E capabilities.

In Algeria, for example, such estimates were made in order to programme the training of human resources. The principal industrial projects in the plan were taken, and a fixed ratio was applied to give the consulting and engineering input. This gave a good idea about the volume of studies and of detailed engineering which was needed, and from this figure the number of working hours was estimated by broad professional categories, such as engineers, technicians and designers. Thus it was possible to make rough estimates of the number of

people needed by area or specialization.[1/]

Demand should also be estimated at the level of the CEDO to help in stabilizing the work load and to permit the planning of CEDO development, particularly in the area of human resources. For this it is necessary to break down projects into areas and specialities, going to the level of unit operations.[2/] This task will be simpler in CEDOs in charge of long-range investment programmes.

4.3. Demand trends

The demand for C&E services is already large in some of the developing countries and may be expected to grow significantly as major investment programmes are undertaken. UNIDO estimates that industrial investment in all developing countries is close to US$ 100 billion; if C&E services represent 5 to 6 percent, total annual demand would be in the order of US$ 5 billion.[3/] Opportunities for developing countries' CEDOs would seem to be large, particularly since many projects are to be undertaken by the public sector. In India, for instance, it was estimated that for the Fifth Five Year Plan some 25,000 professionals would be needed to handle all the engineering and plant design services, but only 6,000 were available at the beginning of the period.

The upward trend is apparently caused by the improvement of the economic situation in some developing countries, the preparation of more ambitious plans, a more intensive process of programming and implementation, a greater awareness of the role of consulting and engineering, and reactions to previous

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1/ A first conclusion from the exercise was that there were not enough training possibilities in Algeria. Priorities had to be set out, both regarding the engineering field and the phase of the consulting and engineering process, and it was clear that full utilization should be made of the opportunities of repetitive projects.

2/ It is likely that much useful quantitative information may be culled from reports about past projects in donor agencies and international banks.

3/ Estimates of C&E services demand for Latin America reached US$ 15 billion for the period 1976-85. Decisions made through those services would be affecting US$ 200 billion of investment, and through it, a strong influence would take place on consumption, production and many aspects of life in the region.

mistakes that took place when there had not been sufficiently detailed studies. Another influence is the increase in the share of C&E within total project costs, in part because C&E costs become more visible as the purchase of turnkey projects diminishes, and also because of a tendency to spend more, in more comprehensive types of engineering services, in an attempt to save on the cost of project investment and implementation.

It is likely that there will be a strong expansion in the demand for C&E services to small investments. Since organizations from the developed countries are not well equipped to do this, such services will have to be provided increasingly from the developing countries themselves, to respond to the needs of their important small and medium enterprise sectors.

4.4. The demand for foreign C&E services

In many developing countries there is a tendency for channeling the demand for C&E services towards foreign CEDOs from industrial countries. If national consulting and engineering capacity is to receive proper utilization and thereby produce the social benefits expected from its activities, it is important to identify the reasons for such a preference and to lay down policy that will permit to redress the situation as far as convenient. Since the reasons and their relative importance may vary with the national situation, a clear research need comes out for the understanding of this behaviour.

Among the causes that have been suggested we may mention:

- The relative weakness of domestic CEDOs vis-a-vis foreign CEDOs which principally comes out of an "inherent inequality" between both stemming from less financial means and poorer credentials. Domestic CEDOs are often caught in a "vicious circle", from which it is very difficult to break.

- Attitudes in public and private enterprises that lead to the disparaging of domestic skills, the use of foreign consulting firms and the turnkey solution. Such attitudes may take a long time to change until confidence develops in regard to local consulting activity. In addition, decision makers --particularly in the State-- may have an attitude towards risk that makes

them behave on the "safety-first principle", and this may constitute a very great obstacle to the demand for local C&E services.[1/]

- Lack of domestic financing for C&E services, the client then looking for a foreign CEDO that can provide its services with financing in easy terms.

- Lack of local medium and long-term financing for investments, obliging both public and private investors to turn to foreign sources that finance the complete package of consulting, engineering, technology and equipment. This problem is dominant in certain countries which depend extensively on foreign aid and foreign investment, and the "untying of aid" has now become an issue in international forums.

- The behaviour of international and regional financial agencies and development banks that, despite pronouncements to the contrary, are alleged to favour the use of established CEDOs from the industrial countries.

- The behaviour of national financial organizations which tend to copy the "prudent" behaviour of the international banks and, just as the latter, are often in favour of "getting the job done" and not complicating things with relatively untried local CEDOs or local inputs of various types.

There are strong arguments for building up a national capacity in consulting and engineering and to achieve "import substitution" in this field. A word of caution may however be in order. Too strong a nationalistic attitude may act as a barrier to the flow of technology; it may impose tasks on local CEDOs which they are not yet ready to discharge; or the policy may be negated in practice if weak local CEDOs are engaged which then take on foreign CEDOs as partners and leave to them the greater part of the substantive work and the decisions that go with it.

The problem is to use foreign C&E in such a way as to maximize its positive features and minimize its negative effects. This means to employ it as a complement rather than as a substitute to local C&E capacity, to seek mechanisms of cooperation between both sources of supply in order to favour

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1/ According to an Indian study, no Government policy has been effective in forcing the Indian clients to use Indian engineering services or indigenously manufactured equipment.

the maximum utilization of local sources and to make full use of foreign C&E as a vehicle for technology transfer and the training of national C&E personnel. Some people feel that the best solution may be to employ a local CEDO as the prime contractor and let it determine what foreign collaboration is needed and how the work should be divided, with the proviso that it should establish a "relationship between equals" rather than just offering its letterhead and its offices to the foreign CEDO.

4.5. Fluctuation of demand

An important characteristics of the demand for C&E services, particularly on the part of the State, is its fluctuating nature. Economic cycles, stop and go economic policies, political changes, lack of long-term and well-balanced government investment programmes, etc. are factors that lead to ups and downs in demand, perhaps more acutely than in the case of the capital goods industry and other activities connected with investment. This is a well-known characteristic that makes life difficult for local CEDOs, particularly in the smaller countries. There is a need for continuity if CEDOs are to work properly and to develop steadily. The drying up of demand has not infrequently meant the disbandment of human groups that had been built up with much effort, and this may sometimes imply a net social loss on account of the accumulated expertise that is lost and of the need to turn to foreign CEDOs when demand picks up again. On theoretical grounds (congestion theory) it may be shown that a certain long-term average level of idle capacity is socially beneficial in activities where the arrival of demand is not constant, on the one hand, and the length of services demanded is not uniform, on the other. Mechanisms must be found to support occasional idle capacity, and to avoid disbanding groups when there is no work.

It is not easy to regulate State demand for C&E. In the first place something can be done through general regulations and a careful drafting of tenders and specifications. If regulations stipulate that local C&E are to be used whenever possible, demand will be more stable and is bound to incrase. Many influences act on State project-owners in this respect. On the one hand, they have to decide whether they want to pay more to the consultant or to the

equipment suppliers. In large package deals there is much C&E work which does not show; if packages are pulled apart, C&E costs increase but the total project cost may diminish. But many project-owners prefer to have one main engineering supplier to avoid complications and extra risks. On the other hand, engineering costs and fees are subjected to market conditions. In bad times it is wished to bring these costs down. Though it is generally accepted that C&E services should be bought by quality and not by price, sometimes the price aspects are more important than the quality aspects.

Secondly, stabilization of demand would follow from an analysis of development plans, and from a coordination of the different agencies that carry out investments. This may be difficult when such agencies are jealous about their autonomy. Third, the government can adopt a counter-cyclical policy creating demand for CEDOs when their usual type of work as producers of services to investment projects has diminished, asking them to carry out certain projects and studies at those times of relative idleness.[1/]

Fourth, CEDOs themselves may try to adapt to these fluctuations. They can continue to work in spite of recessions by diversifying their services, working outside of the public sector, or exporting their services. In many developing countries consulting organizations have a small core of highly qualified managers and some stable technical personnel, and rely on a large network of specialists for specific projects. When the workload diminishes it is the outside collaborators who suffer, but the firms can continue to survive.

4.6. Foreign demand

We should finally refer to the foreign demand that is satisfied by exports of C&E services. Some CEDOs in developing countries have been able to sell their services to other developing countries, and this is bound to happen

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1/ In Brazil, for instance, a Government funding agency, FINEP, finances the working capital of CEDOs and demands other types of services from them when there is little demand for their habitual type of work. FINEP considers that C&E capacity is an important national asset that must be preserved, and that a good way of doing this is to assure a stable work load even if this means that low-priority tasks are commissioned from CEDOs when they have little else to do.

increasingly in some fields since there are advantages in regard to CEDOs from developed countries: lower costs, an approach which is closer to the philosophy and way of being of the client, a greater awareness of local problems and local conditions which may not be too dissimilar to those the CEDO faces back home, the use of technological assets and solutions tried and tested in the CEDO's home country which are better adapted to the conditions of the receiving country.

The export of C&E services is beneficial on several grounds. Foreign exchange is earned, national technology may be exported, and in some cases a CEDO may keep up its level of activity when local demand has momentarily dropped. It may be suggested therefore that national policies should consider promoting such exports through tax measures, the awarding of credit and other means.

5. SUPPLY OF CONSULTING AND ENGINEERING SERVICES

There is a clear tendency in developing countries --as has been the case in developed countries-- towards the separation of the C&E function from other activities, as a consequence of the division of labour in increasingly complex societies. This has happened first through the activity of individual professionals and small organizations, and later through the formation of large CEDOs that are able to put together the various disciplines required, gather sufficient knowhow and experience, and build the necessary links with other institutions and activities so as to discharge their tasks successfully.

5.1. Types of CEDOs

A CEDO may belong to an enterprise (a "captive" CEDO, often known as a "project department" or similar denomination, in a productive firm, an equipment manufacturer, a large contractor), or it may be independent and produce services for various clients. Independent CEDOs may be State-owned or private, of local or foreign capital. The different producers of C&E services in a country compete with each other to a certain extent but there are also relations of complementarity, which a policy for their promotion should consider.

Unless an enterprise or Government agency has a sufficiently steady flow of new investment projects, it does not pay for it to keep a relatively large staff for C&E activities and it becomes economical instead to contract them out to specialized organizations. This would appear to be socially beneficial on the other hand since it allows such units to become larger and acquire a great deal of experience, enabling them to render cheaper and better services.

In many of the developing countries, important sectors are in the hands of the state, such as electricity, oil and petrochemicals, transport, etc. Here demand is correlated with population growth, and there is a need for an increase in capacity which is expressed in a succession of investment projects that can be planned well in advance. There is therefore a steady need for consulting and engineering services and these sectors tend to have their own C&E capacity, or they may rely on specialized State-owned CEDOs with which they contract according to their needs, for instance, in railways, iron and steel, etc.

In countries with a relatively small modern sector, some specialized public-sector institutions may be important suppliers of C&E services and can therefore be considered as CEDOs, for instance, engineering design centres, industrial research institutes, productivity centres, special consultancy units for small and medium-scale enterprise, and occasionally educational and training institutions. It is very important in such countries to employ whatever technical capacity is available for tasks of project formulation, design and technical assistance to Government and production, at rates which are accessible to local clients.

CEDOs in the private sector of developing countries are found in a wide spectrum, from very small groups with a high mortality rate to large, stable firms in some of the larger countries.

In many developing countries there are numerous small CEDOs that carry out preinvestment services and a certain amount of engineering work. They face a large number of problems, among them the instability of demand, the lack of confidence in the effectiveness of their services, and the fact that their clients often are not exactly aware of what they want and may not be capable of controlling the different stages of execution of a project.

Not infrequently these small CEDOs look for foreign collaboration to increase their chances of landing an assignment. Their role is sometimes that of a commercial and administrative agent, or a technical collaborator in pheripheral matters. In other cases they carry out a great deal of the work. They are often organized as a small permanent group of able professionals around which others join temporarily for a specific project. In the best firms of this type, those in the permanent staff have acquired a mastery of the "technology of consulting": methodologies and their use; utilization of outside expertise; forms of presenting results and recommendations for various users (client-investor, government, credit organizations, engineering firms, technology owners, equipment suppliers, etc.). They know well the local conditions (technical, economic, policy, legal, industrial situation, suppliers of local components, suppliers of engineering and other services, relative prices). They keep a dynamic system of contacts with various areas of expertise, R&D institutions, engineering firms, government officials and local and foreign sources of technology and equipment. The outside collaborators,

which are brought in as needed for limited periods of time, provide their expertise and their advice in different aspects: legal, economic, financial, negotiating, organizational, marketing, training, technical (in specific areas such as surveying, soil engineering, water treatment, geology, structural engineering, etc.).[1/]

Relatively large CEDOs are also found in the private sector of some developing countries; some of them have acquired good experience and are able to handle complex projects on their own. In some countries they also operate as contractors and can carry out turnkey contracts for their clients. They may be of local capital but often are subsidiaries or joint ventures of foreign CEDOs. This poses important policy questions to which we refer later.

5.2. Structure of domestic supply of C&E services

The origin of C&E services that are rendered to users in developing countries is extremely variable, according to the level of development, the political system and the historical circumstances of development. An important share usually comes from the industrial countries. We refer below to the issues related to the import of C&E services, and will deal in this section with their local production.

In many countries of incipient industrialization, such as those in Africa, there is little development of what may be called a "C&E sector"; whatever capabilities exist are in production firms --mostly in those of foreign capital-- and in certain Government offices that handle preinvestment work. Sometimes industrial research institutes and other public sector institutions offer C&E services, as we have indicated above. The case of industrial research institutes would seem to be worthy of attention; there are several interesting examples (CARIRI in Trinidad, ICAITI in Central

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1/ We should perhaps stress the kep importance that the collaboration of an individual expert may assume for solving certain problems - for instance, search and choice of technology for a product which is new to the country. This specialist may come from different places, he may only be used for a few weeks, but the knowledge he brings in is irreplaceable.

America, etc.) which deserve to be studied in detail not just as producers of new or adapted technology but principally as suppliers of C&E services, sometimes around the technologies they have developed, in an environment where they may constitute the only feasible alternative to the import of such services.

At the other side of the spectrum, a country like India shows a well developed C&E sector, in addition to strong in-house capacity in the large State and private enterprises. This has been obtained as a result of a 30-year effort of developing C&E capabilities. It is interesting to mention some features to which A. Malhotra has drawn attention:

- CEDOs may be classified in two groups in respect of their ability to provide project consultancy services. Most of the small organizations are in a position to offer only preinvestment or project planning services. It is only the larger organizations that are able to provide comprehensive project consultancy services.

- The small consultancy organizations have been forced to face keen competition from equipment suppliers who provide free consultancy services to the potential investors.

- A review of the activities of various consultancy organizations indicates that so far no specific pattern has emerged. While there are a few organizations e.g., MECONS, Dastur & Co., Engineers India Limited, National Industrial Development Corp., etc. which were originally established with the intention of specializing in particular industry areas, they have entered other fields as well. This may be due to difficulty in securing continuous business in their specific fields of specialization. But this diversification must necessarily reflect the quality of specialization established in highly complex fields.

- There are a fair number of reasonably well equipped organizations in respect of economic, project and management consultancy services in India. But not sufficient headway has been made in developing facilities in respect of process and technological consultancy services. As a result India still continues to depend heavily on external sources for the required process know-how and product-designing technology.

- The level of participation of consulting engineering firms in a sector varies according to the industrial sector to which they supply services. This varying participation, to a very large extent justified by the different rythms of technical progress observed in each sectors, is also determined, to a lesser extent, by factors such as the possibility of access to the sources of knowhow, the structure of the sectoral market, the links with groups in other sectors of the economy, and the links with capital goods producers and research institutes in the country.

In the case of Latin America, data on the supply of C&E services are scarce and it is not easy to estimate the volume of services rendered in recent years, or the installed capacity in C&E. What is clear is that engineers and other professionals are abundant in many of the countries --there is a strong brain drain going on in many cases-- while organizations that produce C&E services are weak and show ad-hoc, fragmentary and individualistic characteristics. There is a proliferation of individual consultants and small CEDOs, a few large CEDOs, some of them subsidiaries of foreign ones, and some State organizations that produce C&E services. Save in a few countries, most of the importat projects are prepared and executed by foreign CEDOs from the developed countries, with marginal participation by local people. The relatively recent emergence of such organizations, which did not exist before the early 60's in most cases, the indifference of Government until a few years ago and even today in regard to their promotion and use, the "vicious circle", the strong fluctuation of demand and the lack of financial means have been the main reasons for this situation.

Studies undertaken by the Andean Pact Secretariat show that by 1972 there were about 180 independent firms in the Andean subregion, which gave permanent occupation to almost 1400 professionals (1300 of which were engineers, 4 per cent of the total stock in the subregion) and nearly the same amount of technicians. As we can see, the average size of a CEDO was rather small. Engineering and consulting services had been contracted in 1971 for some 53 million dollars of which about one half had been supplied by local firms, the proportion varying according to the speciality and the country (the range went from 20 per cent in Ecuador to 76 per cent in Colombia). Most firms were small and were principally dedicated to physical infrastructure projects (transport,

power, sanitary engineering, irrigation, telecommunications, urbanization, structures in general). In Chile, around 1974, about 15 per cent of the total national expenditure for engineering was derived to private firms, 25 to foreign firms and 60 to State organizations. In Venezuela about 3000 professionals were employed in "consulting engineering" but only a small proportion were organized in relatively important firms. Argentina counts with many small C&E firms, and a few large ones, which have had to cope with low fees, tardy payments and a very fluctuating demand. The situation is similar in most of the other countries of the region, perhpas with the exception of Brazil where there is a policy for the support of C&E organizations, and an organism, FINEP, to carry it out.

Some other features of the Latin American situation should be noted. Local C&E capacity for services to industrial investment is much lower than for infrastructural investments. Local CEDOs often associate with CEDOs from industrial countries for a given job, but not infrequently there is no real collaboration between them, the local firm undertaking subsidiary responsibilities and sometimes acting as a mere agent. Some large CEDOs are subsidiaries of firms from developed countries, or joint ventures where the local associate is in fact a junior partner. The large C&E assignments in countries of Latin America and the Caribbean are by and large entrusted to foreign CEDOs or to local CEDOs of foreign capital, while the locally owned CEDOs tend to be engaged in smaller projects, or to be subcontractors for the simpler tasks of large projects.

There is an interesting example of a centrally planned country that has organized in a very complete way its C&E capacity, in line with its project formulation and execution system. Recent legislation in Cuba defines the procedures for preparing and carrying out investment projects, and establishes the CEDOs in charge of this. Some of these CEDOs are organization that existed before while others are presumably new organizations at the most important ministries. The mission and the functions of each are carefully defined; for instance, the CEDO at the Communications Ministry is to deal with all investment projects in the Ministry but may supply to other Ministries consulting and engineering services related to the communications aspects of their projects.[1/]

1/ Time will tell whether the system works efficiently in practice, or whether bureaucracy will smother it.

5.3. Some issues in supply of C&E services

(a) The import of C&E services from developed countries

We have remarked that many large C&E assignments in the developing countries are entrusted to CEDOs from the developed countries, for a variety of reasons.[1/]

While in some cases there is no alternative to the import of C&E services, and recognizing that there are certain advantages in such a course of action on account of speed, efficiency and reliability, the use of foreign CEDOs entails several drawbacks. One of them is their cost: fees per man-hour are larger, expenses on account of travel and subsistence of foreign professionals are sizeable. Other disadvantages may be summed up by the expression "dependence". Many important decisions would be made by foreigners, and this may have several unfavourable consequences, which are mentioned elsewhere in this paper.

The problem is to use foreign C&E in such a way as to maximize its positive features and minimize its negative effects. This would mean the establishment of "rules of the game" and standard procedures that would place foreign C&E as a complement rather than as a substitute to local C&E, seeking mechanisms of cooperation between both sources of supply in order to favour the maximum utilization of local sources and make full use of foreign consulting as a vehicle for technology transfer and the training of national consulting personnel. Some people feel that the best solution is to employ a local CEDO as the "prime contractor" and let it determine what foreign collaboration is needed and how the work should be divided.

The implementation of such a policy may find obstacles in the attitudes of State and private decision-makers, in the behaviours of international and national financial agencies, in the lack of capacity for a proper use of C&E services in the State and the private sector, and perhaps in the attitudes of local CEDOs themselves in so far as they have become accustomed to a subsidiary role in regard to foreign CEDOs.

1/ Imports of C&E services from other developing countries are now starting to be significant. Here is a field of great potential to which we refer in a later section.

(b) Participation of foreign capital in domestic CEDOs

The issues here are similar to those which have been extensively debated in relation to foreign capital participation in manufacturing and other economic activities. Three are however certain peculiar aspects that have to do with the nature of C&E activities and the role they may fulfill in development:

- The true indicator of the extent to which a local CEDO is dependent from a foreign one may be the origin of technological assets and certain specialized technological services it employs, as well as the origin of its key management and technical personnel, rather than the equity participation by the foreign CEDO.

- CEDOswhich are subsidiaries or joint ventures of foreign CEDOs have a number of advantageson account of their ready access to the knowhow and expertise of the parent organization. This is probably favourable to the "private" efficiency of the projects they undertake.

- From the social efficiency point of view, however, there may be disadvantages on account of a tendency to accept solutions suggested by the parent organization and to rely on foreign inputs without making a decided effort to use fully what may be procured domestically. This would mean that many of the favourable impacts of local C&E would not appear.1/

These topics have been debated in several places, particularly countries where successful native CEDOs have been taken over relatively cheaply by foreign organizations. They should be examined closely and reliable evidence should be procured to allow for an objective appreciation, as far as this is possible in issues so controversial.

(c) The notion of "installed capacity" in C&E

It is not easy to arrive at estimations of installed capacity for the production of C&E services. The problems are similar to those of estimating demand. It is important nevertheless to procure this information as a basis for programming the development of national C&E capacity and the training of human resources.

1/ In fact, some people feel that subsidiary or joint-venture CEDOs are like Trojan horses which seduce by their external trappings but bring inside the hidden enemy.

In the recent OECD Seminar (Paris, October 1978) doubts were voiced regarding the usefulness of making detailed inventories of installed capacity in C&E on the basis of volume of sales or even human resources available. The importance was stressed of the type of knowhow that depends on the institutional organization; it was pointed out that skills, on the other hand, are tradeable among institutions.

A suggestion made on that occasion is that installed capacity may be taken to be the total volume of human resources, economic resources and technical procedures of consulting and engineering which are available at a certain moment to carry out services; but these resources must be within certain types of organizations. Ten computers and 200 engineers are only meaningful if they are in an organization and have a methodology they can use to prepare a project and follow up its execution. C&E capacity would then only be significant if there is appropriate management capability (a similar thing may be said about contractors). The kind of estimation or inventory of installed capacity that should be had would therefore be strongly related to management. There are two roles for management: managing the organization itself, and managing projects. In developing countries, in the case of firms which are not too large, these two types of responsibilities are often taken up by the same person. Clients should examine very carefully the management capabilities of the CEDO and of the prospective project managers, before entrusting an assignment to them. On the other hand, in the case of organizations which give advice of a relatively simple nature to small and medium enterprise, one might say that engineering capacity is much more diffused and that the role of management is less important.

(d) The specificity of CEDOs

An interesting question relates to the specifity of consulting and engineering organizations. Recent experience in Argentina has shown that CEDOs engaged in preinvestment studies for road building have not been successful on going into the field of hydroelectric projects, in which the large recent increase in demand for C&E services has been supplied by new CEDOs. The difficulty of switching fields would seem to be even larger on going from civil to industrial work. However, many CEDOs have been able to widen their field of action in a succession of assignments.

It would be important to ask in how a CEDOs specific to certain areas can be put to work in different areas. Would they have to recruit new people (or teams)? Can existing personnel be retrained in a short time? How can the new knowhow be procured efficiently and quickly?

Knowledge about these questions would not only throw light on the chances for survival of a CEDO when demand dries up in its specific field, but would be helpful in debates about the establishment of a national C&E capacity when CEDOs have to be set up in several fields, since specific C&E resources may not be easily put to work in a different field from that in which it has specialized.

(e) State-owned CEDOs and private CEDOs

Private CEDOs have showed great concern about the expansion of State C&E activities, which they feel are encroaching more and more in their market. We may suggest that it is an important question to maintain a balance between public interest and private initiative, and obtain a rational distribution of supply between private and State CEDOs, retaining the innovative virtues of the first and counteracting "bureaucratic" expansion of the latter.

Some people feel very strongly against State consulting. They agree that the State should take over various activities, but they draw the line at consulting since they feel that State consulting has inherent shortcomings. They are not against Ministries and public agencies having their own departments for the preparation of general studies and projects, but object to the growth of institutions that "without being really consulting" absorb many resources destined to consulting. They feel that the proper role of State consulting lies in the promotion of expertise in new fields, which once developed should be set up as private CEDOs. They have doubts about the efficiency of State consulting, and point out that top personnel cannot be attracted to government employ since salaries are lower than in the private sector, that the pace of work in State organizations is much slower due to the characteristics of bureaucracy, that political influences are much more pervasive, and furthermore, that the best technical men move on to administrative posts. They add that private consulting does the job more cheaply, though this may be hidden from

view because a government organization does not include in its costs the full amount of overhead items-sometimes only direct costs are charged, raising the cry of "unfair competition" from private CEDOs. They point out that private CEDOs are strongly motivated to be efficient since their earnings, and indeed their survival, depend crucially on their efficiency. State consulting organizations would lack such a motivation and would have to look to other types of motivation. Successful motivations in government work would greatly depend on the "spirit" of the working group and on the abilities and push of their leaders. These characteristics may be present at a certain moment but many examples may be shown when they ceased to exist, perhaps because of the disappearance of that leader. In such cases the organization may sink to a much lower level of efficiency, and due to the inbuilt inertia of bureaucratic organizations, continue to absorb work it does not discharge well.

On the other side of the debate, arguments of various kinds are presented. It is said that the very profit-seeking nature of private C&E makes it vulnerable to ties with construction and equipment supplier firms, and with foreign CEDOs to which the main decisions are left; legal and administrative regulations, and ethical declarations of principle, would be largely unable to curb such tendencies. It is also said that the small size of many sectoral markets for C&E services induce the appearance of monopolistic situations, or of market-sharing and other restrictive trade practices among the few CEDOs in the sector, with obvious detriment to the clients (which often are public enterprises). Moreover, certain areas of C&E are held to be legitimate interests of the State: such would be the case of industrial sectors like steel, petrochemicals and mining where the State has a central interest, or even a monopoly; of new activities where there is as yet no installed capacity in C&E; of small and medium-scale industry which cannot meet the fees asked by private CEDOs. In the latter case, mention should be made of industrial research institutes that offer C&E services; these activities are a good means of connecting industrial R&D with industry, and if they were not carried out much of the research work would be left without a client and would not be transferred to the users.

The issue of State vs. private C&E probably cannot be solved on rational grounds alone. Much depends on the political style of the country --whether private enterprise is favoured or not-- and other factors of the contextual type.

The discussion should rather try to identify the areas each type of actor is better qualified to deal with, which will naturally vary from country to country, and how State and private C&E may collaborate and complement each other. Some people think that the proper areas for the State would be those of policy, planning, programming and preliminary project conception --the strategical decisions-- leaving to the private CEDOs the detailed and specialized studies needed by such State activities, the preparation of pre-investment studies, and other activities leading to tactical decisions, as well as engineering design and other project implementation activities. But perhaps it would be advisable to develop strong in-house C&E capabilities, coupled to R&D activities, in some large public enterprises operating in modern branches where much investment is undertaken, since this may be the only way to acquire basic engineering capability that may permit full technological autonomy in those branches.

(f) C&E statistics and the formal emergence of a C&E sector

One of the reasons why national policy in many developing countries does not deal explicitly with C&E activities is that the latter do not have visible existence in the national system of statistics, and do not constitute a formal sector or branch. Even though the magnitude of these activities is not large, their importance as organizers and executors of investments, and as suppliers of many different services to production, would justify their constituting a visible aggregate of economic activity to which policy may be applied.

It is possible, and indeed desirable, to measure the production, consumption, import and export of C&E services, classified according to various criteria, and to relate such data to other economic, educational and scientific indicators. Such information would help to diagnose the situation at different moments of time, and to lay out policies and plans related to C&E.

While this should eventually be done within the general framework of economic statistcs, the characteristics of C&E activities and services are such that it would seem appropriate to start measuring them within the framework of science and technology statistics. Most C&E activities would fall within the category "related scientific and technological activities" of the

UNESCO and OECD systems, and within that of "diffusion activities" of the OAS system.[1/]

The suggestion is therefore that within the system of "science and technology statistics" a subsystem "statisticsof consulting and engineering activities and services" may be developed and implemented operationally. This would require a serious effort for the drafting of definitions and classifications conceptually valid and operationally useful, and for their testing through pilot surveys in various countries, until a recommendation for a standard practice may be put out and employed widely. Whilst this effort may be carried out by any country interested in it, it would seem that there are advantages to its being done by a regional or international organization as a natural extension of its work on science and technology statistics.

While it is still too early to make any definite suggestions as to the shape of statistics in C&E, a general observation may be made. In science and technology statistics the emphasis has been on "activities" rather than on "products", due to the difficulty of measuring the latter in physical and economic terms. In the case of C&E, statistics should not only refer to the "C&E activity" --its different types, the human and financial inputs it uses, and other aspects usually contemplated in science statistics surveys-- but also to its product, "consulting and engineering services". This would mean a departure from current science statistics practice, but we feel that it is possible to measure C&E services in physical and economic terms, and to classify the results according to various criteria - type of C&E activity producing it, type of customer demanding it; local production, consumption, exports, imports; etc.

1/ See: -OECD, "The measurement of scientific and technical activities: proposed standard practice for surveys of research and experimental development", DAS/SPR/74.63, Paris, October 1974.
-UNESCO, "Manual for surveying national scientific and technological potential", Paris, 1969.
-OEAS, Subcomisión de Estadísticas de la Ciencia y la Tecnología, "Informe de la I sesión", Washington D.C., 1975.

6. THE IMPACTS FROM EMPLOYING DOMESTIC C&E

We have indicated in a previous section that the use of domestic C&E services may produce a number of positive impacts on development over and beyond the impacts that would take place if a foreign CEDO were employed.

Most of the effects will need time to appear, as the processes set in motion are worked out, so that it will principally be a case of medium and long-term impacts. Some of them will be desirable and positive, others will be negative and constitute drawbacks to the use of local C&E services. The ultimate impact on development will be a resultant of the positive and negative effects. We may relate it to the social costs and arrive at an idea of the social efficiency of using a local CEDO.

There are difficult problems in measuring these effects. First, we are interested in the differential or marginal consequences of applying certain ways of formulating and executing an investment project rather than other ways which were previously used. Second, these consequences will appear usually after some time and other influences will be at work. Third, some of the variables affected tend to be of a qualitative nature, such as "technical level", "learning" and "vulnerability". Quantification of the effects will not be simple and in some cases may be practically impossible. But it is worthwhile to analyze the different effects and to arrive, at least, at a general appreciation of their magnitude in a particular situation. This will perhaps be sufficient to provide a clear guidance for policy decisions if, as would appear from the limited evidence so far, positive effects are high for certain ways of carrying out the investment.

6.1. How decisions in the project sequence are linked together

It is often found that certain early decisions at the preinvestment stage set the ground for later decisions in the design and even the operation of the project, particularly when the project is large and complex. It is very important to make the early decisions in such a way that later decisions will be favourable to development objectives. Let us look at this matter more closely, examining the three phases of a project: preparation of the project

(preinvestment), execution of the project, and operation of the resulting installations.

It is at the preinvestment stage that the principal characteristics of the investment project are considered, and a number of decisions are made which have strong implications regarding the characteristics and origin of the goods and services that are to be bought in the subsequent stages.

When in a developing country a local organization participates in pre-investment work, or preferably takes charge as the "main contractor" to which outside consulting and engineering organizations may give collaboration, the project will probably be conceived with much more relevance to local needs and conditions than if a consultant from a foreign developed country is solely in charge. The local organization may be a project engineering group within the investing agency, or an outside local consulting and engineering firm retained by the agency. At this stage decisions are made about the principal parameters of the project, the sources of technology, the types of capital goods, the inputs to be employed at the production stage. The approach employed by the organization in charge of project preparation, and the implicit and explicit biases, will be reflected in the way purchases are distributed between local and foreign suppliers.

The choice of who is in charge of project preparation, then, is vital for the choices that follow.

During project preparation a number of alternatives will be studied, as the work proceeds from the project identification stage (where there may be a number of programming studies about the development of the industrial sector in general and of specific industrial branches), to a pre-feasibility stage (where a preliminary choice is made of the main project parameters, following from studies of markets, technology, location, etc.) and finally to the feasibility report in which more detailed market and location studies, preliminary engineering design and tentative negotiations with prospective suppliers will allow to develop alternative technological solutions, submit them to appraisal, and make recommendations to the project-owner. It is naturally the latter that will have to choose which alternative it prefers (and for this it needs a certain techno-economic capability of its own); but it is important to point out that the organization making the preinvestment

work will have already taken a large number of preliminary decisions, which are incorporated in the alternatives submitted to the project owner, so that these alternatives may be more or less appropriate to local conditions, or oriented towards the use of local inputs, according to the approach and biases of that organization. Experience would seem to show that when a local group is in charge of preinvestment work, a better technological choice may result and more local inputs are likely to be incorporated.

Another important decision has to do with the way in which the investment project will be financed. Experience also shows that the local content is highest when the investor uses its own funds and lowest when supplier credit is employed.

Once a decision has been taken about carrying out the project according to one of the alternatives put forth in the preinvestment stage, and once financing arrangements, Government approval and other necessary preliminaries are ready, the project enters the execution stage, and a number of decisions have to be taken regarding the supply of various inputs. The technological solution will have been chosen already, and this will generally mean that a supplier of the basic engineering design will also have been chosen, either the technology owner or a firm that has been licensed by it. In many modern industrial investments, technology and the basic engineering design that applies it are imported; there is room however for detaching certain "peripheral" technologies from the "core" process and getting them engineered locally. Also, it is sometimes necessary to conduct R&D work to adapt the process, or the product design, to local conditions, and it should be possible sometimes to have this R&D performed locally. The extent to which peripheral basic design and adaptive R&D work may be carried out locally will vary with the level of technical development of the recipient country, and with the attitude and the efforts of the project owner and his consultant organization.

The next task is detailed engineering, in which the basic design is converted into a set of detailed drawings and instructions for the purchase and installation of equipment and for the construction activities. At this stage, a number of seemingly minor decisions take place which when added together may make up important differences regarding the characteristics and sources of the inputs to be employed. The participation of a domestic

engineering group is important to assure that such decisions are made so that local inputs will be incorporated into investment and production as far as possible.

An interesting case which happened in a Latin American country some years ago illustrates this. A number of simple industrial buildings had to be built. Some of them were designed by local engineers, and used 75% of domestically produced steel; others, designed by foreign engineers, imported 75% of the steel required. The large difference did not result from different characteristics of the buildings, which were alike, but from the approach of the designers. Foreign engineers were not familiar with local steel and would only employ it when they were sure it would not endanger the structure. Local engineers knew well the local steel and employed it unless they were sure it would not be appropriate. The "safety-first" attitude of the foreigners, added to their imperfect knowledge of the local product, unnecessarily multiplied by three the steel imports.

It is through a large number of decisions of this nature that a local engineering group can fulfill a socially important role in specifying inputs that can be produced by local suppliers. At the investment stage, this will affect the origins of different capital goods, technical services, construction materials, and construction services. At the operation stage, previous design engineering decisions will influence the nature and source of raw materials, basic inputs, components, parts, spares, technical services and administrative services, all "current" purchases on which decisions taken at the investment stage will exert some influence.

We can easily see how important it is to have domestic control of the preinvestment and the design engineering activities if full use is to be made of potential domestic supply at the investment stage and also during the operating or production stage of the new installations. Consulting and engineering organizations in charge of those activities should be well aware of the possibilities of local supply in each of the items we have mentioned, and should have the right attitude regarding modifications in process and product design, specifications, standards and delivery dates. They should appraise the risks and the extra cost --if any-- in each local purchase, and advise the project-owner regarding the decision that is best in the long run.

It may be useful to analyze past or on-going projects to appraise the performance of the CEDO and other actors that define the final results of a project. To do this use may consider the sequence of critical decisions, which form a "decisional chain", from the moment the project was identified until the resulting installations were operating to specifications. At each point in the decision chain various elements may be identified: the actors involved; the alternatives considered at the time of decision, and how they were identified and formulated; the alternatives not considered, and the reasons why; the decision methodology employed, explicit or not; the information used for decision making; and the principal influences at work --explicit and implicit policy, contextual factors, motivation and attitudes of the actors, characteristics of the production branch, etc.-- which have operated directly (i.e. through the information employed for decision making) or through the actors (i.e. affecting their behaviour).

The resulting descriptions may be sumarized in a table which would permit fruitful discussions with the actors themselves (see model in following page). This description can help to understand the influence of successive decisions on the relative success or failure of the project to comply with private goals (getting the job done quickly and efficiently) and social objectives (keeping decision in national hands, using more adequate technology, maximizing favourable impacts on local production and engineering, increasing learning opportunities for the CEDO, its client and the latter's suppliers, giving opportunities to local R&D, etc.).

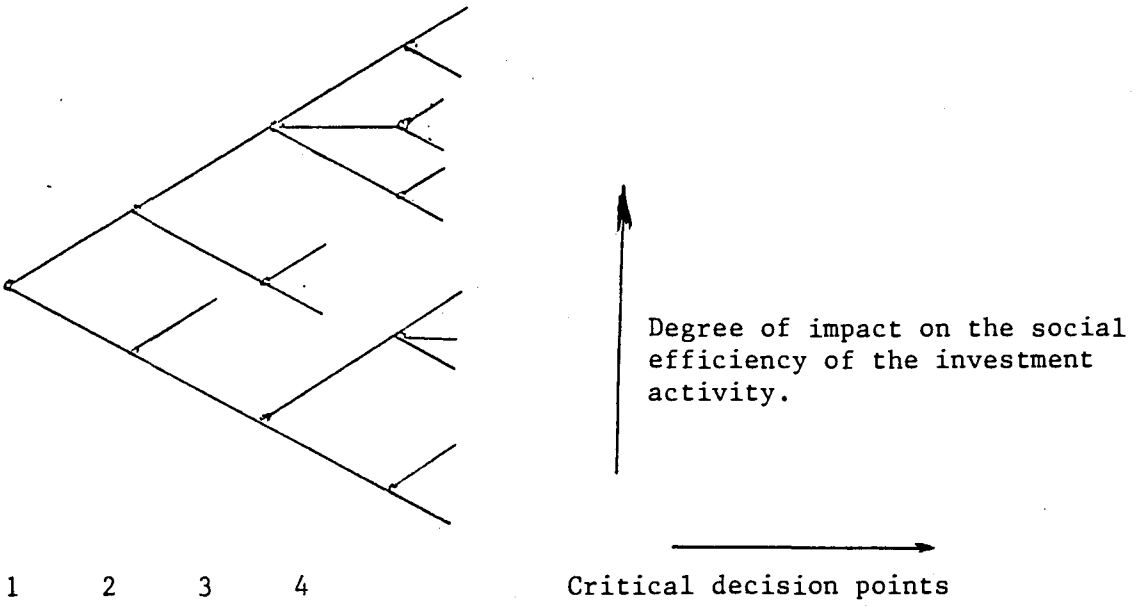
At each point of the decisional chain two or more alternative decisions may be adopted. The set of all possible decisions may be said to make up a "decision tree". We start at the first point in the chain and identify alternative decisions that may be taken -those explicitly considered by the actors as well as those not considered but possible. At a second point in the chain, each previous outcome would branch out into two or more possibilities, and so on.

The usefulness of this representation may be improved if we qualify alternatives according to the degree to which they are expected to enhance the social efficiency of the investment activity, and order then accordingly in a listing or a graph.[1/]

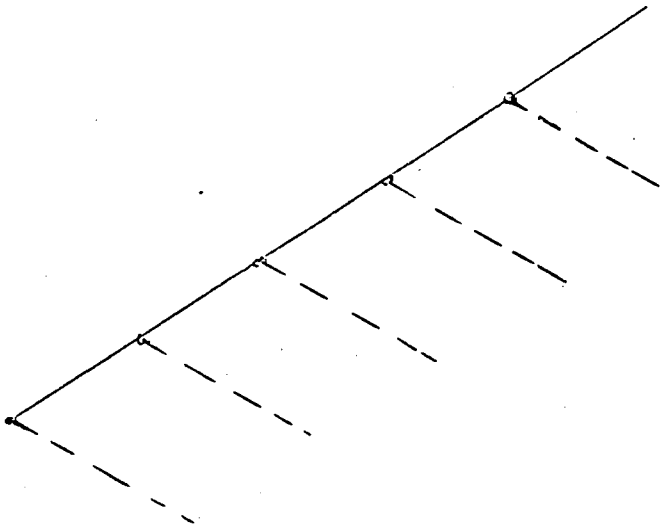
1/ We leave aside here the very real possibility that the decisional sequence should go back one or more steps to change a previous decision.

ANALYSIS OF AN INVESTMENT PROJECT

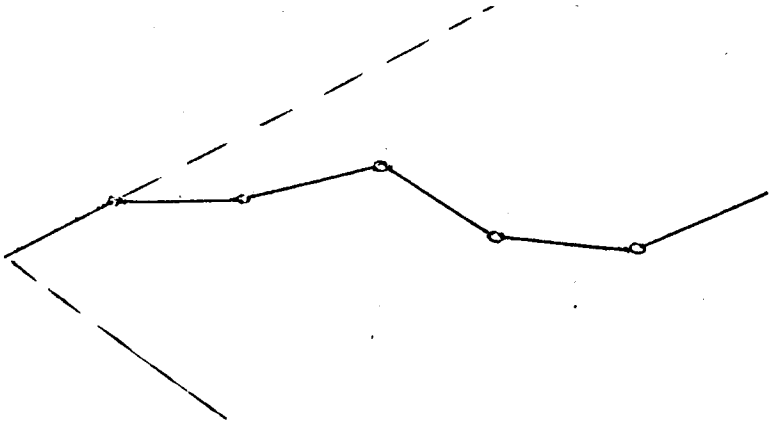
CRITICAL DECISION POINT	DECISION ADOPTED	ACTORS PRESENT	ACTORS THAT MIGHT HAVE BEEN PRESENT	ALTERNATIVES CONSIDERED	ALTERNATIVES NOT CONSIDERED	METHODOLOGY OF DECISION	INFORMATION FOR DECISION	INFLUENCES AT WORK	OBSERVATIONS REGARDING CEDO ROLE	OTHER OBSERVATIONS
1. Conception and identification										
2. Decisions on Pre-investment work: (a) Whether to do it. (b) Choice of who will. (c) Depth and scope of work.										
3. Guarantees asked of the CEDO selected.										
4. Choice of technology and how to obtain it										
5. Decision on size, location, product mix and other parameters.										
6. Decision on structure and sources of financing.										
7. How will detailed engineering be done and by whom.										
8. Where is the equipment to be procured and how.										
9. How will equipment be inspected: (a) while being manufactured, (b) upon delivery.										
10, How will construction and assembly be done and by whom.										
11. How personnel will be recruited and trained.										
12. How to carry out the commissioning.										
13. How to supply follow-up technical services.										
14. How to carry out feedback from operations to designer/engineer.										



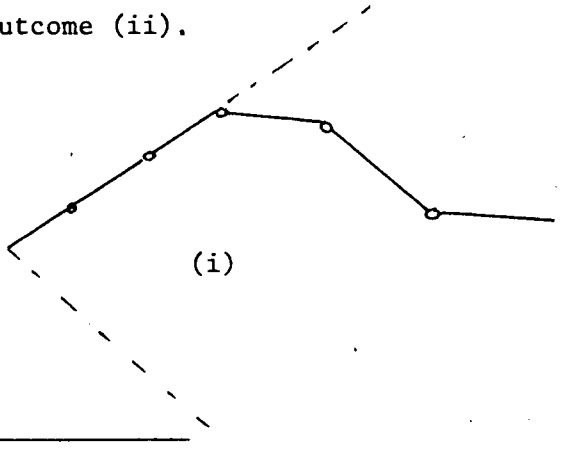
It would be possible to specify a "best" chain of decisions in the sense that at each point an alternative is chosen that will mean maximum social efficiency:

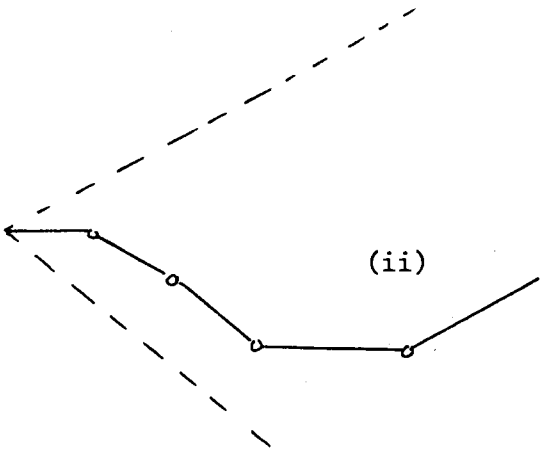


In practice such an optimal sequence may not be feasible and the outcome would look somewhat like the graph below. The reasons for not adopting the "best" decisions should be examined.[1/]



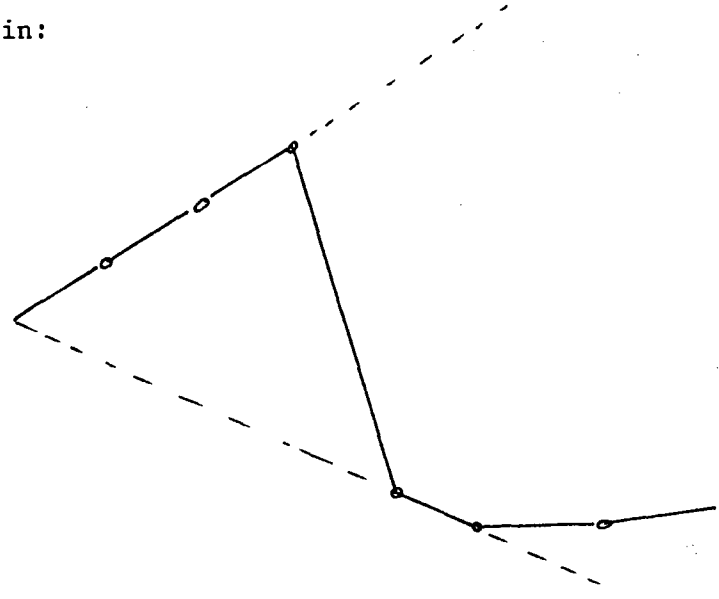
It is likely that it will be easier to achieve a higher overall efficiency of the complete investment project (once the decisional chain has been gone through) when the first few decisions are optimal. This is in line with the proposition in the literature that decisions taken during the preinvestment period largely set the stage for later decisions --the choice of a local consultant, for instance, would make it much more probable that the technology chosen will be more adequate, that local capital goods and other inputs are fully employed, etc. If this is correct, outcome (i) below is much more probable than outcome (ii).





1/ Some people feel that one of the main influences behind a near-optimal decision sequence is the positive attitude of the main actors -principally client and CEDO- and that without a favourable philosophy on their part it is easy to fall on decisions that maximize private efficiency but not social efficiency.

At some decision points the outcome of certain alternatives may limit the choices in later decisions and be strongly negative for social efficiency. This would particularly be the case with the election of the source of finance. A decision to accept supplier credit, for instance, would throw our sequence into a tail-spin:



6.2. Impacts on the actors that participate in a project

There has been in the literature a tendency to emphasize the effects on suppliers and on the development process. The effects on the investor or project-owner may be far from negligible, and in fact they may constitute the principal motivation to embark into the cost and effort required by forward-looking procedures to carry out investment projects.

(a) Effects on the investor

We may briefly indicate the following benefits to the investor:

- A first benefit may be forthcoming already in the short run, through a reduction in the costs of purchases, as efforts are applied to certain activities that may have been disregarded before --for instance, better-thought specifications, choice of more appropriate standards, simplification of product design to enable local producers to supply parts for it, better quality control, the search for new sources of supply, more frequent contacts with suppliers.

- By employing local consulting and engineering services, and by opening up the "technological package" in the case of an investment, the investor may be able to choose a better adapted technology, lower the cost of many items, supervise closely the construction of equipment and fixed installations, and decrease its vulnerability in future operations since it will be able to obtain locally spare parts, inputs and technical advice which it would otherwise have to import (with costly delays, possibly at a higher cost and with the risk of being left stranded if the foreign supplier has discontinued production, or if there is a balance-of-payments or political crisis). All this may mean a substantial saving in costs of investment and operation of the project in hand. The influence in this regard of a good technology choice and in general of an adequate process of technology transfer would be particularly important, as shown in Annex 2.
- Through the many efforts required, the investor and its local CEDO will undergo a learning process which is bound to increase the efficiency of production and maintenance operations, permit better investments to be made in the future, and help incorporate a stream of product and process improvements, some of which may originate locally. The cumulative effect of this learning process, and of a similar learning process in the investor's local suppliers, may be very important.

The magnitude of these positive effects will depend, among other things, on the situation before the new practices are adopted. It would seem that in many developing countries there are numerous Government agencies and enterprises, as well as private firms, whose investment practices may be considerably improved. Hence there are good opportunities to apply better practices.

There may be a number of drawbacks for the investor, principally higher prices and poorer quality of local supplies, the difficulties of financing local items, and the risk of technical failure and late deliveries. The latter stand behind the refusal of many State organizations to open up packages, rely on local engineering, and buy from local suppliers. It is likely that such risks have been exaggerated by public decision-makers in the past, resulting in the continuation of poor practices for too long. However, too sanguine an approach could backfire and should be avoided; there should be a careful and realistic appraisal of how far it is possible to proceed with forward-looking

practices at a given occasion, in the understanding that another step forward can be taken at a later date. By following a stepwise process of improvement the investor can build up solidly its technical competence and that of its CEDO, and develop a network of reliable suppliers. Some risks are however unavoidable, particularly when a certain supplier is given a chance to produce something it has not produced before. But risks are a part of economic life, and "he who does not risk does not gain".

Costs to the investor would include, first, those of building up internal technical capabilities and a purchasing organization. These costs rightly belong to the capital account since they mean an addition to the investor's technical and human capacity, which can be repeatedly used in the future. Second, there may be costs in using those new capabilities, in accepting higher prices, lower quality and late deliveries from local suppliers (but such things need not take place), in helping the latter financially and technically, and perhaps in bearing higher production costs because of the use of less efficient (but possibly more "appropriate") domestic technologies.

(b) Effects on suppliers

The positive effects on suppliers are rather obvious. They come, first, from an increase in demand for what they produce, particularly if the client switches from imports to local purchase. Second, from a more stable demand, that means a reduction in the fluctuation of the workload and a lower entrepreneurial uncertainty; such an effect would be felt particularly by suppliers of inputs at the production stage. This opens possibilities for applying resources and efforts for technological improvement, productivity increase, personnel training, and expansion of plant. A purchasing programme for some time in the future can sharply diminish uncertainty and can lower the level of idle capacity in the long run; these would be important effects on the efficiency of certain capital goods manufacturers that are usually subjected to violent ups and downs in their activity. Third, from tighter specifications that require a higher level of accomplishment and are key inducements for learning and technical progress. This is particularly the case when a supplier is asked to produce something it has not produced before. Fourth, from the support measures extended by the investor, and possibly by the central Government, principally credit and technical assistance.

One of the results may be that the supplier undergoes a learning process which leads to better technological levels and an enlarged market on account of being able to widen its range of products. Such a consequence is well known in developed countries, where a large number of technical innovations developed in relation with Government work in aerospace, defence and other areas have found their way into civilian applications. The supplier acquires a certain knowhow with the Government footing the bill, but is allowed and even encouraged to apply this knowhow to new products in other markets. In the developing countries the industrial branches involved will be much less sophisticated, and the knowhow will not usually come from original R&D but rather from technology imports, personnel training, engineering efforts and a sequence of minor changes and innovations. But the phenomenon is essentially similar. It can be clearly observed in mechanical industries supplying parts to manufacturers of automobiles, ships and other complex products, which have shown remarkable technical progress. It is possible through adequate purchasing policies to accelerate and orient this learning process; a good example is the role that French Government enterprises played through their procurement policies in developing the capital goods industry in France in the early postwar.

The effect on R&D institutions may also be significant. When an investment is made with strong local participation in the preinvestment and engineering stages, a number of requests for R&D work may be made to deal with various problems regarding the adaptation and improvement of technology. Other research needs may be identified in relation to production problems. If a local institution is engaged to carry out R&D on these problems, the institution will be getting involved with practical problems, a very welcome thing in developing countries where research institutions are notoriously isolated from production problems.

Suppliers may encounter a number of drawbacks in purchasing policies that are aimed at them, such as the possibility of very stiff conditions on the part of the purchasing organization (leading to low profits and even losses, "sweated labour", etc.), the strategically weak position of being principally, if not wholly, dependent on just one or a few customers, and the ever-present

possibility of a sudden drop or cancellation of orders on account of a change in policy, a not infrequent occurence in some developing countries in the case of Government organizations.

(c) Effects on other actors and institutions

When purchases are made from local suppliers they may produce effects on other parts of the economic system through market and non-market mechanisms.

A rise in the output of suppliers will produce demand increases elsewhere through the multiplier mechanism, and if there is not enough idle capacity in manpower and equipment to allow a corresponding increase in output, new investments may be carried out. All this would mean an increase in economic activity, employment and investment, to analyze which it would be necessary to count with an appropriate macro-economic model. A second type of effect, probably much more difficult to analyze, has to do with linkage effects, what the French call "effets d'entrainement", through which important changes in the industrial structure of the country may result in the long run.

The magnitude of the multiplier, accelerator and linkage effects would result from the orientation and magnitude of the investor's demand, at the investment and operation stages, and could achieve significant values when large investments are carried out, such as happened last century with railways and is today happening in oil-producing countries that have ambitious plans for developing their petrochemical industry. The opportunities for an enlightened policy about investments can easily be seen in such cases.

The above effects are in principle quantifiable. There are other effects, or externalities, not transmitted through the market, where quantification may not be possible, but which may prove to be even more important for industrial development in the long run. They should be explicitly considered and their mangitude should be appraised, if only by means of qualitative judgements, when investment programmes are being formulated. Among them we may mention:

- The favourable psychological impact of successfully employing local consulting engineers, disaggregating complex investments, relying on local technological developments, and utilizing local capital goods and other inputs in investment and production. This "demonstration effect" is potentially so important that a strategy for building up C&E capabilities and utilizing them for maximum

impacts on development should carefully select its initial activities so as to maximize the chances of success, and should devote efforts to propagandize the achievements.

- A number of technological effects may occur as human resources are trained, researchers' attitudes are improved, technical knowledge is diffused, and capabilities for problem-solving and for the improvement and generation of technology are reinforced throughout the industrial system. All this means a learning process sparked by investment activities, which may have important implications for an increase in technological levels, the use of more appropriate technology and in general a strengthening of technological self-reliance. A CEDO may fulfill a crucial role in this process by applying to different clients what it learns from its local activities, its foreign associates and its different contacts with technology owners, R&D centres equipment makers and information systems. In this sense an independent CEDO may help in the "socialization" of knowledge otherwise locked up within an enterprise.

6.3. Impacts on development

We have reviewed a number of effects that the appropriate use of domestic C&E capabilities may have on the investor, its suppliers and other actors, and ultimately on the pattern, rate and characteristics of development.

Impacts may be concentrated on certain activities where suppliers already abound, or can be set up, and this may promote the development of branches such as building materials, machine tools, mechanical components, etc. They can be directed to certain types of producers, according to the products that are bought, for instance medium or small enterprises in a certain region. Such decisions may be oriented by the overall industrial development policy.

Generally there has been a bias in Government policy favouring the importation of capital goods, through lower tariffs, cheap credits, etc. Economies of scale, however, are not too large in many different types of capital goods, or in certain products which may be efficiently put out by small-scale producers such as transformers, metal structures, certain building materials, and items requiring a large amount of manpower for assembly. The purchasing power resulting from a number of investments could be used to create

a demand for products where the economies of scale are not large and demand may be enough to achieve an efficient scale of operation, particularly if labour is an important input. It is also in these products that appropriate technologies may be developed and applied, lowering the scale of production and using more labour.

The effects on industrial development to which we have just referred impinge on certain branches, types of producers, and geographical regions where purchases may be concentrated. Other effects will be transmitted throughout the industrial spectrum by market and non-market mechanisms. Here we wish to underline the importance of the learning process, and suggest that to a considerable extent investment projects should be designed and conducted so as to have strong effects on it.

The outcome of learning is the increase in productive efficiency, the reduction of costs and the technological progress that will allow to develop new productive activities and eventually modify comparative advantages. Its influence on the characteristics of development is therefore very important. In developing countries emphasis should be put on the improvement and diffusion of technology, rather than on the generation of new sophisticated technologies as in some developed countries. Technology diffusion is an essential ingredient of industrial development policy, and the way investment projects are undertaken may be instrumental in fostering it in key branches of production. Research is needed on the ways in which this can better be accomplished.

Impacts on the activity of R&D, and on the utilization of R&D results, can also be very important. In fact, the results of R&D activity carried out in specialized institutions have little chance of being employed in practice if C&E activities are not applied to evaluating such results, finding possible uses, identifying clients and users, developing product and process designs that can be applied commercially, and in general carrying out the wide array of activities needed to transform a technical advance into a commercially successful innovation. Some R&D institutions have their own C&E departments, which may go under the denomination of "techno-economic services", "sales", "consultancy", etc., whose job is to link R&D activities with prospective users. In other cases the task may be done by an independent CEDO. In some large public enterprises in developing countries (oil, iron and steel, power) in-house R&D and

engineering departments work hand in hand to develop and apply new technology, and may enable new investment projects to be made with basic engineering of their own. At this stage a very high degree of mastery of technology will have been obtained.

The final impacts on development will be expressed in a change of structures and a modification in the values of macro variables such as employment, productivity, imports, qualified personnel, etc. Other influences will be at work so that the contribution of local C&E in investment projects may not be easy to ascertain. The stage of development of the country may be an important influence. In countries of incipient industrialization there may be few opportunities, while in semi-industrialized countries the scope will be much larger. Let us look at this more closely.

In several semi-industrialized countries the process of import substitution has go to a point where further industrial development is being blocked by a variety of reasons. The country does not utilize properly its industrial sector on account of high prices, late deliveries, quality defects, etc., which may be adscribed among other things to a process of industrialization that has not allowed a complete development of the engineering design and capital goods branches. It is frequently observed that much demand is diverted away from domestic industry because of the absence of an efficient capital market, lack of national standards, little confidence and little knowledge about the abilities of industry, and other structural and institutional reasons. At the same time industry carries out little innovation of its own, tending instead to import process technology and product designs.

It may be possible to help overcome such a blocking of industrial development through substantial and sustained purchases of industrial products from the enterprises that are more receptive to innovation and more able to profit from it. Such an impact may result from a conscious effort of managing investment projects in such a way that demand is generated for those enterprises, purchase specifications are carefully drafted, adequate prices are agreed, flexible contracts are signed, financial and technical support is provided. In such a case the positive effects will not only come from the increase in demand and its repercussions throughout the economy, but

will also derive from the technical progress that suppliers will be induced to make in order to respond to increasing technological requirements, from the widespread learning process that such technical progress will cause in other parts of the industrial system, and from the restructuring of relations between public enterprises, foreign and national private enterprises, R&D, financing organizations, and the Government.

We have referred so far to the positive impacts that may result from adopting forward-looking procedures in investment preparation and design, which hinge on the development of domestic C&E capabilities and their proper utilization. On the other side of the ledger, there may appear a number of drawbacks and costs in following this approach.

We have already indicated those that fall on investors, suppliers and other actors; in addition these are others which would amount to definite social costs:

- Monopoly situations may have to be accepted in certain C&E areas and in certain types of products, since the domestic market may be too small.
- Inefficiencies may result because of the virtual protection awarded in some cases, and the low productivity of favoured small enterprises, regional activities, and suppliers employing technical solutions that end up costing more or simply failing.
- Conflicts may appear between different Government agencies, enterprises and departments; for instance, when a Government enterprise invokes reasons of urgency to avoid regulations in favour of local supplies. Such conflicts can be damaging to the parties involved.
- There may be retaliation by other countries that see their exports go down when Government decides to rely on local suppliers. This, however, would not seem to be a grave danger as it is in the case of straightforward protection.

6.4. Procedures and decision models

The achievement of maximum impacts from investment expenditure would require a programming of purchases in the medium and long term, after a careful disaggregation of the projects and a study of local supply possibilities, including new products that were not manufactured before. Negotiations may be conducted with the primer contractor and the local subcontractors in order to arrive at supply programmes that are progressive but feasible, particularly if there is a succession of investments in which the proportion of local inputs is constantly being increased. If impacts are to be maximized on suppliers, consideration should be given to the demand of other public and private investors on the same goods. To achieve best results the planning of purchases should be made in concert with the supplier branches.

As a working method, it is possible to apply a distinction adopted by Argentina's Atomic Energy Commission. The required supplies can be classified under three headings: positive list (the items are already being produced with the required quality at acceptable prices), negative list (it is not possible to produce them locally) and probable list (production may take place if several problems are overcome, such as small local market, quality, safety). Efforts will be principally devoted to the probable list, and will require a decided action of supplier development. It is also possible to apply the concept of supplier development to the case of technological inputs; action would be taken not on productive firms but on consulting and engineering organizations, research institutes and other organizations of the science and technology system.

Similar procedures may be used in the stage of operation of already installed capacity. But the difficulties will increase since the project-owner, now a functioning enterprise, will be dealing with many supplier units, especially if the latter are small or medium-size. There must be a development of adequate administrative procedures to construct effective purchasing system, through which the enterprise may carry out a truly active purchasing policy including technical, financial and training assistance to its suppliers.

In relation to models and rules for deciding about local procurement, little is found in the literature. In principle the investor should make a long-run evaluation and attempt to get its private maximum return, or ideally a maximum social return if it wishes to go beyond the limit of its investment or production activities. It is not easy to implement this in practice.

There have been in France some interesting attempts at constructing formulas for the pricing of local inputs under different conditions, and it would be useful to analyze such solutions in detail.

In relation with the installation of the second atomic power plant in Argentina, G. Gargiulo has analyzed the acceptability of higher local prices (as compared to imports) for components that may be locally manufactured. Local purchasing induces the expansion of productive capacity, a higher quality, more diversification of production. Local production of components has micro-economic, macroeconomic, social and technological effects that should be identified and quantified. If the component is already being produced locally, with sufficient quality, the purchasing decision is based on a comparison of the local and the import costs, with due regard to existing incentives and protective tariffs for local production. If the component is made locally but with not enough quality, or if it is not yet made but could be manufactured, the indirect benefits brought about by local production should be taken into account. If local manufacture is to take place, an increase is needed in the technical capabilities of the supplier - in equipment, technology, training. This produces benefits to the firm (over and beyond those that come from an increase in output) and may be estimated by comparing the benefits the firm would obtain if its technical capability increased according to the historical rate and those resulting from the much faster increase, during the time needed for the first to catch up with the second. On the other hand, in addition to the costs of producing the component there are costs occasioned by the sudden increase in technical capability, from which should be deduced the discounted costs that would have been necessary to reach this level of technical capability if the historically defined path were followed. The author adds that the valuation of costs and benefits requires the definition of quantifiable indicators and the solution of the price system that should be applied. He lists several

indicators referred to the above costs and benefits, and concludes that it should be possible to develop and use a system for evaluating what extra prices may be paid for the local supply of an item required by the investment project.

We still know far too little about the practical aspects of heightening and transmitting the impacts of investment activity. Many positive experiences have taken place in developing countries and no doubt the practices currently employed in some industrial countries may also be valuable as examples. There is here a clear research need to identify and analyze successful cases and evaluate the procedures and decision rules employed, from which guidelines may be prepared for the benefit of developing countries.

7. THE EFFICIENCY OF INVESTMENT ACTIVITY

Let us suppose that an investment project is being carried out and that we may assign a certain index of efficiency, which will somehow relate costs and benefits, to the way this is done. Leaving aside extraneous influences, such as graft and political factors, we may expect the investor to attempt to maximize the efficiency of its investment activity, i.e. obtain what it needs at minimum cost, good quality, etc. The question to be asked is whether in practice this is achieved.

If we examine an actual instance in a developing country, we may conclude that this is not the case. The way the investment is conducted may respond to very limited short-run objectives of the organization and may be up against various limitations and constraints -for instance, unwillingness to assume risks, lack of qualified technical advice, very imperfect information about alternatives, restrictions imposed by outside finance, etc.- so that a foreign CEDO is employed and the project is carried out in a turnkey manner.

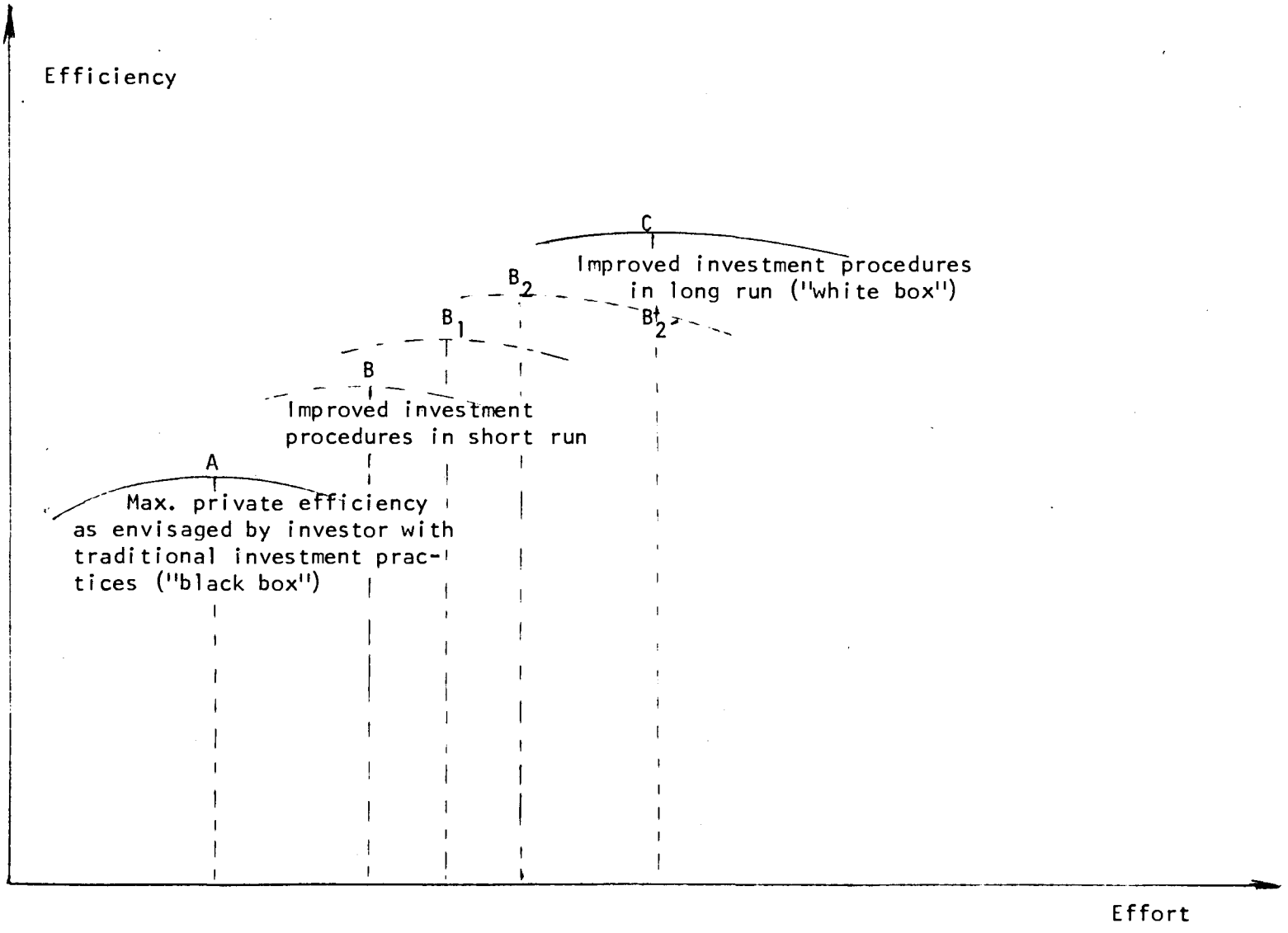
It is likely that if a long-term outlook is adopted, internal limitations are eased or removed, and a certain amount of effort is applied --in other words, if improved procedures are employed for project formulation, design and execution, involving a domestic CEDO at all stages in a responsible role-- a better efficiency may be attained through the positive effects we have reviewed in the previous section.

Extra efforts applied by the investor and its CEDO to the investment activity will produce an increase in the private efficiency of the activity, that is, on the relation of the benefit reaped by the organization itself to the extra costs it must bear. The efforts will have a more than proportional return until an optimal point is reached, where more efforts do not pay. The investor may get to a new optimum in a reasonably short period of time, by acting on aspects that can be modified rather quickly, to which we have referred already. If given a longer period to build up internal capability, undergo a learning process, improve its purchasing procedures, set up a network of reliable suppliers, etc., and particularly if during this period there is an adequate development of one or more domestic CEDOs on which the investor may rely, a further improvement may take place as a succession of investments are carried out.

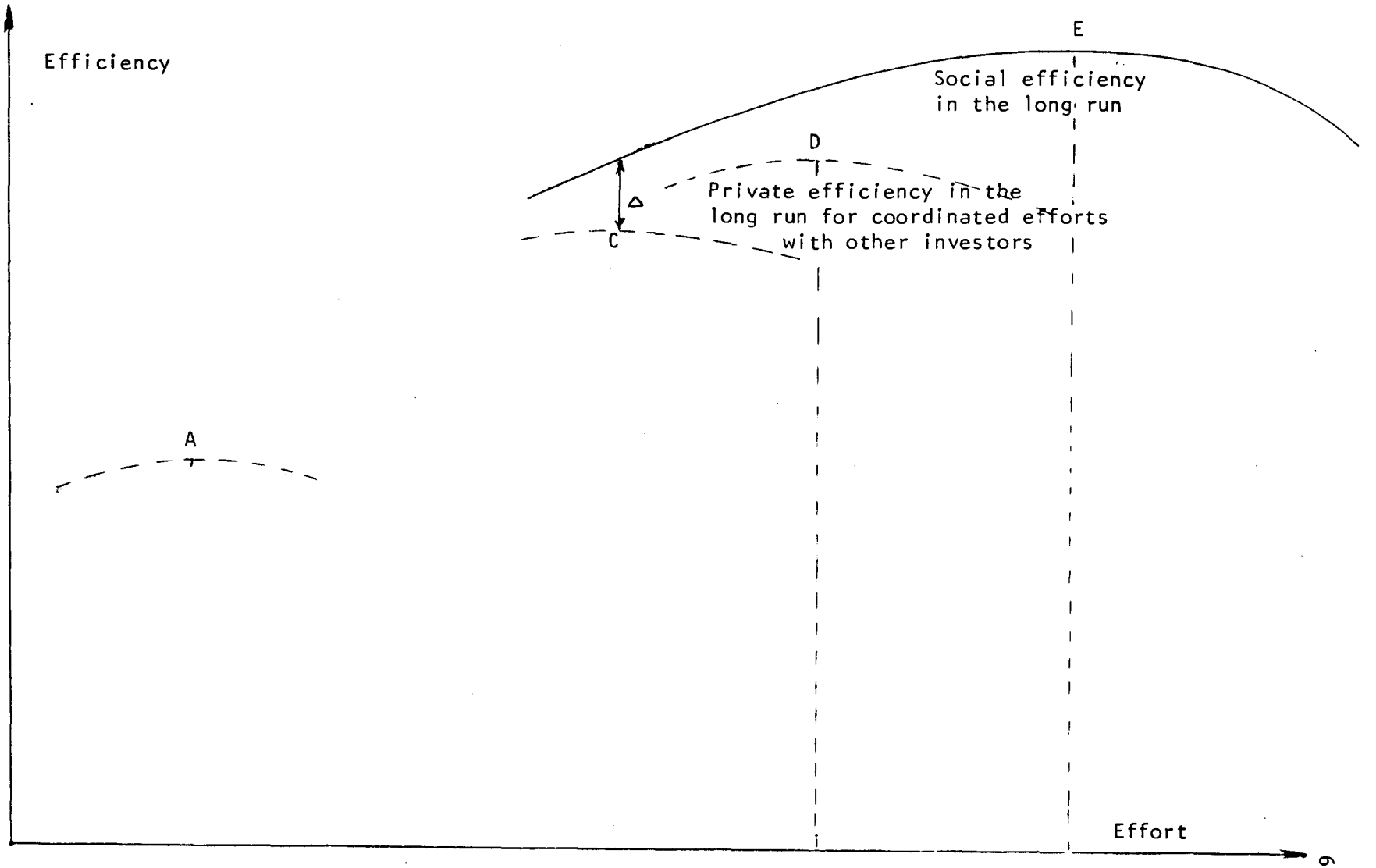
These situations may be represented in a graph in which efficiency is plotted against the effort spent by the investor and its CEDO on investment activities. (See Graph 1). To start with the investor is applying a moderate effort and obtaining an efficiency (private) which it regards as maximal (point A), feeling that extra efforts are not warranted and may even be strongly counterproductive. This would be the turn key or "black box" situation. But changes in attitutdes, a more long-term view, the increasing use of local CEDOs and improved purchasing procedures may allow it to reach a higher maximum of efficiency in a relatively short time (point B) and an even higher maximum in the long run (point C). The successive maximal positions between points B and C will be attained gradually along time in successive investments, as learning proceeds and various effects are worked out. The process is that of going from "black box" to "white box" through a succession of "grey boxes", each of a lighter shade than the previous one.

Point C would be the optimum from the private point of view in the case of an investor that makes his decisions according to long-run considerations. But an additional increase in efficiency may result if efforts are joined with other investors --this is a distinct possibility in the case of public enterprises-- so that CEDOs can accelerate their learning process, specifications are unified (particularly in the design of peripheral installations), product varieties reduced and larger consolidated purchases carried out at lower prices. In this way the optimum may move to D (Graph 2), though in practice it does not appear easy to coordinate activities and unify criteria and purchasing mechanisms.

Up to this point we have been referring to the efficiency within the investing organization, that is, its private efficiency. Meanwhile, what is happening to social efficiency? In a developing country there is the likelihood that due to the divergences between social and private costs, and to the effects produced on the suppliers and on other actors via the market and the positive externalities, social efficiency may be higher than private efficiency. It may be suggested that social efficiency can be strongly enhaced if certain "best


Efficiency
C
Improved investment procedures in long run ("white box")
B2
B1
B
Improved investment procedures in short run
A
Max. private efficiency as envisaged by investor with traditional investment practices ("black box")
Effort

GRAPH 1


Efficiency
E
Social efficiency
in the long run
D
Δ
Private efficiency in the
long run for coordinated efforts
with other investors
C
A
Effort

GRAPH 2

practices" are actively followed in investment activities, so that it would be desirable to proceed further with the efforts until a social optimum E is reached, where social efficiency would be highest. This may require incentive mechanisms of various types, so that the extra costs of going beyond the private optimum will be borne by the community at large rather than by the investor.

The model of analysis we are suggesting is conceptual and qualitative, and it would not be easy to express it in quantitative terms. The graphs therefore have a heuristic character; but they suggest a number of things.

We may expect that in a developed industrial country investors will have already learned to invest well, and that social efficiency is very close if not equal to private efficiency. In such case, points A, C and E will more or less coincide. Ideally, organizations in these countries would not need any additional efforts to improve their investment practices.

But this is not so in developing countries; and it is important to ask in a specific situation questions like: How far is the private maximum (point C) from the original situation (point A)? How many steps would it take to reach it, and what is the optimum path (through the stages indicated by points B, B_1, B_2, etc.)? How higher is social efficiency than private efficiency at point C (represented by the distance $\underline{\Delta}$ in the graph)? How higher is social efficiency at its maximum point (point E)?.

A first observation that has strong policy implications is that the point of maximum private efficiency may be reached by the investing organization without any other incentive than its self-interest. It pays the organization to increase its efforts up to that point. From the policy point of view, there appears a need to teach investors how to improve their ways to achieve this goals.

Now, if the increase in social efficiency from the original position to that corresponding to point C is very high, this would mean that a great deal could be accomplished without having to oblige the investor to follow certain compulsory practices, or appealing to its social or patriotic spirit; it would be enough to show that it stands to profit from following certain enlightened practices. Further social benefits could result from accompanying Government

measures to help suppliers through training, credit schemes, a measure of protection, etc., so that the social optimum could be approached quite a bit without having to ask the investor to go out of its way and do something contre-coeur.

To get to its point of maximum efficiency, the investor would have to:

- Modify its previous attitudes, plan its strategy for carrying out its future investments, study the possibility of using local technology, engineering, capital goods and inputs;
- Improve its technical and management structures to make them able to carry out the expanded tasks involved in opening up the "package", dealing with local CEDOs, perhaps developing its own project formulation and engineering departments ("captive" CEDO) and R&D groups.
- Develop and adopt adequate methods of analysis and decision rules to deal with the various activities involved in an investment project, particularly in regard to purchasing decisions.
- Externally, it should assist its domestic suppliers financially and technically, so that their efficiency and technical level may increase; it should also schedule its purchases far in advance and make this known so that suppliers will have firm expectations regarding the type of purchases and their timing, a fact that will reduce uncertainty and induce them to invest in physical facilities, training, technological improvements, new technology, etc.

The maximum private efficiency that can be reached would partly depend on internal factors --for instance, the technical and managerial level, the correct appraisal of real risks-- and partly on factors of the environment, among them, coherence of policy, stability, etc. Countries which are well organized, and stable organizations, will reach higher levels of private efficiency in investment activities. The same will happen in the public sector in so far as all Government organizations are managed as a whole, with a general rationality rather than a scatter of partial rationalities. In a market economy with relatively autonomous decision centers more efforts will be needed, and incentives will be required to compensate extra costs in each organization that is being influenced.

Care must be taken not to rush things too much without adequate preparation, trying to achieve too soon a high level of incorporation of domestic technological assets and services, or of domestic purchases, since the organization may find itself in the descending part of the curve (point B_2). It is necessary to understand the limitations that exist; time must be given for the learning process to produce results that are incorporated in successive investment projects, so that progress is achieved by stages. An important question is how far to go in each stage -for instance, what percentage of local participation may be sought in successive investment projects.

8. THE CONSULTING AND ENGINEERING DESIGN ORGANIZATION

This section examines some issues that have to do with the characteristics of a CEDO in its "mature" state and the process through which it arrives at that state.

CEDOs can be very different and it is not easy to make general statements about them. They differ in the way they originate, which may affect significantly their later development and characteristics,[1/] and in many other things. What makes them comparable is that they have to carry out certain activities concerned with the organization and application of knowledge, and that they must acquire the resources and abilities to perform those activities in an efficient way.

We suggest that a CEDO, like other institutions, develops in time until it reaches a situation of maturity, or "steady state", in which it is reasonably well equipped with human, physical and intellectual assets, has achieved sufficient size that allows it to perform efficiently, has stable relationships with its environment --clients, suppliers, Government, Banks, other CEDOs local and foreign-- and as a result of this is able to fulfill efficiently its social role.

The problematique of a mature CEDO is somewhat different from that of a CEDO in its developing stage, since one of the main imperatives of the latter will be to achieve the mature stage and this may need special measures of support by the public authorities. Hence our considering separately both stages. When a macro view is adopted, policy issues will be different in sectors where there exist mature CEDOs than in those where CEDOs are developing, and the same may be said of countries as a whole. International cooperation between CEDOs will also acquire different characteristics according to the "maturity" of the weaker partly.

Let us now make a brief exploration of the above points.

1/ This was discussed extensively at the Corfu meeting in 1976, where a typology of "emergency patterns" was considered ranging from professionals getting together and looking for clients, to a building firm that branches into C&E services, to the carefully planned creation of a large C&E department by a large production enterprise.

8.1. The CEDO in its mature state

Graph 3 presents in outline the elements that should be examined when styding the mature CEDO.

We suggest that the performance of a CEDO should be measured by its social efficiency. We may define this parameter as the impact on national development in regard to the resources employed.[1/] It is not easy to measure SE in a cardinal scale unless simplifying assumptions are adopted, so that it may be necessary to employ an ordinal scale, as happens with other complex social variables.

An observation here is that one should be careful with the indicators of "success" that are sometimes used, since they may not adequately reflect SE; for instance, the fact that a CEDO is profitable, or shows a good rate of growth, is a good measure of its commercial success but only a partial indicator of its social efficiency.[2/]

What influences social efficiency? We suggest that SE depends on the adequate performance of CEDO activities, which we group into three main categories: determination of the products to be produced; production; distribution. In these activities we will seek, respectively, a maximum social utility of the products, a maximum productive efficiency, and a maximum distribution efficiency. The better a CEDO performs in these respects, the better its SE.

These activities will themselves be influenced by internal factors that come out of the characteristics of the CEDO. Some of these characteristics may have evolved in response to needs posed by the activities carried out by the CEDO.

The characteristics of the milieu or environment in which the CEDO exists influence the structure and characteristics of the CEDO, and its activities. CEDOs sometimes try to change external conditions so that they are more favourable to them; for this they unite in associations of a national or

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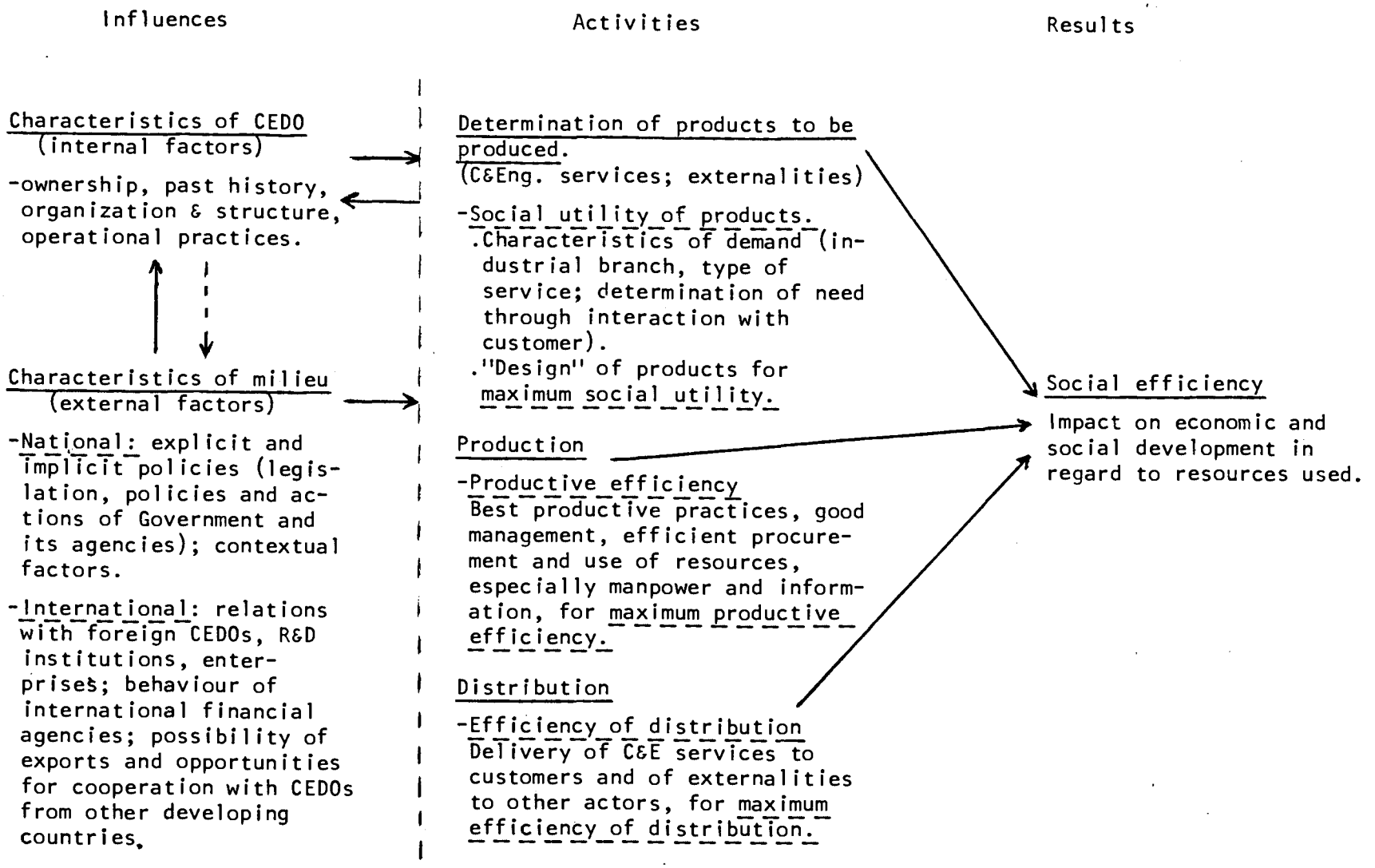
1/ The concept is related to, but different from, that of social efficiency of the expenditure on an investment project to which we have referred in the previous section.

2/ To give extreme examples, the Red Cross probably has a large SE but is not profitable while exactly the opposite happens with the Mafia.

GRAPH 3

THE CEDO IN ITS MATURE STATE



international scope. They also may carry out a dialogue with national authorities and with international agencies.

Let us now briefly examine these aspects.

(a) Determination of products to be produced

Here the rule would be that, within its field of work, the demands of its clientele, and its production possibilities, the CEDO should aim at selecting its products, and "designing" them, in such a way that their social utility is highest.

A CEDO produces consulting and engineering services that have a value for the client, but the utility for society may be different, since the set of prices that is relevant socially may be different from that which is relevant privately, and other costs and benefits may appear elsewhere in society on account of the impacts and externalities associated with the rendering of C&E services and their use by the client.

Such discrepancy is probably not too large in a country with a well-functioning market mechanism and a high level of industrial development, but the situation may be very different in a developing country where externalities are likely to be an important part of social utility. This is a hypothesis that would need to be carefully tested, but there seems to be much evidence already in its favour.

We have already referred to the role of a CEDO in a developing country for preparing and implementing good projects and thereby promoting technical development, the expansion of the capital goods industry, the circulation of information, the use of research results, etc. The CEDO should not only do a good technical job, but should carry it out in such a way as to produce long-run favourable impacts on the investor and also on other social actors so that maximum social benefits are derived from the task. The aim should not merely be "to get the job done". Hence, we suggest, the "design" of the product includes two parts: consulting and engineering services as regards the strict needs of the project, and long-run impacts on the client and on other actors.

The problem, of course, is that the extra costs and risks of designing for maximum social impacts are to be borne by the client, while the benefit brought about by those impacts may be capitalized by him only in part. It may then be necessary to provide incentives that will induce a socially desirable course of action. This may range from a strong motivation on the part of the principal actors, the CEDO and its client, to pressures by Government (which can be expressed in legislation, such as some countries have adopted in relation to their public enterprises) and monetary inducements. The obstacles from risk-averting attitudes, lack of confidence in domestic inputs, and other reasons, may be very strong and this may need a reinforcement of such incentives. Clients of CEDOs should be studied before policies are designed for influencing them.

A number of issues may be brought up in regard to the social utility of the CEDO products. The first one is how to measure this variable, and here our comments above for the case of social efficiency are relevant. What weight shall we give to long-term impacts vis a-vis short term ones? It is likely that this whole matter can only be discussed properly within the framework of a development plan.

Other issues have a more operative content. Can we suggest certain practices that may be applied for maximizing expected social utility? What guidelines may be derived from the experience of the CEDOs in the developing countries? What internal characteristics (for instance, national or foreign ownership of CEDO) help or hinder a high social utility? What policy instruments are best to promote maximum social utility? Research is needed to answer these and other questions.

(b) Production

The CEDO should attain maximum production efficiency; the "production" programme resulting from the previous point should be executed in minimum time and cost, with adequate quality and reliability. This is obviously an important objective for a CEDO, and is a necessary though not sufficient condition for maximum SE.

There is much diffused knowledge about CEDO production but not too much has been written about it, and even less in the case of developing country CEDOs. Here is an important field for research, which goes well beyond the usual "management" problem on account of the peculiarities of a CEDO. One of these peculiarities is the nature of the principal inputs used by a CEDO: (a) high-level human resources, and (b) knowledge, technical know how, information of many kinds. The management of these resources is not simple; the current management literature is of limited value here. This is particularly so in the case of a developing country where problems are more acute.

The questions we may want to ask about the procurement and management of human and knowledge resources would make up a very long list. For instance, in the case of highly qualified personnel: what sort of professionals should a CEDO recruit? What training should they be given and where? How to make an efficient team out of a collection of individuals? How fast can this team grow by incorporating new members with little disruption of the efficiency? How far can the CEDO meet on its own the challenge of developing a new team? When is it better to rely on an association with another more experienced CEDO?, etc.

It is on questions of productive efficiency that the experience of the CEDOs of industrial countries, and the literature from these countries, is more pertinent. This is to be contrasted with questions about the determination of products, and about their distribution, where the peculiar conditions in developing countries and the nature of the role of their CEDOs would seem to call for fresh approaches. While in the industrial countries the well-structured socioeconomic context largely reduces the problem of a CEDO to that of attending the expressed needs of the client and attaining a high productive efficiency, in a developing country the situation is much more complex and the optimum social efficiency cannot be reached by acting only on production. The two other groups of activities require much attention, and often the CEDO will have to surmount adverse characteristics of the milieu.

(c) Distribution

It is not enough for the CEDO to produce efficiently products which possess a high social utility. It is necessary that those products should reach their users at the appropriate moment, in a form that will respond to their needs, and that they should be presented appropriately so that they may be employed by them. In this way the CEDO makes sure that the results of its production activity will receive proper utilization and hence that the promised social utility will indeed materialize. This is the problem to be considered by the activity of distribution.

In a highly industrialized country the problem is not acute. Clients are able to state very precisely their needs for C&E services, and have their own technical structures to absorb efficiently what the consultants give them; the market mechanism takes care of most if not all of the impacts on development of C&E services, true externalities being probably of small magnitude.

Instead, in a developing country there is a danger that the client will not ask for the type of C&E services he needs, that he will not absorb well the C&E services for want of a technical capability of his own, and that the potential externalities of the CEDO's work will not completely materialize if the actors that might benefit are not aware of opportunities or are not capable of seizing them.

To avoid such outcomes, a good "delivery system" is needed. This requires the CEDO to forge good links and play an active role in regard to clients and to receivers of impacts.

With respect to clients, the CEDO may carry out an activity of marketing its services, and will have to overcome barriers such as unfavourable client attitudes, lack of a common language, lack of economic incentives for inducing the client to contract with a local CEDO and utilize a high proportion of local inputs, etc. The CEDO may have to educate the client and help him to consolidate a technical group of his own.

Regarding other actors in society that may receive benefits from the CEDO's activities, the CEDO should ideally go beyond its strict duty of providing C&E services and engage itself in a larger task of identifying those actors and of convincing and educating them so that they may profit from the opportunities opened up by C&E activities. For instance, the CEDO may look

for research centres and capital goods firms that may supply certain inputs specified in the project report, show them the opportunities they have, talk them into presenting a bid, pass on to them relevant information and in general help and even push them along.

In this way the CEDO may round out its social task. The problem is in how far are CEDOs prepared to do such things on their own, obeying their own motivation, since this activity is costly and time consuming.

We have suggested that the CEDO should aim at a maximum efficiency of distribution, and a first issue here is how to measure this parameter. Other issues come up on the theoretical and the practical planes. What are the best ways of assuring the "distribution" of impacts and externalities? What inducements can be given to the CEDO? How does a CEDO learn to carry out an efficient distribution? Can the client, correctly motivated, help significantly in this?

(d) Characteristics of the environment

The characteristics of the national and international environments in which the CEDO and its clients exist and operate will affect significantly the CEDO's internal characteristics as well as its activities.

The list of such external factors may be very long, and their relative importance will vary with the country and the moment of time. We may classify them as follows:

(i) National environment

- Legislation, policies and actions of the central Government and Government agencies (particularly those that finance development projects) which may affect the way in which the CEDO performs its task, the demand for CEDO services, and the utilization of the latter. We may distinguish explicit policies, which are expressly designed to affect CEDOs and their activities, and implicit policies which are directed to other institutions and activities. Among the problems encountered by CEDOs that hinder their work are the instability of demand, the lack of financial strength and the competition from foreign CEDOs; if conditions are to be improved, implicit policies may have to be changed and explicit policies formulated and

implemented. For instance, regarding demand instability, the implicit policies contained in the growth and pattern of public investment should be examined since slight changes in timing may mean the survival of certain CEDOs; on the other hand, it is possible to set up a fund with which a countercyclical policy is carried out by awarding contracts to CEDOs for performing long-term studies when there is not enough work stemming from investments.

- Contextual factors that affect or limit the performance of CEDOs. While the factors dealt with in the previous point may be changed by modifying legislation, policy, procedures or decision rules, contextual factors are not changed by ukases but through processes that may take a relatively long time, and therefore they are to be assumed as fixed in the short run though some of them are modifiable in the medium term. Among them we should highlight the attitude of clients, principally the public sector, towards the use of domestic C&E services, technology, capital goods and inputs. Perhaps the most serious obstacle to CEDO development resides in the cautious, risk-averting attitudes of decision-makers which make them opt for foreign suppliers. Other contextual factors relate to the administrative practices in Government procurement, which are often heavy and cumbersome; the technical capabilities of clients, often low; the understanding in Government and political circles of the importance of having strong domestic and engineering capacity and using it, which is frequently missing; the quality of University graduates which a CEDO recruits, which may attain a not too satisfactory level in some countries, etc.

- CEDOs need not accept with resignation the limitations and negative influences resulting from such causes. They may carry out a steady and tenacious action to modify conditions in their favour, influencing their national environment in different ways. Such action may be directed towards Government, seeking changes in legislation and practices, suggesting new measures, building up a favourable image; towards clients, even to the point of helping them to create an internal technical capability of their own; towards universities, research centres, industry and the public. Some of these actions may be done

individually by a CEDO, others through associations of CEDOs at a national or even international level. It would be important to make an empirical study of these actions in order to find out about their nature and effectiveness. Ideally they should not just be means to make life easier, obtain protection and augment profits, but should constitute part of an ample dialogue with Government, clients and other institutions with the aim of improving the environment so that the CEDOs may fulfill their potential social rule.

(ii) International environment

- Non-national organizations may affect the performance of CEDOs by influencing their internal characteristics, behaviour, choice of roles, determination of products, production activity, distribution activity:

  . Foreign CEDOs may be strong competitors in the national market, and the local CEDOs, by virtue of the usual selection procedures applied by clients, may find themselves unable to break a vicious circle in which lack of previous experience precludes them from getting contracts that may give them experience. This subject properly belongs to the developmental and not the mature stage of a CEDO; but even in this last stage it is likely that a certain measure of protection should be given to most CEDOs in LDCs since foreign CEDOs may have strong advantages from the financial backing and export subsidies of their countries, and from their proximity and familiarity to owners of technology and producers of capital goods. On the other hand, a foreign CEDO often associates with local CEDOs for certain assignments. In such cases, there is the danger of the local CEDO becoming the junior partner, without participating in the main decisions. This should be avoided and, furthermore, associations with foreign CEDOs should be employed for gaining experience, training staff and obtaining information; this may be amenable to regulation by the receiving country.

  . Regional and international development Banks and financial agencies may be important funders of large development projects and as such their policies and practices have an influence on domestic CEDOs. The record shows that these agencies have principally wanted to "get the job done"

though recently some of them have shown interest in using their loan operations as an opportunity for fostering the development of national C&E capabilities, a trend that should be encouraged by LDCs through their policies and by concerted action at international forums. The behaviour of international development banks is often imitated by domestic banks and this gives more urgency to the redressing measures that can be taken.

. Other foreign entities may be the source of important inputs; for instance, R&D centres, information systems, capital goods manufacturers, manufacturing firms, etc. The CEDO should maintain a network of relationships in order to have "on tap" information, experts and other critical inputs.

- Some large CEDOs in certain developing countries are already exporting their services to other developing countries, and sometimes they cooperate with CEDOs in the latter for sale of their services abroad. These markets may expand significantly in the future by reason of lower costs, more appropriate technical solutions, a better understanding of conditions in the receiving countries, etc. One of the principal issues here is whether it is possible to keep such operations of technology commerce free from the drawbacks that similar operations between developed and developing countries have had in the past, and furthermore, whether such operations may be endowed with certain characteristics that would give them positive social impacts in the receiving country by creating domestic demands for goods and services, contributing to the domestic development of skills and technical capabilities, and other desirable effects. This would fall under the subject-matter of "technical cooperation among developing countries" (TCDC) and may require positive guidelines expressed in international agreements, and incentives for operations that comply with them.

(e) Characteristics of the CEDO

A mature CEDO would be expected to have acquired a mastery of the technology of consulting and engineering, and a reasonable degree of competence in the technology of the area or areas it attends, which can comprise a wide range from intimate knowledge about equipment suppliers to the possession of

knowhow with which basic engineering designs may be prepared. For this it should have acquired a certain size, good management procedures, organizational knowhow and other characteristics that will allow it to perform its role as best as possible and maximize its social efficiency, given the products it will put out, the way in which it will produce and distribute them, and the influences to which it is subjected by its environment. These questions do not have univocal answers, but it is likely that some general patterns will be identified through a study of mature CEDOs in different sectors and countries.[1/] Such patterns will probably be somewhat different from those that obtain in developed countries' CEDOs.

The characteristics of a CEDO will be influenced by several groups of factors: its ownerships; whether it is captive or independent; the environment in which it grew and operates; its past history, starting from the original objectives and circumstances at birth and culminating in the most recent events; its activities and the sector or sectors it attends, which contribute in moulding the internal characteristics and in their turn are affected by the latter; and finally the policies and practices adopted by managers and senior staff members, volitional factors that find expression in the choice of the role, structure, strategies, etc.

The CEDO will try to further consolidate itself in human capacity, physical installations, knowledge resources, etc. and at the same time will attempt to better its relations with the environment, even to the point of acting on the latter to improve in its favour certain characteristics that will allow it a higher productive efficiency. Both efforts will take place concurrently, or in an iterative process in which the sequence will be dictated by circumstances and opportunities.

In regard to the modification of aspects under the CEDO's control, we may ask: how the adequate orientation is reached given the peculiar characteristics of the envirnoment; how is a good human team consolidated; how is the

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1/ Successful CEDOs in India show characteristics such as: good management; tendency to recruit the best people and pay them well; acceptance of risks; good marketing; support from Government or political sectors to obtain key contracts during their first few years of life; flexibility and willingness to go into new fields; agreements with foreign CEDOs; disaggregation of C&E services until only basic engineering is purchased outside; offer to the local investor of a complete package from conception to startup as well as technical services at the operating stage.

work organized to create a climate of productivity, responsibility and participation; what forms of motivation may be used for creating and maintaining positive attitudes in the staff; what administrative organization is best for the role and objectives; how are technical and financial results to be appraised.

In the case of characteristics strongly influenced by external factors, the CEDO may do much to modify those factors or moderate their influence. This action directed towards the "manipulation of the environment" is possibly an important difference between CEDOs of developing countries, which must modify a hostile environment, and CEDOs of developed countries which find a favourable or at the worse a neutral environment. It is worthwhile to ask what perception does the environment have about the CEDO and viceversa; how are stable and useful links forged with the various social actors; what role can the CEDO have in the formulation of sectorial development plans; what minimum size should the CEDO have, in general as well as in its various technical areas, for adequate efficiency, given the type of work it will be doing which itself will depend on the development of the sector or sectors it attends; what structures should it have to withstand the ups and downs of demand so common for C&E work in developing countries (for instance, a relatively small stable staff and an ample roster of collaborators that can be drawn into projects as and when necessary).

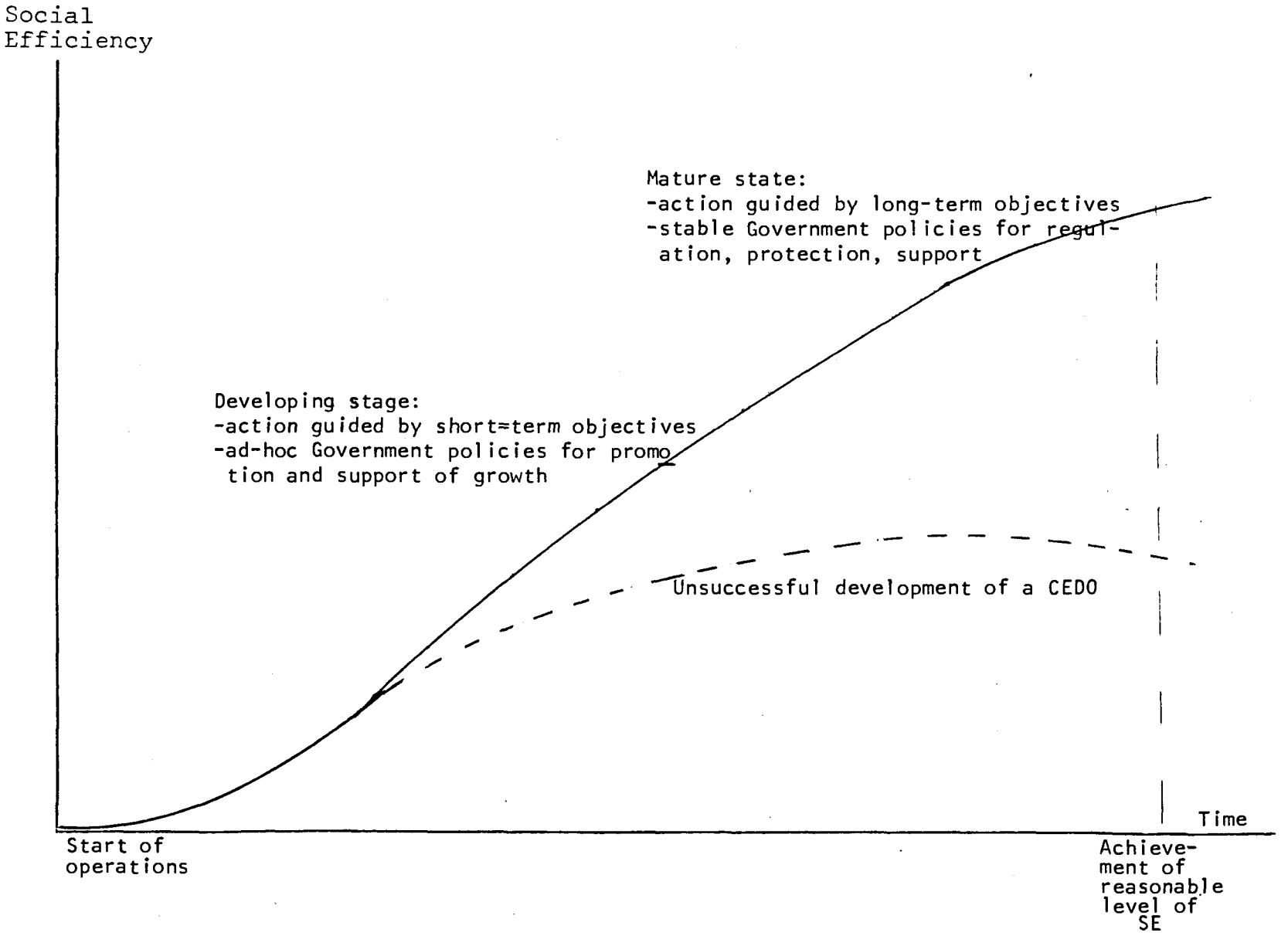
8.2. The development of a CEDO

A CEDO may emerge in many different ways, and its development along time until it hopefully reaches maturity may show very different characteristics according to its origin, ownership, captivity and sector of activity. There are however a number of aspects and issues which would seem to be relevant for many differente types of CEDO, and which it is worthwhile to examine.

(a) The development process and the obstacles to it

The process of development of a CEDO until it acquires maturity is bound to be gradual and may ideally be represented by a "logistic" curve as that shown in the following graph, which shows the increase in social efficiency as a function of time.

THE CEDO IN ITS DEVELOPING STAGE



The final goal of this process is the achievement of a mature state (or steady state) in which the CEDO will function at a reasonable level of social efficiency. In this situation, the CEDO will have its own strength and impulse so as to face future challenges, undergo change, and continue its expansion, its action being guided by long-term objectives, with the support of stable Government policies.

During the developing stage the CEDO will principally guide its actions according to concrete, short-term objectives, the main purpose being to get to the mature state. Ad-hoc Government policies may be required for the promotion and support of this process. The time needed to complete the process and reach maturity will be variable and will much depend on the support received by the CEDO and on the characteristics of its environmental situation. Important questions for research are whether some indications may be obtained regarding the length of the maturation period for different types of CEDO s and national situations, and in how far this time may be shortened through adequate measures.1/

The development of an independent CEDO in a developing country finds many obstacles, due to the nature of its activities and to the environment in which it acts. Consulting appeals to people who like to work independently, a characteristic that may not help the formation of large CEDOs. Finance is hard to come by; equity capital is scarce for C&E activities, and financing tends to be expensive. Tardy payments when a job is done for the State puts a strain in CEDO finances; competition and downturns in demand mean a high death rate. A small CEDO may be caught in a vicious circle: it cannot get the large assignments it needs to grow because it cannot show qualifications since it

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1/ Some CEDOs will never get there and will remain at a low level of social efficiency, or will eventually disappear. This may not be disastrous from the social point of view since the principal assets of a small CEDO are its human resources, which are bound to find new employment in other CEDOs or elsewhere.
It may be otherwise with a mature CEDO which has important intangible assets in its organizational know-how and experience, contacts, clientele, access to technology and information, etc., much of which will be lost if the CEDO disappears.

has not had large assignment before. Even when experience has been acquired, for instance by working for some time as a subcontractor to a large local or foreign CEDO, other obstacles persist in the shape of legal and administrative requirements such as the need for offering financial guarantees.

No wonder then that some important CEDOs in certain developing countries are subsidiaries or joint ventures of foreign CEDOs. However good this may be from the point of view of survival and of productive efficiency, it is probably not the best from the point of view of social efficiency. A country cannot leave permanently in foreign hands the greater part of the work involved in organizing and carrying out investment projects, and sooner or later will have to develop its own C&E capabilities around efficient domestic CEDOs.

State support is required for this. In some countries there will be a tendency towards public-sector CEDOs, in others towards independent CEDOs. The principal role of the State regarding the development of a CEDO is to assure it an expanding and stable demand, with prices and contract conditions that will mean an incentive for technical development in the CEDO; to provide credits for working capital, guarantees and other needs; to extend to it a measure of protection; to help it in acquiring technology, experience and a good human team.

(b) Carrying out the process

If the development of a CEDO is to be carried out efficiently and in not too long a time, clear ideas should be had about the characteristics of the mature state which is the objective of the process. They will vary with the country, the sector served, the type of services offered, the ownership, etc., so that no general rules may be laid down, though a study of CEDOs in developing countries may show some useful patterns that may guide the design of this "desired situation". Let us only remark here that care should be had regarding the uncritical adoption of CEDO models that are more appropriate for a developed country; careful research should be conducted on optimal CEDO models for the developing countries - their characteristics, their management, their "technology". To this we have already referred in the previous section.

There is not a unique model for CEDO development. The way the organization develops will depend on the specific circumstances. Paths and strategies will be dictated by the concrete objectives to be achieved, but it would seem that the process should be gradual and should rely on the acquisition of expertise and credibility in successive stages. The experience of successful CEDOs in developing countries should be examined in this respect.[1/]

Based on the considerable experience attained in India and other countries participating in the STPI project, Malhotra has suggested a number of alternative development strategies for CEDOs which we summarize in Annex 4.

CEDO development should pay attention to a number of aspects, some of which have to do with the internal functioning of the CEDO and others with its relations with clients and other actors. Let us mention the following:

- Paths of development. The areas in which the CEDO is to work will come up as a result of an interplay between immediate market opportunities and long-term objectives. There is a danger of growing along an "easy" line, as market opportunities appear and clients "overburden" the CEDO, making for imbalances, too much specialization and possibly shallow technical development. Thus the CEDO may find itself expanding greatly its economic analysis capabilities, or

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1/ This is one of the objectives of the case studies being conducted at present (December 1978) in Argentina, Brazil, Korea and the Philippines. Unfortunately only partial results from the first two countries were available at the time this paper was written. On the other hand, there is a wealth of experience about CEDO development in the industrial countries that may have some relevance for developing countries. For instance, the OECD studies have indicated that in the USA, CEDOs showed no established historical pattern of growth, many of them having started as boiler makers, mechanical or electrical designers, civil engineering contractors or even construction material suppliers; that continuity of demand was extremely important; that there was diversification by accomodating a diverse range of tasks along the specialities that made them leaders in particular fields.

its structural design activity, while subcontracting other areas of work. Or the CEDO may diversify too much through accepting all customers, stunting its technological capabilities. The CEDO should lay out its long-term objectives, and develop fully one or two technological areas which show good promise; once a mastery has been acquired it may be the moment to start a new area.

- Acquisition of knowhow and expertise. This is the key aspect of CEDO development. It may be said to comprise three inter-related aspects: human resources development, technology acquisition and the development of management capabilities We take these matters up in the following section.

- Development of Clients. As the CEDO develops it will reach a widening circle of prospective clients and may have to help them in acquiring sufficient capabilities to deal efficiently with tasks such as the preparation of terms of reference, the drafting of tenders, the evaluation of bids, the control of progress, etc. This requires the client or user to develop its own techno-economic capabilities and to set up procedures that will guide its dealings with CEDOs and other suppliers. Government policy should help in this, particularly in the case of State investors.

- Type of contract. Some types of contract are more favourable for CEDO development. Lump-sum contracts are usually preferred by the client, but CEDOs prefer cost-plus-fees, since they often find it difficult to make accurate cost estimates because of unstable conditions in a developing country. A small CEDO may not be able to absorb the losses of a single contract, so this is a critical point.

- Pricing policy. Many prospective C&E clients in a developing country, principally the medium and small scale enterprises, are not in a position to pay fully for the services they need. Sometimes such services are provided at a loss by special State institutions. At the other end of the scale, large State investors may give opportunities to developing CEDOs to bid for a certain C&E task. If this is large, the CEDO may have to charge more than usual because it has very high indirect costs; it has to employ new management resources because its own resources have to be kep at least partially free for other activities in order to provide continuity for the firm. This could

perhaps be interpreted economically as a firm working on the rising part of its cost curve. The State client would be footing part of the costs of CEDO development; if it did not accept this, it is possible that the CEDO would be deprived of an opportunity to expand and to acquire more knowhow.

- Network of contacts. The developing CEDO will need to devote efforts to develop a network of contacts internationally so that it may have good and prompt access to information, technology, equipment makers and other suppliers of inputs for its work. If should also build up its relations to local research institutions and manufacturers, which should be close enough to permit it to discharge a socially important role as an intermediary between domestic producers and users of technology and capital goods.

(c) The acquisition of knowhow and expertise

This depends on the building up of a good human team, the acquisition of technological knowledge and the development of management capabilities. The three aspects are interrelated. The development of human resources cannot be separated from the acquisition of knowhow; and in particular the development of management requires that key knowledge be absorbed by it so that it can be used for best effects. Concrete objectives should be adopted by the CEDO and actions undertaken to fulfill them.

The development of human resources should be in step with demand, or possibly somewhat ahead of it, in order to tailor them to the types of work to be carried out. Ideally the CEDO should formulate a manpower development programme. The recruitment and training of stable personnel are two factors that interplay. What type of recruits should be had and what training should be given them will very much depend on circumstances and opportunities; there seems to be no agreed procedure, and practices differ from firm to firm. Recruits may be fresh graduates, persons with three of four years' experience in technical work, or experienced professionals. In regard to training, two important elements are academic training at home or overseas, and on-the-job training while assignments are carried out, particularly when this is done in association with a more experienced CEDO.[1/] It is important to use the training

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1/ To give one example of a training procedure, a large State-owned CEDO hires fresh graduates, keeps them for two years as trainees, and then encourages them to go into industry, hoping to hire them back in a few years.

opportunities when there is collaboration with a foreign CEDO, but this may not be easy if the latter believes that it will raise costs or lengthen the job, or if it is wary of helping the development of a potential competitor. These are aspects where explicit policy may help by inducing the local CEDO to maximize the use of training opportunities and the foreign CEDO to conduct the training.

The efficient operation of a CEDO requires the use of modern management techniques, and needs the acquisition of expertise in handling complex tasks that are carried out by persons from different backgrounds. In organizing its programme of work the CEDO will have to pay particular attention to the allocation of its resources to the best effect. It should operate in a business-like manner, if it is to become cost-conscious and efficient; this should apply too in public sector CEDOs. In this sense a cost-plus type of contract would be less effective. Attention should be paid to the setting of standards for executing consultancy projects, the control of costs, schedules and the quality of work, etc. All this may be embodied in standard procedures, for preparing which the experience of other developing country CEDOs may be of much use.

We now come to the acquisition of technology and expertise by the CEDO, which implies a lengthy learning process about which little hard data exists so far. In the first place, the technology of consulting and engineering should be mastered, including techniques such as demand analysis, project evaluation, mathematical model-making, electronic data processing, scheduling, design routines, drafting techniques, preparation of reports, etc. which should be acquired and put to good use.

Secondly, the technology of the sector to which services are rendered must also be mastered, and this poses very interesting issues on which research would be needed:

- This technology should not only be in the minds of the CEDO's staff but should somehow be incorporated in the organization itself, through specialized routines, computer programmes, technical files, lists of technology and equipment suppliers, etc. This "firm-embodied" knowhow may reinforce the aggregate knowledge of the staff, improve their efficiency and allow to replace a departing staff member by a new recruit with little disruption.

- Technology acquisition may reach different levels of depth and complexity. The mastery of basic engineering design would be an appropriate goal in the long run; other more accessible goals may be formulated for different moments of time as a guide to the CEDO's technical development.

- Among the forms of technology acquisition and learning we may mention the recruitment of experienced personnel; the repetition work that may be carried out for successive clients; the establishment of feedbacks from clients once assignments are over, possibly through follow-up visits and meetings; the close interaction with R&D institutions, technology owners and equipment makers; the further training of staff members through special programmes; the formation of a special group to master a certain technology (it can be a "process group" which can carry out development and pilot plant work); and very importantly the association, permanent or temporary, with an experienced foreign CEDO. This last point deserves a special paragraph.

- It may be desirable for the CEDO to establish links, or even associate itself, with a foreign CEDO, either in a stable manner or for the duration of a project. In the best of cases this may mean a quick way to acquire knowhow; but there is a danger of remaining a junior partner. Experience shows that the local CEDO usually has problems to have access to crucial data, obtain manuals and operating instructions, and in general procure written documents that collect and summarize years of experience. The CEDO should negotiate so as to obtain access to that information,[1/] which is vitally needed if there is to be an effective transfer of corporate knowledge. Government policy should support it in this sense, for instance by requiring that the local CEDO should lead the project with the foreign firm helping to carry it out: the project director can then have direct access to the top personnel at the foreign CEDO's headquarters, instead of having to go through the foreign personnel who happen to work on the spot. Training may also become one of the items of cost in a contract between a Government and a foreign CEDO. There are several interesting experiences in the developing countries that it would be worth analyzing to find out the types of agreements and the operating procedures that may be best for technology transfer from a foreign to a local CEDO.

1/ For instance, through a "full disclosure" clause in an agreement for collaboration on a specific project.

9. BUILDING UP A NATIONAL CONSULTING AND ENGINEERING CAPACITY

We have argued that developing countries need to build up a national C&E capacity and put it to good use if they are to have control of decisions which are important for their development, employ well their intellectual resources, carry out optimal investments projects, and achieve a harmonious growth of their industrial sector.

The growth of C&E capacity for the supply of services to different user areas in the economy will not easily take place in a spontaneous manner, but will require promotion policies from the Government if the end result is to be a set of CEDOs able to provide those services with efficiency and reliability. Ideally, a "C&E sector" should be formed and the infant industry argument may be applied to it as it is applied to other incipient sectors. The long-run benefits accruing to the whole country are expected to be significantly larger than those being received by the user of the services, and therefore it would seem logical that the costs of developing C&E should be shared by the country as a whole through appropriate Government action.

9.1. Obstacles

A number of obstacles are found for developing a domestic C&E capacity and using it efficiently. Some of them are a result of the characteristics of investors, CEDOs and other actors at a given moment; others of the local or the international environment. A study of them may suggest the type of policies that should be adopted in a certain national situation.

Internal characteristics of clients, CEDOs and other actors may change in time as development proceeds and learning takes place. In the national environment, implicit policies may be changed once identified.[1/] But many

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1/ By implicit policy we understand the effect on C&E and its utilization of Government policies, measures and actions which are designed to operate in other fields. The effects are usually unintended and there may be little awareness on the part of those that implement the policy. A better knowledge of them may enable policy-makers to lessen their negative influence or heighten their positive implications, and eventually to transform implicit policies into purposeful "indirect" policies for the promotion and utilization of C&E services.

contextual factors are difficult to modify save in a very long time; some of them may be overcome through persuasion and strong incentives, others will have to be accepted as part of the environment of policies in favour of C&E. Regarding the obstacles that originate in foreign actors, the country may adopt defensive policies and also join other developing countires in a united front to provoke changes in the international environment.

Let us now make a brief review of some of the principal obstacles. The exercise should be carried out in each country where C&E capacity is to be built up, as a prelude to the design of policies.

- Few countries have shown a political will strong enough to produce significant changes in their technological situation. There are subtle but strong foreign interests which originate pressures for maintaining the present state of affairs; these outside interests frequently find internal allies, such as lobbies and pressure groups wishing to maintain certain privileges (i.e. imports), which makes it more difficult to carry out changes.

- Policy makers in many countries have not yet understood properly the key role of C&E in carrying out better investments and contributing to self-reliant development. There is a need to educate them so that they will suport measures in favour of these activities.

- Political instability and lack of continuity are common in many developing countries, making life difficult for institutions that are vulnerable to changes of Ministers, viewpoints, and economic situations, and diluting the effect of policy decisions.

- Some countries are too small to acquire C&E capacity save in a few areas.

- In most developing countries there is a limited technical capability in the public and the private sectors, not only to negotiate technology purchases but also to identify clearly production problems and the technological requirements they pose. This is not too helpful for achieving an efficient technology transfer and efficient investments.

- Government organizations in general are pressed by their users and clients, and by the public, to comply with their avowed objectives of supplying certain goods and services. This may make them disregard an ampler role they could play in respect of other desirable social goals such as we have explored here, and induces them to look for "efficiency" in the short term, to "get the job done", putting aside any complications that may imply extra costs and delays.

- A very serious obstacle is found in the cautious, risk-averting attitudes of decision makers, which may make them opt for foreign suppliers, frequently through turnkey operations, for fear that domestic C&E and other goods and services may turn out to be inferior.

- The system of selection and contracting of State suppliers established by law or by traditional administrative practices has often been designed for protection against bad commercial practices, and is not appropriate for the promotion of technical competence and creativity. This does not favour local CEDOs and other local suppliers which have to fight much red tape and find little support for tasks that go beyond immediate requirements. It becomes difficult to set up contractual agreements of sufficient flexibility to permit an adequate concentration of efforts by suppliers so as to produce significant technical developments.

- Supplier financing and tied loans reduce very much the investor's scope of decision. In many large purchases outside financing is sought, which usually involves the use of foreign consultants and the purchase of foreign technology, engineering and equipment. Many countries find it almost impossible to untie a package of "finance-technology-equipment" and yet are forced to accept this way of conducting large investments since they have no alternative.[1/] The

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1/ In Colombia, hospitals have been equipped totally by one supplier country which extended the necessary credit. There are "English", "American" and "Czech" hospitals. In addition to having lost the opportunity of including national inputs, there appear serious problems in operation and maintenance because of the diversity of the equipment and instruments.

situation is less critical in projects financed by the World Bank and other international and regional financial agencies, but insistence in these agencies about "getting the job done" puts the focus on short-term efficiency aspects rather than the long-term ones we have treated in this paper. Domestic investment Banks tend to behave like international Banks and may not be too willing to take what they consider high risks. Self-financing allows the highest latitude for choice of CEDO, technology and equipment. But investors, particularly those in the public sector, can rarely generate sufficient funds of their own to finance large investment programmes. In the case of State enterprises it may be asked whether they should sometimes be allowed to make higher profits so that they may generate their own investment funds, this being justified by the additional impacts new investments would have.

- Domestic CEDOs face strong competition from industrial countries' CEDOs on account of an inherent inequality between them. The latter may show much more impressive credentials, promise better guarantees and provide more favourable financial terms (sometimes preinvestment services have been offered practically free). Such circumstances, added on to the subjective factors we have discussed, often lead to the choice of a CEDO firm from an industrial country either on the part of the ultimate client--principally Government agencies--or of local CEDOs that are scouting for a partner that will make them win the bid or land the job. Many Governments wish to promote the development of a local C&E capacity, but faced with the choice, real or subjective, between delays, uncertainty and few guarantees, on the one hand, and speed and efficiency, on the other, they frequently select a foreign CEDO. Short term considerations prevail, and long term ones, which might help in the reduction of technological dependence, are not considered.

- C&E capacity is incipient and little developed in many countries; foreign capital CEDOs predominate in some key branches; there is a tendency in CEDO professionals to adopt foreign models and patterns in their work. Such characteristics, together with users' tendencies not to employ indigenous CEDOs, make up a situation that is not conducive to CEDO development if a laissez-faire attitude is adopted. Domestic CEDOs find themselves in a vicious circle, with the danger that up-to-date knowhow in many important fields will never be achieved.

9.2. Strategy aspects

(a) Policies from the top and policies from the bottom

Technological policies in many developing countries have tended to rely principally on laws, regulations and other rules of the game which have been administered by high-level institutions. These "top-downwards" policies have not been altogether successful in accomplishing the purpose for which they were designed. They are sometimes disregarded by the different actors that are supposed to apply them. This is particularly grave in the case of public sector investors with an attitude of "getting the job done" that makes them look for total safety and devote far too few efforts of their own to their investment activity, so that packages are not disaggregated, few chances are given to local CEDOs and orders are not placed with suppliers that are not considered absolutely reliable.

A different approach would be to elicit actions from the actors of the technological development process themselves, through which may be put in motion a cumulative and expanding process that will overcome obstacles, change attitudes and bring about CEDO development and utilization as a consequence of the interest and efforts of those involved. These actions would be formulated and carried out by people who believe in their usefulness, and therefore the resulting "bottom-upwards" policy would tend to be highly effective.

It would seem that the correct strategy for building up C&E capacity and using it efficiently is to combine both approaches. It is not so much a question of drafting ambitious legislation and writing perfect standard procedures, but of motivating people and institutions, and multiplying initiatives. There should be an effort to coordinate and orient the latter towards the achievement of certain desirable goals, and to complement them with adequate policy measures at the right moments. Persuasion, the diffusion of experiences from home and abroad, and the training of responsible officials in investor enterprises are general measures that can be taken at a early period. As the process gets going, a number of general or sectoral policies may be adopted to support it and at the same time existing policies may be revised when they have a negative influence on the development and use of C&E capacity.

A main element is the presence of a general policy that recognizes C&E as an important activity to be promoted. This gives a framework for applying specific measures in favour of CEDO development over a period of time, so that there is some assurance that things are not going to stop in a year or two.

Within a general strategy such as we have indicated, many specific actions may be carried out, from the top and from the bottom. Which, and in what order, will depend on the context, the opportunities and the interest and eagerness of the actors. It is possible, for instance, that major advances in the process can only take place when there is a tight balance of payments, and investors --particularly public enterprises-- have to turn, faute de mieux, to local CEDOs and local suppliers. If things are done well the terrain that has been gained may be kept in a subsequent phase of easy imports. Perhaps it is a process with this sort of "ratchet effect" that may prove to be best, rather than the smooth evolution so beloved by planners. For the process cannot be planned in detail; it is rather a case of the "disjointed incrementalism" approach suggested by Lindblom and Hirschman, the pursuit of an objective when there is only a general idea of where it lies and little knowledge of the obstacles, like crossing a minefield with the help of a mine detector.

(b) Objectives; policy alternatives

No general suggestion may be validly put forth about the best way to organize national C&E capacity. The solution may be different for different countries, and for different main fields where C&E services are needed. In principle, strong and mature CEDOs should be had in the principal productive sectors. However, it is possible to point out to many complementarities between the various producers of C&E services, so that the question is not to develop one type of producer to the exclusion of the rest but rather to find the adequate combination which, taking into account both the current situation and the political "style" of the country, will assure a maximum social efficiency of the set of CEDOs that make up the sector's or the country's C&E capacity.

The objective pursued, and the probabilities of achieving them, will depend on many things. Developing countries can be very different; the goals of developing the C&E sector in Brazil and in Paraguay cannot be the same.

Sectors differ in their size, the size of their production units, their technology. Political conditions, historical situations, national objectives differ. Choices have to be made in several instances so as to define concrete objectives that will guide policy-making and action.

Let us review some of the main aspects on which options have to be made:

- There is a problem of priorities regarding the type of service and the industrial branch on which first to construct C&E capacity. This is because resources are limited in availability, in particular human resources with sufficient abilities and experience. In has been suggested that priority should be given to preinvestment studies in the first place, since these set up the framework within which important investment projects are carried out.[1/] After preinvestment, a second line of priority would be detailed engineering, an activity which allows the linkage with the capital goods industry.

- In regard to branches, priority should probably be given to those in which there are possibilities of repetitive investments which will maintain a demand and allow experience to be gained in successive similar tasks. Repetition possibilities for engineering are also present in peripheral technologies used by many different investment projects; to make use of them it is necessary to disaggregate investment packages and parcel out contracts.

1/ M.Kamenetzky suggests that it is easier to train manpower in project preparation, since "the knowledge required may be transferred through formally teaching how to select and evaluate technologies and how to conduct financial analysis. The corresponding methodologies may be exercised through paper work in which fictional or real cases are recreated. All this is much easier than transferring the skills required for engineering production facilities or the ability needed for handling them... A sound petrochemical project may be organized by a consulting team with no previous experience in that field, provided its members adequately sense the context of the project and look for proper specialized advice at the right time. However, the design of the facilities by an engineering team calls for the latter to include people having previously designed a petrochemical plant and thus having acquired skill in the use of the related specific knowledge."

- Options about the type of CEDOs that are wanted would need the debate, at the level of the branch, of alternatives such as

  . Private or State-owned independt CEDOs. Which should be favoured? Each type shows its own advantages and disadvantages, as we have seen above. Much will depend on the prevailing opinion and the "style" of the country concerned.[1/] State CEDOs however would seem to be a neccessity to serve small and medium industry, which cannot pay fully for the services it requires.

  . Captive or independent CEDOs. The answer here cannot be clear cut. Independent CEDOs may sometimes offer advantages both from the private and social points of view: clients would not be saddled with project offices which are active only part of the time, and such CEDOs probably have a stronger impact on the diffusion of knowledge by virtue of the many clients for which they perform assignments. But large enterprises may prefer to have their own captive capacity, which may allow them a high degree of mastery of the technology in their branch, particularly if R&D activities are also carried out.

  . Specialized or multi-purpose CEDOs. Is it better to count with CEDOs specialized by sector and type of service, or CEDOs able to provide a wide range of services for different sectors? The latter solution would diminish the problems associated with demand fluctuations but it tends to disperse efforts, particularly on the part of key management personnel of the CEDO. However, in small countries it may be unavoidable to rely on diversified CEDOs.

1/ There is a country where the National Development Bank has created technical groups in certain new areas like forestry and has made them private after some time, continuing with its support in the shape of assignments and credit. In Indian the Government has tended to build up its own C&E capacity. Government CEDOs act as prime contractors in large projects and subcontract certain parts to private CEDOs.

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. Should CEDOs be totally independent from ties to technology owners, contractors, capital goods producers and other commercial interests? This issue has been debated for a long time in various forums.Associations of C&E firms, national and international, have maintained that the client can only get proper and unbiased advice if the organization he retains is not tied to any other interests, and have incorporated this principle in their codes of conduct. However, international Banks allow CEDOs related to such interests to participate in the formulation, engineering and supervision of investment projects provided that their associates do not supply any inputs. In a developing country there are reasons why the principle should not be absolutely upheld: (i) a captive organization belonging to a contractor, for instance, may sometimes represent the best domestic source of C&E for a certain client; (ii) the volume of business and particularly the profits will be much larger when the CEDO is integrated within a larger commercial operation, such as a contractor, significantly increasing the chances of development of the CEDO. This is an important argument from the point of view of developing an indigenous CEDO capacity; (iii) in any case, many developing country CEDOs have originated in civil constructors and other contractors that established an engineering department which became large and gave services to other customers. In certain sectors of some countries C&E capacity is already tied up to a large extent to commercial interests.[1/]

- The organization of CEDOs nationally and sectorally would require a discussion of topics like the following:

. In some areas the expected workload may not justify more than one or two large CEDOs; the danger would be that there would exist strong competition and a high death rate among many small CEDOs, none of which could aspire to become large enough to carry out an efficient task, so that foreign CEDOs would keep on being employed indefinitely in key assignments. Hence a monopolistic situation would have to be accepted, and some sort of contracting and pricing procedures should be agreed to avoid the possible drawbaks.

1/ This happens in Argentina and Mexico with CEDOs in the process engineering branch.

. A position should be taken regarding the place of foreign-controlled and joint venture CEDOs. We have already touched on this issue.

- The support awarded to developing CEDOs is essential if they are to reach maturity. Questions should be posed regarding the extent of this support and the means by which it will be extended:

  . How much direct support to private CEDOs, through loans, scholarships, fiscal incentives, and other means.

  . How much support to private CEDOs through contracts for which relatively high rates are paid.[1/] In principle the extra cost here would be footed by the investor organization unless arrangements are made otherwise.

  . How much may be spent in installing a new State-owned CEDO and paying for its development costs.

  . How much may be spent to support the running costs of CEDOs aimed at small and medium enterprise, project departments of industrial research institutes, and mechanical and industrial design centres.

9.3. Policy measures; actions

We have suggested that the development of C&E capabilities and their appropriate use should come about as a result of measures and actions by the actors themselves --the users and the producers of C&E services-- and policy measures adopted by the Government to promote and regulate demand, help the expansion of supply and improve the social efficiency of C&E and the activities it serves.

1/ High rates may result because of high costs of operation or because of extra costs of training personnel academically or on-the-job (for instance, if a foreign CEDO is given a plus to allow locals to be trained). Sometimes the public sector should "make a bet" on a certain CEDO, awarding to it a large contract through which it can gain experience, train its personnel and acquire a higher technological level.

Studies of C&E requirements by sector and type of services should be carried out in order to provide an overall guidance to this process, which is not linear and evolutionary but incremental and disjointed. A principal problem is to break the "vicious circle" in the main user branches. Here the role of the State would seem to be essential, and should be expressed by a well defined policy at the top level and most importantly by pragmatic actions at the operational level of public agencies and enterprises. The opportunities stemming from major investment programmes should be seized, in order to build and use C&E capabilities, and extra costs should be accepted as necessary. At the same time, foreign capabilities should be made to contribute to the process by making the best use of them.

We now make a brief review of measures, actions and policies without attempting a comprehensive survey.

(a) Measures and actions by the users of C&E services

We shall speak mainly of public sector users, which are the principal demanders of C&E services in a developing country. Their policies and actions will be instrumental in the growth of C&E capability.

- The selection of a CEDO should depend on a careful appraisal of expected performance. It should not be influenced by price considerations; or by financial facilities, risk avoiding attitudes, too much reliance on the sheer weight of a foreign CEDO's credentials, and other factors that have nothing to do with quality. Improved methods of selection should be developed that will give domestic CEDOs the possibility to overcome the "inherent inequality" they suffer in regard to foreign CEDOs.

- Investment projects should be prepared and carried out with improved, "enlightened" practices such as we have discussed in a previous section. Unpackaging of investments is a most important instrument. Local CEDOs should be given significant responsibilities as well as opportunities to train their personnel and acquire knowhow even though this may signify a cost.

- Users should develop their own technical cadres. A minimal capacity should exist to deal with suppliers, and it will often be convenient to build up a true technical and engineering capability. The process of creating this internal capability is not simple; it is not merely a question of hiring professionals, but also of transforming them into a team. This takes time and resources. During the building up period the energies of the group will be principally devoted to its own development and consolidation, a fact that should be taken into account on programming the group's activities. To a large extent there will be "learning by doing", perhaps using opportunities to collaborate with outside groups in project preparation and execution.
- Relations with CEDOs should be handled carefully. Terms of reference should be precise but flexible. The user, if it is large, should have a register and a permanent evaluation system to qualify CEDOs. It should control carefully the work of CEDOs and other suppliers. It should integrate its own personnel into the CEDO's technical teams for better overseeing of the work and as a means to train people who will later be engaged in operation and maintenance. It should provide the necessary feedback information to allow the CEDO to learn from its past work.

(b) Measures and actions by CEDOs

CEDOs in developing countries can exercise a strong effort on their own account to achieve progress both in the quality and the scope of their activities.

- They should attempt to utilize fully the resources and skills available in the country, establishing stronger ties with various institutions --Universities, research institutes, development agencies, banks, equipment makers-- and at the same time creating links between them for the benefit of an integrated industrial development.
- They should programme their development, establishing concrete objectives along time and marshalling the means to achieve them. We have touched on these questions in a previous section.

- They may pool resources to carry out large assignments. This does not exclude foreign inputs through joint ventures or individual consultants to carry out specialized tasks.
- The formation or strengthening of professional associations of consultancy organizations can be useful in raising professional standards through registration, establishment of codes of conduct, exchange of experience, and improved communications channels. Such associations can also help Government to formulate and implement policies for the strengthening of national consulting and engineering capacity.
- Quality assurance mechanisms should be developed if a solid and reliable structure of C&E services is to be created. In developed countries, the profession of consulting engineer usually has a self-policing mechanism, such as the periodic renewal of a qualification, which gives the user some guarantee as to quality. In addition large CEDOs continuously check the quality of the work in their various projects and can change the project manager and his professional staff is necessary. But CEDOs in developing countries may have just one or two projects that are managed by the principals of the firm. This would point to the need for a central organization, possibly set up by a CEDO association, that will supply reliable information to prospective clients, help in drafting guarantee and bonding clauses, and carry out a control of the quality of services rendered.

(c) Government policies

Governments should ideally define a long term programme for the development of C&E capacity at national and sectoral levels. This would require the formulation of clear objectives regarding the different aspects where choices have to be made. It should take into account the efforts that are to be undertaken by the users and by the CEDOs themselves. Specific policy measures should be taken and implemented at the appropriate moments of time. Among the latter we may mention:[1/]

1/ We refer to policies that will help the development of CEDOs; some of them may be applied too in branches with mature CEDOs which it is wished to keep on supporting. Some of the policies would be applied throughout the different branches, others would be specific to a branch.

- Policies on the demand of C&E services

. Political support and the right attitudes are of great importance. They may vary from branch to branch --for instance, atomic power development in Argentina and India relied from the beginning on domestic C&E efforts, disaggregation of packages, increasing local inputs, etc., while steel and other industries in those countries relied on turnkey projects for too long. Government may influence attitudes and behaviours through persuasion and other means.

. The Government can often award contracts directly to local CEDOs. It can establish a legal code for the user of local (in preference to foreign) C&E in public investments. This however may not be all that simple; experience shows that public enterprises and agencies may invoke urgency, safety and other reasons, and use all possible loopholes to avoid taking the trouble and risks of following such a course of action. Hence a preference system for local C&E would also be needed.

. The protection of domestic C&E production needs the establishment of a system of preference. C&E however is a peculiar activity and the usual tariff mechanisms do not appear to be effective. C&E services are bought --or should be bought-- on grounds of quality rather than price, and there usually is a bias towards what comes from an industrial country; price signals are largely inoperative since the customer prefers to pay more --anyhow this is only a small part of the investment cost-- and use "more reliable" and "better quality" services. The application of common regimens for the control of technology imports, foreign investment and industrial property rights, while helping to reduce costs of technology imports, does not provide enough inducement to select local C&E services. There are many factors in technology choice that escape those regimens; some of them are subjective, other depend on how activities that demand technology are organized, who takes the decisions, what decision rules are applied. To act on those factors and favour the contracting of domestic C&E services we may suggest the use of preference systems of a qualitative nature. Domestic CEDOs face stiff competition from foreign firms, and are

at a disadvantage on account of an inherent inequality stemming from less financial means and poorer credentials; they are often caught in a "vicious circle" from which it is very difficult to break. To eliminate this disadvantage, and further, to tip the balance in favour of local CEDOs, at least two things are needed. First, to devise financial mechanisms that would grant adequate credits to CEDOs (for their capital requirements and the preparation of proposals) and to their clients (so that consulting and engineering services may be had on favourable terms). Second, to devise a method of selection on the part of the client in which the sheer volume of background experience and the renown of professionals listed do not automatically determine who is to be awarded the bid. Such a method would probably include two main aspects: (a) standard procedures for the assessment of quality of a firm and of its proposal without undue emphasis on the volume of background experience, and (b) the award of extra points in a point system if the firm is local.

. Demand from the public sector should be regulated so that CEDOs are not exposed to great fluctuations in the workload. We have discussed this point already.

. Government should promote the exports of C&E services through measures like identification of likely foreign customers, help to local CEDOs through embassies and missions overseas, tax rebates and subsidies for the export of C&E services, etc. In some countries a special trading company has been jointly founded by the Government and exporters of technological services.

- Policies on the supply of C&E services

. Direct establishment of State CEDOs in certain areas of the economy. In some cases these may be captive groups that are pulled outside their parent organizations and given a wider role.

. Preferential tax treatment to CEDOs for some of their activities, such as the export of services.

. Credit facilities for working capital, training, research, technology acquisition and other needs.

. Support to the establishment and functioning of consultants' associations.

- Policies on the activities of CEDOs

The purpose here would be to improve the social efficiency of CEDOs and the investments they serve.

. Support should be given to improved, enlightened practices that will mean high social efficiency. This may be done through persuasion, and by teaching such practices to investors and CEDOs.

. Legislation may be adopted for the compulsory use of domestic CEDOs and local inputs on a certain percentage basis. This type of action has been very effective in the case of inputs for automobile production, where local subsidiaries have been forced to "integrate" their production. In the case of C&E services success is less likely. Experience in Argentina and other countries show that such legislation is frequently bypassed by public enterprises. It is possible however to establish a mechanism --such as the NAI in Brazil or the "ancillaries policy" in India-- to fight for the compliance to such legal measures in every possible instance.

. Regulations may be adopted for the best use of foreign CEDOs in favour of technology transfer and training. Such regulations may be implemented for instance by a Technology Registry that has to approve all technology agreements. We have already referred to the principles that may be followed.

. Relations should be promoted between CEDOs on the one hand and R&D organizations, equipment makers and input suppliers on the other. The Government may play an important part in this through its financial, administrative and technical units, acting in accordance to a central policy.

9.4. Actions at the international level

We have taken up so far the question of national efforts to develop C&E capabilities and thus augment the power of technical decision in national hands. On an international level, two main areas should additionally be cultivated as an important complement:

(a) Cooperation efforts among developing countries in technical matters. This may take place through traditional channels (programmes set up bilaterally by Governments, programmes of multilateral agencies such as those in the UN system) and through commercial channels (operations of technology commerce between a supplier in one developing country anda client in another). Technical cooperation through commercial channels offers a great promise of expansion. The operations may be of benefit to the exporter in terms of a greater mobilization of its C&E potential and the expansion of markets for its CEDOs. The receiving country may benefit through lower costs, the possibilities of obtaining more appropriate technologies,[1/] and the likelihood that such transactions will create much weaker links of dependence and may be endowed with characteristics that make them socially useful for the receiving country, helping the latter to build up its own C&E capacity. Cooperation of this sort may lead to the creation of large technology markets, the establishment of joint programmes and joint institutions in certain fields, and eventually the achievement of technological integration between two or more countries. As we have suggested above, a small country may not find it easy to develop independent C&E capacity in certain fields and cooperation with other countries may be the

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1/ Two points may be made in this respect. First, a large part of the technologies needed by developing countries are already usedand mastered by other developing countries; the "technology gap" between developing and developed countries as a whole is significant only in certain areas and branches mainly of the "science-based" type. Second, adaptive efforts, innovations and cumulative production experience have produced "appropriate" technical solutions in many fields. Such solutions constitute "technological assets" that in many cases are implicit in existing plant and operating practices. To transfer such technological assets it is necessary to make them explicit, i.e. to derive a "conceptual engineering" from existing practice. This needs technical efforts of the "reverse engineering" type which may be forthcoming if there is market for such technological assets. With the "conceptual engineering" in hand a proposal may be prepared incorporating the "basic engineering" of a project that fits the client's needs and contemplates the local conditions under which he operates.

only way to count with a C&E capacity that responds to its interests. Examples may be found in the Andean, the Central American and the Caribbean subregions in the American hemisphere.

(b) Actions on foreign and international institutions

The developing countries should cooperate among themselves for improving the conditions under which take place operations of technology transfer, direct foreign investment and others that may influence their technological development. The negotiations being carried on in UNCTAD and other international forums, particularly those on "codes of conduct" for technology transfer and multinational corporations, should be continued with energy and it would be convenient to start other actions to change the behaviours of various actors such as international and regional development banks, and the productive enterprises, CEDOs, donor agencies, and Governments themselves of the industrial countries. To carry out this "technological diplomacy" with a high probability of success, efforts should be put on the analysis of the problems that have appeared, the characteristics and attitudes of the actors, and many other aspects that deserve examination.

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10. RESEARCH SUGGESTIONS

We hope to have shown in this paper that a country should have a consulting and engineering capability of its own as a key element of its self-reliant development.

There is no need to review once again the arguments we have already presented, save to suggest that it is this type of capability that permits a country to have the capacity to transform itself according to its self-imposed objectives, starting from a situation where most if not all the knowhow and technological services for its modern sector are being imported. Developing countries will continue to import knowhow, but it is largely through their C&E capabilities that they may improve the procurement and absorption of this factor and use increasingly their own science and technology resources.

Two main questions should be asked: How to build up an adequate consulting and engineering capacity? How to use this capacity in the best way? These two questions, which are related, give rise to further questions at the conceptual, policy and operative levels.

There is much scattered knowledge on some of these matters but there is also much ignorance. It seems desirable to gather and analyze information that may be of use to policy makers, and to the actors themselves, for planning and carrying out actions that may improve the current situation in developing countries.

The present author feels that a major comparative research effort on the building up and utilization of C&E capabilities in developing countries, such as envisaged by the IDRC "CEDO Project",[1/] is desirable at the present moment

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1/ The CEDO Project is a collaborative research effort promoted by the IDRC with the participation of research teams from several developing countries. The aim is to study the development of consulting and engineering design capabilities in those countries, centering the analysis on consulting and engineering design organizations, or CEDOs, so that policies may be designed and instrumented to promote their growth and make them effective tools of national development. It should be noted that several international organizations are also keenly interested in the subject and would probably collaborate in a project of this type.

on account of its likely impact on policy making and practice in the participating countries, and of the contribution to the advancement of knowledge in the general field of technological and industrial development.

This section will examine briefly the type of research work that may be carried out, and will point to some of the main themes to which attention may be devoted, as they come out of the analysis carried out in this paper. Discussion of these suggestions, in the light of the results of the case studies now being conducted, and of the needs and interests of the national teams already involved in the CEDO Project, will permit an adequate design of a programme of work for this project.

10.1. Nature of research work

There are some aspects that do not make it a simple matter to carry out research in consulting and engineering in developing countries. The subject is vast and complex; its limits are not easy to define, and there is a large variety of problems at the micro and macro level in which our knowledge is not yet very advanced. Basic concepts have not crystallized sufficiently so that significant conceptual efforts are still to be made, on the basis of which agreements on definitions and categories may be reached among different research groups, nations and international agencies.

There is a definite need to structure properly the field of work, and this paper has been an attempt in that direction. This would seem to call for a great deal of further exploratory work, and for comparisons between national and sectoral experiences which may clearly show those aspects which are specific to certain sectors and countries, and those which are of a more universal interest.

The need for further mapping, exploration, characterization and conceptualizing should not come as a surprise in view of the relative novelty of this field as a focus of research. Such a situation has appeared quite often in other areas of the social sciences,[1/] and even in recent cases of the physical

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1/ To give just one example. A group sponsored by UNESCO undertook to carry out research on the productivity of scientific organizations. Work started in 1970. Although the units to be studied were easily identifiable (much

sciences.[1/] These efforts may take some time but seem to be needed before making a meaningful effort of theory, a formulation of detailed hypotheses, and the application of the hypothetical-deductive methods of social science research.

This does not mean that some important issues and problem-areas cannot be fruitfully explored at this stage. But this would have to rely mainly on inductive methods, which gather a large amount of information and extract conclusions on a sort of "weight of evidence" approach. Statistical testing of hypotheses would not seem to be a feasible procedure at this early stage of research, except perhaps in a few well defined situations; it would mainly be a question of carrying out case studies, collecting information from a variety of sources, interviewing people and arriving at conclusions through an inductive process. Case studies, in particular, are useful ways of starting research in complex situations where many variables and decision centres are present, as happens in many aspects of C&E development and utilization. Case studies incorporate this complexity on describing and analyzing in detail individual situations. Since they require the use of an inductive methodological approach, and do not imply the collection of data for testing conjectures and hypotheses, they cannot give conclusions of a general validity. But the analysis of all the elements of a situation and their interrelations permits the identification of aspects of the phenomenon which otherwise would not be clearly perceived. Case studies performed in different sectors and countries on the same situation or

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.... more so than CEDOs), a good amount of research had been done in the past by many distinguished social scientists, and much lore existed in the scientific world on which to construct approaches and put forth hypotheses, the group -- which included social scientists from half a dozen European countries-- took almost four years to formulate a viable research design. In this period many ideas were formulated, examined and scrapped; there took place an important exploration of the field. Only in 1978 were results ready for the original participating countries, and at this moment there are plans to extend the research to a number of other countries, among them some developing ones.

1/ A case in point is the development of radioastronomy since the end of the war. For more than 15 years radioastronomy refined its observational equipment and put it to work in mapping the skies and identifying totally new and unexpected phenomena. Theorizing mainly followed after this lengthy exploratory period.

issue (for instance, training of C&E personnel through association with a foreign CEDO in an investment project), if done with a similar design as regards the main questions asked and the type of information collected and examined, may allow a certain degree of comparison of results and make it possible to formulate conceptual interpretations and hypotheses that may later be submitted to further corrobation, perhaps by statistical evidence.

Let us examine briefly some problems that are found for research on C&E in developing countries, beyond those associated with the still incipient development of this general research area, on which we have just commented.

The CEDOs we may take as units of analysis are sometimes difficult to define (for instance, when does a technical group in a productive firm become a CEDO? What part of an industrial research institute should be considered as a CEDO?). They vary widely in their characteristics; their behaviour tends to be strongly idiosyncratic; there are few of them in a given country and sector; they are probably not close to being in a steady state where their behaviour exhibits some stability; an important focus of research would consist of the processes through which they grow, develop and mature, processes which may exhibit enormous variations from case to case.[1/]

Another problem in studying processes of this kind is that whatever factors have been important influences in a given situation some time ago may no longer be valid on account of the time that has passed and the change in circumstances, and may therefore be of little use for making predictions or as a guide to action. Are conclusions about certain experiences transmissible to another moment in time, even within the same country and the same sector? If a CEDO has used a certain strategy successfully in the past, would this be also successful for a similar CEDO today?

1/ We may take as an example the study of technology acquisition by a CEDO, in some of the most important branches. It is likely that very few CEDOs will be found in a certain branch and country for which it makes sense to study this characteristic, so the universe is small. On the other hand each CEDO in a certain way is unique: technology acquisition would seem to be a highly idiosyncratic process where personal and chance factors play an important role. Anthropological approaches would probably be more adequate here than sociological ones. To simplify things as to be able to apply the latter may mean that the very richness and diversity of the process under study is largely lost.

We should also touch on the practical problems of having access to information. Even with a great deal of openness and good will on the part of the CEDO it may be difficult to carry out the necessary series of interviews with key personnel which is scarce of time and always in the run, or to obtain information from documents and files which may be in disarray, if they exist at all, since many CEDOs in developing countries are rather small and devote litte time to housekeeping chores.

These difficulties may be even greater when the unit of analysis is the investment project, or the consultancy assignment. Here it may be difficult to contact all the principal actors, particularly if the task has been carried out long ago; and there is the danger that research efforts may stay only in a descriptive level because there is no time or opportunity to deepen the analysis. Besides, projects tend to be very different and subjected to widely divergent influences, so that comparability and the formulation of generalizable conclusions are not easy.

Another unit of analysis may be the policy instrument, and here the conclusions of the STPI project would seem to be relevant: the evaluation of policy measures in favour of certain objectives is something very complex; there are limits to the possibilities of experimental verification, and to attempts of explaining clearly causal relations between measures and effects. On the face of such limitations STPI was not able to give a definitive reply to the questions originally posed, but it was able to develop explanatory hypotheses, which were confirmed to a certain degree, that were able to reduce the uncertainty born from ignorance and be of help in connecting knowledge and action.[1/] Research on C&E may obtain a similar result.

To sum up. The subject is still to be thoroughly mapped and requires further exploratory work. A number of important problem-areas and issues can be identified and may be explored principally through inductive approaches that need the gathering of ample evidence, although deductive methods may find use in some specific cases. The results would undoubtedly lower the coefficient of ignorance of policy makers and actors so that better measures may be envisaged

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1/ F. Sagasti, Science and Technology for Development: Comparative Report for the STPI/Project. IDRC, Ottawa, 1978.

to develop domestic C&E capabilities and apply them efficiently in a given country. This would seem to be very desirable in view of the importance of C&E as a factor in self-reliant development.

We suggest that research efforts should be of an "action-oriented" type,[1/] aiming not only at producing intellectual results but also a number of practical results, principally a change of attitudes, a learning process in those participating in the work or being in close touch with it, and the collection and analysis of much useful information thorough the study and comparison of experiences, the discussion of results, and the gathering of data in general.

In action-oriented research the objective should be to generate useful knowledge for policy making, decision making and planning. This calls for a different attitude than in academic social science research.

A characteristic of action-oriented research is to avoid simplifying too much a problem but rather to look at it in all its complexity. The temptation should be resisted to fragment it too much and introduce simplifying assumptions that would allow the use of more conventional research approaches. There should be an effort to understand the nature of conflicts, the value premises, the attitudes of different actors. The collaboration of researchers from different disciplinary backgrounds would seem to be important in order to look at issues from different viewpoints and avoid the straight application of approaches stemming from just one discipline.

Another characteristic is the involvement of policy makers and actors in the research process. This close interaction may bring about important practical results, as a consequence of the collective learning exercise.

10.2. Areas for research

A number of issues and problems about C&E have been suggested at different times, notably by Araoz and Politzer, Malhotra, and the participants at the recent OECD Seminar.

1/ Action-oriented research is treated at length by Sagasti in his STPI Project Report.

We have identified in this paper several areas where research efforts may be applied, having based ourselves on the above references and other sources. At this stage it may be convenient to make a summary of such areas, classifying them under three headings: conceptual, policy and operative.[1/] There are evident connections between the work that may be carried out under each heading, so that the following list should not be interpreted as an attempt to split up research efforts in three separate categories. Conceptual research would improve the quality and impact of work on policy areas and operative aspects. Research on policy questions should be considered as the heart of this project. Work on operative areas would have as a purpose the development of useful procedures, guidelines and methods of immediate practical use.

We shall be referring principally to semi-industrialized developing countries, in which some significant experience already exists and which can profit from the analysis of their experience and that of other countries.

(a) Research on conceptual areas

- Definitions, terminology and classification of C&E activities, services and organizations (p.4)[2/]
- Nature of C&E links with productive units, capital goods production, R&D and other activities. Systemic relations. Type of flows. Decisions. Information and its handling. Fedbacks (pp.12, 16).
- Demand estimations. Methods. Coefficients (p.17).
- Mechanisms through which a CEDO may counteract the effects of fluctuating demand, such as internal organization, diversification, exports, scheduling, price policies, etc. (p.24)

1/ Our purpose is not to suggest concrete "issues", or to formulate hypotheses. This is a later stage which would have to be tackled by each national team, since the way a proposition is drafted and worded will be very dependent on the national situation, though of course in many cases very similar formulations will exist among countries.

2/ Page numbers in this and subsequent entries indicate the place in this paper where reference is made to the research area and the various issues within it.

- The notion of "installed capacity" in C&E (p.32).
- Development of a system of statistics on C&E (p.36).

(b) Research on policy areas

We start from a number of general propositions that come out of the analysis made in this paper:

- It is extremely important for a country to build up and use efficiently a domestic C&E capability. A first step should be to acquire capacity in preinvestment work on account of its importance in technology transfer and the proper use of local resources.
- Regarding C&E capabilities in branches where medium and large investments are carried out:
  - . C&E should be considered as an "infant industry" and CEDOs should be helped in their development; support should continue to be extended to mature CEDOs if they are to compensate their inherent inequality with CEDOs from developed countries (p.14).
  - . The role of the State is crucial as policy maker and especially as owner of important investments in many branches (p.13).
  - . Actions and measures taken by the actors themselves, principally State investors and CEDOs, would appear to be more effective than general policies from the top, though the latter will be needed as the process of building up C&E capacity gathers strength (p.90).
  - . It pays for an investor to adopt enlightened investment practices, including especially the use of a domestic CEDO, since it may increase its private efficiency in the long run. This will also be beneficial for the social efficiency of investment activity (p.62).
- Adequate C&E capabilities should also be created to serve the investment and production needs of small and medium industry. This may sometimes be done within industrial technology institutions or other existing organizations.

These propositions represent wide policy areas on which research may concentrate. A number of more specific areas will now be listed as a guide to the formulation of a research programme:

- Demand of C&E services:

  . Principal sources of demand (p.15).
  . Needs of small scale industry (p.16).
  . Behaviour of investors, particularly in the public sector. Reasons for demanding foreign C&E services (pp.16, 20).
  . Use of demand estimations for policy purposes (p.18).
  . Relations with foreign CEDOs (p.21).
  . Fluctuations of demand and their regulation (p.22).
  . Exports of C&E services and their promotion (p.24).

- Supply of C&E services:

  . Participation of foreign capital in local CEDOs (p.32).
  . Specificity of CEDOs (p.33).
  . Pros and cons of public sector CEDOs (p.34).
  . Policy implications of C&E statistics and the formal emergence of a "C&E Sector" (p.36).

- Impacts from using domestic C&E:

  . Optimal sequence of decisions in an investment project (p.42).
  . "Learning" as an important effect on investor, suppliers and other actors (pp.49, 51, 52).
  . Role of C&E as a link between R&D and the productive sector (p.52).
  . Overcoming the blocking of industrial development through the purchases set in motion by forward-looking investment practices (p.53).
  . Procedures and decision models (p.55).

- Efficiency of investment activity:
  - . The process of increasing efficiency. Characteristics and steps (p.59).
  - . The gap between private and social efficiency. Possibility of reaching a maximum social efficiency. Measures needed for this (p.60).

- The mature CEDO:
  - . Social efficiency of a CEDO. Influences on it (p.66).
  - . Selection of "products" (p.68).
  - . Productive efficiency. Management of a CEDO in the environment and conditions of a developing country (pp. 70 and 76).
  - . "Delivery system" of a CEDO; efficiency of distribution (p.71).
  - . Influence of the environment on a CEDO. Implicit and explicit policies. Contextual factors. Influence of foreign and international actors (p.72).
  - . Models of CEDOs in the mature state. Differences with CEDOs from the developed countries (p.76).

- Development of a CEDO:
  - . Paths of development (p.81).
  - . Types of contracts. Pricing policies (p.82).
  - . Acquisition of knowhow and human resources. Organizational knowhow (p.83).
  - . Strategies of CEDO development (Annex 4).

- Building up of a national C&E capacity:
  - . Obstacles to growth of C&E capacity (p.86).
  - . Policies from above and from below (p.90).
  - . Policy alternatives in the development of C&E capacity (p.91).
  - . Measures by users of C&E services (p.96).
  - . Measures by CEDOs (p.97).
  - . Government policies: protection, regulation of demand; increase of supply; increase of social efficiency (p.98).
  - . Policies for technical cooperation with other developing countries and for a common action in international issues (p.102).

(c) Development work in operative areas

- Ways and means for educating project owners, banks, Governments and other actors about the role of C&E in development (p.14).
- Procedures for estimating the demand for C&E services (p.19).
- Guidelines and procedures for using foreign C&E in the best possible way. Types of contracts that may be adopted (p.21).
- Elements of the "technology" of C&E in a developing country. Manuals and guidelines may be prepared in different aspects, such as CEDO management, technology search and choice, appraisal methods, engineering design procedures, etc. (p.26).
- Guidelines for the development of suppliers by project owners (p.49).
- Guidelines for carrying out forward-looking, enlightened investment practices that will maximize social efficiency. A related area is the development of guidelines for operations of technology commerce among developing countries so that full benefits accrue to the recipient country (p.57).
- Models of adequate contracts between project owners and CEDOs (p.82).

10.3. The shape of an international comparative project

An international comparative project on C&E would centre its attention on a number of main areas and issues, which may be selected among those we have listed above. It should cover preferably the same sectors or branches in the participating countries and employ very similar methodological tools (questionnaires, interview schedules, outlines for case studies, etc.) in order to allow for a certain degree of comparability.

The selection of areas and issues should follow from ample discussions among the different national teams participating so that a maximum amount of information and results may be obtained from the effort. It is possible that some of the topics under (a) and (c) above may be treated initially by just one of the teams, or even by an outside consultant, in order to avoid too much duplication of efforts. This would have to be carefully considered.

We suggest that the project should concentrate on three important types of CEDOs:

(a) CEDOs that principally carry out preinvestment consulting, which abound in many developing countries. They tend to be in the private sector and to serve a wide variety of customers. They are usually small and share a number of problems.

(b) CEDOs that provide a wide range of C&E services to small and medium industry. They may be part of an institution like a technology institute, information centre, productivity organization; some countries have developed special consultancy institutions for the small scale sector. These CEDOs are mostly in the public sector, attend a very large variety of customers and may charge only nominal fees for their services. Once again, they share many similar problems which are worth studying. In particular, the case of technology institutes may constitute a worthwhile focus for research efforts.

(c) CEDOs serving modern infrastructure or industrial sectors that carry out important investment projects, where the main agents are public enterprises and agencies. Such CEDOs may be captive or independent, public or private; and it is probably here that a country wishing self-reliant development should put its main efforts regarding CEDO development and use. It is suggested that three branches should be studied in each of the participating countries, of which at least one should be the same as in other countries.[1/]

In addition to the studies of CEDOs and their activities under the three headings above, national teams should carry out certain studies at the country level. A survey of the evolution of C&E activities in the country should be made, with a historical perspective, and should be related to the characteristics

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1/ As candidates we may mention the following branches:
- infrastructure (buildings and civil works, roads, ports, airports, water and sewage systems, transport systems, communications systems);
- energy (oil and gas extraction; generation of thermal, hydro and nuclear energy; electrical transmission lines);
- mining (coal, iron, copper, tin, etc.);
- basic metallurgy (iron and steel, aluminium, copper, etc.);
- chemicals, petrochemicals and in general process industries;
- mechanical and electrical industries.

of industrial development and science and technology development in the past. This would serve as a framework to the detailed sector studies and would illustrate the factors that have influenced past development and utilization of C&E capability. A second general aspect to be examined is the national environment within which CEDOs operate at the present moment -policies, legislation, contextual factors. This would permit a more adequate discussion of possible action in the policy areas under study. Finally, some attention should be put on the possibilities of cooperation with other developing countries to improve the external constraints to the domestic development and utilization of C&E capabilities.

ANNEX 1

CEDO Research in Development Agencies

Interest in consulting and engineering activities, and in the organizations that carry them out, has been on the increase during the last few years in different institutions concerned with development.

The OECD Development Centre has conducted studies on CEDOs of industrial countries and their activities in developing countries, and has supported six case studies (in Cameroon, Colombia, Egypt, Ivory Coast, Peru and Thailand) which were reviewed at a Seminar in Paris, October 1978. The Seminar underlined the importance of CEDO development and identified several areas where further research would be required to better understand the problems involved and the policy options. One of the important findings of OECD research was that CEDOs of developed countries are not much aware of the conditions and needs of the developing countries for which they design investment projects, or about the question of "appropriate technology" and tend to transplant their own solutions to an environment where they may not be fully adequate. Such solutions tend to favour the purchase of technology, equipment and production inputs from the country in which the CEDO resides; the possible supply by entities of the recipient country is not fully taken into account. If behaviours of this nature were verified in practice, they would point out to certain disfunctional characteristics of imported consulting and engineering services that should be curbed by national policy.

UNIDO has been looking at the question for several years and has contributed to the creation of consulting and engineering capabilities in several developing countries, within industrial research centres or as separate institutions. In June 1978 it convened a meeting in Ljubljana to discuss the problems faced by CEDOs in developing countries and to appraise the possibilities of cooperation among them. The report of this meeting was later submitted to the UN Conference on Technical Cooperation among Developing Countries (Buenos Aires, August 1978). An important conclusion of the meeting was that "industrial consultancy should be recognized as a basic essential service and as a vital instrument to achieve the Lima target. It is a key

element of industrialization programmes since it contributes directly to evolving appropriate technical and economic solutions in harmony with nationl socio-economic objectives, securing improved terms in technology acquisition and achieving technical and managerial self-reliance through a more effective use of national resources. Consultancy is the "software" equivalent of capital goods, which is the essential "hardware" input for industrialization."

The United Nations Development Programme has been keenly aware of the importance of consulting and engineering for the formulation of appropriate development projects and has tried to enhance the participation of CEDOs from developing countries in the projects it promotes. In 1975 it sponsored a meeting on "Consulting Services in Latin America and the Caribbean", which took place in Mexico, with the participation of several hundred consultants from that region. As a result the CODELCA Group was founded with the participation of UNDP, the Inter-American Development Bank, the Federation of Latin American Consultants and National Financiers (the Development Bank of Mexico), with the purpose of analyzing the problems of consultancy in Latin America and the Caribbean and of promoting its development. In its first meeting of November 1975 the CODELCA Group approved the preparation of a Directory of Consultancy Organizations in the region and commissioned a paper on "Cooperation in Consulting and Engineering in Latin America and the Caribbean", which was submitted at the Regional Preparatory Meeting of the UN Conference on Technical Cooperation among Developing Countries, Lima, May 1976. Unfortunately the Group has not met again and it is not known whether it will be revived in the future. On the other hand, the subject of "cooperation in consulting and engineering" was included in the agenda of the UN TCDC Conference and recommendations were included in the final report. It is very likely that the UNDP will take it up again in the future in one way or the other.

Consulting and engineering activities have also been the subject of concern in some international financial agencies. The Inter-American Development Bank created several "Preinvestment Funds" in Latin American countries since the mid-60's with the purpose of improving project preparation in the public sector; such Funds became explicit supporters of national consulting and engineering, and have recently inaugurated a programme of collaboration among themselves in which this support will be further enhanced. The IDB also sponsored the

Mexico meeting in 1975 and was one of the participants in the CODELCA Group, as we have seen.[1/] In the World Bank careful studies were carried out regarding the use of Bank-funded projects for building up local technical and project capabilities, and the results have allowed to draft improved procedures which have recently been incorporated as operative suggestions in the Bank's manual of operations. But it is not yet clear whether activities of this nature have had a significant impact upon the operations of the two Banks: the attitudes and the practices of personnel in charge of operations --both from the Bank as from the client-- are not changed overnight.

The International Development Research Centre has sponsored work on consulting and engineering since 1974, when it commissioned M. Kamenetzky to carry out a study of the evolution of process engineering in Mexico and Argentina. Several case studies were carried out by national teams within the framework of the Science and Technology Policy Instruments (STPI) Project, and a technical meeting took place in Caracas, Venezuela, in October 1975, where papers were submitted by the teams from Argentina, Brazil, India, Korea, Mexico, Peru, Venezuela and Yugoslavia. Observers fromUNDP, the World Bank, the OECD and the IDB-ECLA research group were also present and referred to the work carried out in their respective organizations. One of the conclusions of the meeting was that the subject was of great importance and that it was ripe for research.

After the Caracas meeting the IDRC commissioned Dr. A. Malhotra to prepare a paper on the subject which could be used as a basis to formulate a research project in which several national teams could take part. A meeting took place in Corfu in late 1976 and a preliminary proposal was drafted. It was later felt that further preparatory work should be undertaken and the present author was asked to draft guidelines for case studies in several countries, and to review the whole subject and make concrete proposals for further research.

1/ In addition, work on engineering firms has been carried out by F.Sercovich within the research project sponsored by the IBD and the Economic Commission for Latin America.

A first paper was prepared in December 1977, with a conceptual framework and guidelines for a case study. Four case studies were undertaken in Argentina, Brazil, Korea and the Philippines during the second half of 1978. Partial results are already on hand for the first two.

The present paper is an attempt to examine the subject-matter, identify some important issues and suggest what may be done in the way of further research. This paper and the results of the case studies are to be considered at a meeting early in 1979, as a result of which, it is hoped, a full-fledged research project on consulting and engineering design organizations may result.

ANNEX 2

The role of CEDOs in the transfer of technology

In the developing countries the main source of new technologies is the process of technology transfer from the industrial countries. This situation is bound to persist in the future and could even become more acute, since as a country makes progress in its economic development it needs to introduce new technologies but its own technology-generating efforts usually lag behind such needs.

It is therefore important to understand the process of technology transfer in order to guide it according to criteria that agree with national conditions and national development objectives. We shall examine the principal aspects, placing emphasis on the role that domestic CEDOs may play in it so that results are best for the recipient country.

Nature of technology transfer

Technology transfer operations may be said to consist in the transfer of elements of technical knowledge needed for the conception, design, construction and operation of units that produce goods and services, including the performance of activities such as natural resources surveys, education, health, public administration, the solution of social problems, etc. The transfer of these elements of technical knowledge may take place through (i) the transfer of technological assets, and (ii) the rendering of technological services: consulting, engineering, and other technical services.

Technological assets comprise knowledge about products, processes, organizations, methods and systems. They may be protected by industrial property rights. They constitute the nucleus of the "technology" which is subjected to practical applications. Their origin may be empiricism, trial and error, scientific and technological research; they may also originate in a previously imported technology which has been subjected to change and improvement to adapt it better to local conditions and to improve its technical and economic characteristics.

We have already referred to consulting and engineering services. "Technical services" cover a wide array of activities that usually accompany the transfer of technological assets and the rendering of consulting and engineering services. They go from personnel training to quality control services, and from analysis and tests in laboratory and pilot plants to advice on production or management problems.

Technology transfer comprises operations through which the supplier unit (which may be an enterprise, engineering firm, R&D institute, etc.) gives the receiving unit access to the use and exploitation of technological assets, and may also supply the technological services needed for their economic utilization, given the particular conditions in which they will be used. The content of such operations frequently constitutes a "package" made to measure for the client. The supplier unit organizes the package around the "core" technological assets, central to the process, to which it adds the "peripheral" technological assets, which may be common to different projects, obtaining the elements from various sources in its own country, in that of the client or in a third country, and adapting their specifications to the peculiar conditions of the project it is preparing. Such packages may be taken to constitute intangible capital goods made to order.

Consulting and engineering activities are crucial for the choice of the technological assets, their adaptation to the conditions of the project, the detailed design of the latter and other related tasks. C&E activities may be performed by one organization, "captive" or external, or else they may be shared among several organizations and groups, with one of them in charge of coordination and general supervision of project design.

The magnitude, complexity and contractual form of technology transfer operation may be very variable, as specific actors and circumstances vary. It may be a large investment project; a medium size investment; a significant change in the conditions of production, which only needs the introduction of a new product design with little additional investment. The first case is that of the so-called "development projects", usually undertaken by the State or by large private investors, employing special credit lines which are often of international origin. However, the general characteristics of the technology transfer process are similar in all these cases and the stages of solution are the same.

In the simplest cases, certain services will be rendered or certain technological assets will be licensed. In other cases a more or less complete project will be prepared and technological assets will be lincesed. The most complex situation is that of a "turnkey" agreement in which the supplier undertakes to provide all services and inputs needed to deliver a productive unit in full working conditions. The supplier need not necessarily supply by itself all the technological and physical inputs required; many of them may be procured from other sources through the supplier's intermediation. One of the characteristics of a turnkey agreement is that the supplier give guarantees about the efficiency and the safety of the installations; another is that the supplier is in charge of their start-up or commissioning. A turnkey investment project frequently incorporates process knowhow, or product designs, covered by industrial property rights. These technological assets are not necessarily controlled by the supplier; they may be procured from a third party by means of licensing.

What may be done to improve technology transfer

It is common for a developing country to buy and implant technology with little previous study and following the recommendations of foreign equipment manufacturers or foreign constultants. In such cases a badly known package is imported. This should be contrasted with the importation of elements of technical knowledge which are not locally obtainable, preceded by a careful search, selection and evaluation on the part of a local CEDO and infused with a will and effort to import only those intangible and physical inputs which cannot be obtained locally at adequate price and quality. In the first case several unfavourable characteristics from the social point of view may be present, particularly the long-run effects of depending on foreign suppliers of technology.

The characteristics of these two extreme models, and the reasons to undertake actions that will create favourable conditions to approach the second one, have been trated by many authors in much detail. It is evident that in many cases it will not be possible to proceed according to the second model and that, even though this may technically be feasible, the task is not simple

for countries with small scientific and technical capabilities. In such a case more limited objectives may be adopted, putting efforts on those parts of the process of technology transfer in which it is possible to obtain in the short run certain significant achievements which may cumulatively contribute to the possibility of pursuing more complex objectives in the long run. But it is important to point out the crucial role of captive or independent CEDOs in tasks of such importance for an efficient and autonomous development.

Many of the problems in technology transfer to developing countries originate largely for internal causes, such as the attitudes and behaviour of decision-makers and the lack of technical capabilities needed to conceive and carry out investment projects, identify technological alternatives, choose the more appropriate ones, negotiate with suppliers of technology, services and physical inputs, prepare bid documents, etc. To this should be added other factors like the scarcity of local investment funding which makes it necessary to rely on international credit or supplier financing. All this favours the dependence on foreign consultants and suppliers for recommendations and even decisions which should truly remain in the domestic sphere, while at the same time little confidence is shown on local personnel of industry, science and engineering. This finds expression in "safe" and "efficient" patterns of behaviour, frequently translated in the purchase of technological package and turnkey plants. Curiously, this search for safety which moves to place total confidence on the foreign supplier of the package has not always produced the hoped-for results in terms of costs, efficiency and delivery dates. There have sometimes been delays, design or construction errors, failures in the operation of imported equipment, etc., which have caused serious problems. Sometimes this may be attributed to the introduction of technologies which are still experimental so that the recipient country is functioning as a test bench for the supplier's new process or product

To diminish these problems in technology transfer, "defensive" policies may be applied to regulate the characteristics and the terms of technology imports and foreign investment. Many developing countries have legislation of this type. But this is not enough. An "active" policy is also needed, which will work on many fronts, developing and using domestic technical capabilities

in consulting, engineering and research, with which it may be possible to carry out an efficient management of imported technology and the generation of local technology. In the long run emphasis should be put on these active or offensive aspects if it is wished to get to manage the technological variable and through this acquire a measure of self-determination in technical matters and therefore on the process of development.

In large investment projects, which are the most important users of foreign technology, the main problem is to progress from a "turnkey" situation to another in which the projects are conceived and managed domestically and incorporate as much domestic technology, engineering and phsysical inputs as possible. It may be suggested that a turnkey import whose internal structure is not known is truly a "back box". The investor should eventually carry out its investments in a disaggregated manner, as a "white box", making by itself or through a local CEDO the feasilibity study and the construction of the package according to local conditions and using maximally physical and intellectual inputs of local origin. To go from white box to white box a learning process is required which usually cannot be accomplished in one jump, so that it will be necessary to go through a succession of "grey boxes" which gradually incorporate more local contributions and inputs, so that the box is "whitened" in successive investment projects.

A process of this nature, which implies the growing mastery of technology, finds a number of obstacles which must be overcome. Perhaps the most serious one is the cautious, risk-averting attitude, which may induce those responsible for the investment to purchase what they need outside the country, often through a turnkey purchase, for fear that the locally supplied goods and services should be of an inferior quality. We have already suggested that this caution does not always give good results. Another important obstacle in public investments is the system of selection and contracting of suppliers legally imposed in certain countries, and the accompanying administrative practices. When it is a question of developing new products and processes, industrial countries frequently resort to direct contracting, establishing a programme of work jointly with the supplier in which payment is in the cost plus system. This modality is not contemplated in many developing countries where purchasing systems are designed to protect the State against dishonest commercial practices but not to utilize as well as

possible the scarce technical, human and financial resources that are available.

Serious obstacles still persist even when the investor has a positive attitude. The most significant derives from the frequent need to look for foreign financing, which often implies the use of foreign CEDOs and the import of technology, engineering and equipment. Countries like Pakistan and the Philippines, to name only two, with few capital resources and little negotiating strength, are trapped in this situation and find it very difficult or impossible to untie the "finance-technology-equipment" package. Another obstacle is the absence of technical capabilities in the investor, which may then find it impossible to take up responsibilities about specifications, unpackaging of technology, choice and negotiation of goods and services to be procured, and other activities that need a strong technical backing, and cannot find help in domestic CEDOs in the area of its interest because they do not exist or are still weak.

From the preceding description, the role of consulting and engineering activities in technology transfer and industrial and technological development clearly emerges. These activities appear as organizers and implementors of projects, and as such they constitute crucial links between the availability of financial resources and their materialization in efficient investments; between the production of knowledge in R&D institutions and the incorporation of such knowledge in the productive system; between the capital goods industry and the users of capital goods. The action of CEDOs may be carried out with more or less "private efficiency", i.e. that which is directly relevant to the investor and its project; but the key location of these organizations in a network of relations between finance, capital goods, research and investment permits them to generate impacts on socio-economic development that go much farther than the project walls, so that there is an important influence on the "social efficiency" of the investment activity.

ANNEX 3

Consulting and Engineering in an Investment Project

To appreciate in detail the role of C&E activities in technology transfer and capital formation we will examine the case of a large, complex investment project. We shall refer to the process industry but the description can be applied with few changes to projects in other branches.

The investor --private firm, State agency or enterprise-- makes a point for project formulation, a task that will be in charge of a CEDO frequently external to the investor. Through a series of successive approximations the CEDO helps the investor to define its specific objectives and from them it prepares a pre-project that may be submitted to economic and financial analysis. This is employed as a basis for negotiations with the Government and the financial institutions, and serves as a starting point for the engineering design of the project.

The CEDO will attempt to identify the available technological alternatives and will develop preliminary designs around them. This will require detailed conversations with suppliers on the price of technology and equipment, so that investment and operating costs may be estimated. At this stage the CEDO may have to reach an advanced stage of negotiation, and will undoubtedly need competent personnel.

On carrying out a technology search overseas, the CEDO should consider whether the technological alternatives it identifies are adequate for local conditions both from the point of view of private efficiency (technical and economic aspects of the project) and social efficiency (social, ecological and other impacts). A number of technical analyses and preliminary adaptation work are frequently required until a satisfactory solution is reached that may be expressed in an appropriate "basic engineering" design. This may offer good opportunities to local scientific institutions, and the tasks asked from them represent a first impact of the local CEDO on domestic science and technology development. Sometimes it may be preferable to have a local R&D institution working in collaboration with the foreign technology supplier or

R&D institution. Here the CEDO should help establish the international contacts needed by the local institution. The CEDO should participate closely in the organization of these tasks and the evaluation of their results, helping in this way the incorporation of local technology into the basic engineering design.

At this point there will be enough information to allow a first evaluation of the technological alternatives, which needs a preliminary estimation of investment and production costs, and of profitability in private and social terms.

To estimate investment costs, the CEDO cannot be guided by approximate data given by the supplier nor can it simply use data from the technical literature. These sources would only be acceptable in a very preliminary stage of preinvestment work, the so-called pre-feasilibity study. For a precise estimation, the CEDO should have a list of the main pieces of equipment, with their dimensions, and of the prices quoted by vendors. The CEDO would therefore be asking for firm quotations from the manufacturers of the main components. To do this the CEDO should know well the international market.

The CEDO should also know well the domestic market, in order to analyze possible purchases of local inputs. In this respect a passive attitude may be taken, buying locally what is already being produced at adequate price and quality; or a positive attitude may be adopted, inducing the local manufacture of goods which were not produced previously but may now be made if the prospective suppliers are granted financial and technical support. Public sector investment should adopt the active approach if they are to become a positive factor for industrial and technological development.

With the list of the main items and their quotations, the CEDO should estimate the cost of the whole project, using various estimating methods and criteria. The calculation will be redone later on, once the technology is chosen and the detailed engineering has been made

The next stage consists in estimating the costs of production, using supplier information about the necessary inputs (materials, energy, manpower, etc.). It should be noted that "technical" values of yield may be different from "guaranteed" values. Factors that depend on project location should be

considered, such as the consumption of energy, water and other central services which may vary considerably according to the way detailed engineering is made, the characteristics of local raw materials, etc.

By now the CEDO will have prepared the basic elements of a feasibility study, having identified several technological alternatives and prepared around each of them alternative preliminary projects which include physical and intangible inputs of local origin. In other words, the CEDO has "aggregated" or put together its own "technological packages"; it has carried out the "preliminary engineering" of the alternative pre-projects. It may happen however that a local CEDO cannot put the package together if the project is exceedingly complex, or for other reasons. In such a case the technological alternatives would lead to alternative packages prepared by foreign CEDOs or suppliers, though the local CEDO may have some participation in the task.

Whatever the case, it is now necessary to make an appraisal of the alternatives. In public sector projects it is usual to carry out a social cost-benefit appraisal.

The report to be prepared by the CEDO --the feasibility report-- should generally cover the following points: (a) market: present, projections, possible exports, how should output grow, and what are the implications for installed capacity; (b) available technologies; (c) investment alternatives and their costs; (d) production costs alternatives; (e) appraisal; (f) recommendations on technology and plant location. Some additional items may be suggested: (g) impacts of the project on local science and technology development; (h) sources of imported items; (i) sources of local items.

On the basis of this report, the investor and the CEDO may prepare strategies to carry out the purchase of technology, trying to strengthen their bargaining power through the support of Government and of local legislation, and particularly through an active search of technical, economic and commercial information that may be used in such negotiations.

Throughout all this process of project preparation, the investor has to keep a running dialogue with the CEDO and should be able to appraise the CEDO's work. To do this it should have a techno-economic group able to maintain a close and fruitful contact. This need is probably more urgent if the CEDO is foreign, in order to take care of aspects where the previous

experience of the foreign CEDO, its natural tendency towards "safety" and the established links with equipment suppliers of its own country may make it recommend, consciously or unconsciously, solutions not entirely appropriate to local conditions or the achievement of national goals.

The following steps in the project have to do with looking for financing, obtaining the benefits of promotional legislation, preparing documentation for tenders or price competition, and evaluating offers. In all this the CEDO may give the investor a very valuable contribution.

Detailed engineering is the next step with important implications for technology transfer. The investor must select the CEDO or CEDOs to which it will entrust this task. The CEDO that has worked during the preinvestment stage would be the logical candidate if it has experience and trained personnel; it can naturally bring in other local or foreign CEDOs. It is advisable that detailed engineering should be under the responsibility of a local CEDO, in order that the design will be adapted as much as possible to local conditions and needs, and that opportunities are used to incorporate local inputs. Each of the many decisions taken in the process of design may be small but the cumulative effect may be important (as was shown in the case of design of buildings in Chile which is described in the main text of this paper), and often it is only the participation of alert and experienced local personnel that may endow these decisions with maximum social utility for the recipient country.

As we have already suggested the positive impact on the development of local industry and its technological progress may be even higher if inputs or equipment that had not been manufactured locally before are now ordered because it is felt that they may be successfully produced if opportunity is given to the manufacturers. This approach has been applied by different organizations in developing countries, producing a gradual increase of local content in each successive investment. It requires a careful study of local manufacturing possibilities, and may need extended negotiations with foreign suppliers to open up packages and incorporate local inputs.

It also needs the development of suppliers of capital goods and other inputs for the investment and operation phases. A dynamic action of supplier development may be very important to improve quality, lower costs, adapt designs to local conditions, promote new designs and in general carry out a progressive

substitution of imports of complex goods. This requires many decisions about the physical, chemical and operating characteristics of the goods to be purchased. Designs, specifications, standards, and quality controls set up by important purchasers may favour the progress of production activities on requiring an incrase in the quality of products, promoting the adoption of new processes, demanding better management practices and making it necessary to train managers, technicians and workers, all of which are key aspects of technical progress in the supplier enterprises. It is convenient, especially in public sector purchases, to define needs several years ahead and establish purchasing plans in concert with the supplier branches, to which on the other hand technical and financial support should be extended to allow them to comply with ever tightening technical requisites. In this way it is also possible to help the expansion of markets for small and medium enterprise, and to develop industry in certain regions where demand may be focused. Positive impacts on development result over and beyond the contribution of the project itself.

The following stages of the project have to do with its materialization. The CEDO may contribute in many of these stages, taking on tasks related to supervision, inspection, procurement, training, etc. Training should be carefully planned on account of its importance as a channel of technology transfer both for the CEDO and for the investor which will later operate and maintain the plant.

The case of investments by small and medium enterprise

These investments often consist of machinery purchase to be added to existing plant or to replace obsolete machines. The industrialist generally does not look for information in a systematic manner. He gathers it from other industrialists, from machinery sellers, brochures, visits, fairs. He rarely carries out a wide search of technical alternatives or worries about getting technical advice beyond opinions from colleagues or acquaintances. It is common to find an industrialist buying a machine after visiting a fair or making a quick trip overseas.

Small and medium enterprises generally cannot form their own technical team or ask advice from a large CEDO regarding a proposed investment. But they will certainly need advice if they are not to buy their machines or their small projects from the first salesman. The stages to be followed are similar to those of large investment projects; what will be different are the actors and the time taken. Assistance will be requested from an organization that renders services to numerous small enterprises within a branch; this may be a technological institute, a small engineering group established by a branch, a productivity centre, or a technical assistance service for small and medium enterprise. Since it is a matter of largely repetitive situations such as the purchase of more or less standard machinery for the production of not too complex goods, it seems reasonable to expect that economies of scale will exist as the institution gives advice to many small firms. Many branches are apt for such a treatment: leather, food, certain agroindustries, non-ferrous metallurgy, etc. Several countries such as India and Mexico have developed a sizeable consulting capacity for producers in these branches.

A similar approach may be adopted in situations where technology refers principally to the design of a product. It is beneficial for a country to count with industrial design bureaus or workshops that can give advice and perform design work for a large variety of clients. There are experiences in several developing countries (Chile, Argentina, Egypt, India) that show the important role of institutions of this type, particularly when they are closely related to industrial research institutions.

ANNEX 4

Alternative strategies for development of CEDOs in developing countries, according to A. Malhotra[1/]

CEDO development can follow a number of different paths. Malhotra suggests that successful paths will result from following one or the other of the following strategies:

1. The "Project Engineering" Strategy

The total package of services required by a project is disaggregated; the CEDO performs some but assumes overall responsibilities for execution. This usually means buying process packages and basic engineering, and doing the detailed engineering and project management services locally with only marginal assistance from outside. The approach seems to work in the process industries where projects are large and local technology usually unvailable. It permits a greater utilization of local inputs. The attempt would be to absorb the imported technology and simultaneously, in collaboration with local R&D institutes, to develop technology for future projects.

The successful CEDO here will be a large CEDO, State-owned or a subsidiary of a foreign CEDO, focusing on detailed engineering and project execution services. Appropriate policies for its development and growth would be restricting the award of turnkey contracts; use of local CEDO as prime consultant in all major projects; fiscal incentives to local CEDOs for use of local equipment and goods; incentives to investors if they use local CEDOs; easing the import of equipment needed by the local CEDO; support of purchase of knowhow by lump sum with possibility of re-use; insistence on use of local codes and standards.

2. The "Specialized Services" Strategy

The emphasis is on developing only one type of C&E services, such as preinvestment services, operation and maintenance services, or inspection services, on which the CEDO would specialize.

1/ We summarize in this Annex Section V.5 of Malhotra's paper.

In the case of consultancy or preinvestment services, the CEDO would be of medium size. It would have an interdisciplinary group with a heavy emphasis on market, economic and financial analysis, covering a wide range of products in different sectors. It can be a part of a Government financial institution, or a part of a private manufacturing unit which is making the investment.

Among the policies leading to its development are: a public sector requirement of a detailed project report for funding of major projects; a stipulation by financial institutions that no loans will be given without an independent techno-economic study; the development of Project Investment Manuals; permission to employ foreign consultants or CEDOs to check conclusions of local CEDOs; strengthening contractual and negotiating components in CEDO; allowing turnkey contracts after completion of project report by the CEDO if no local group has capability to provide services or goods; support training of CEDO personnel and visits to overseas plants; incentives to CEDO for developing of regular maintenance and trouble-shooting groups; requirement that local consultants be associated in all studies; financing of costs of local services.

3. The "Reverse Engineering" Strategy

The origin of the CEDO would be the groups that operate imported turnkey plants and carry out troubleshooting. As experience accumulates and market pressure mounts for efficiency and new designs, serious attempts will be made to build up this CEDO, which will draw its staff and expertise from the operating plant. Detailed engineering will be emphasized very little; the CEDO will deal principally with maintenance and operation, and with procurement and inspection services.

This CEDO will mean a very good way of utilizing scarce technical manpower. It will be found in sectors with high maintenance costs or where product redesign is needed. It will be medium-scale, and belong to the manufacturing organization, or to a foreign-owned subsidiary of the company that provided the initial hardware for the project.

The following policies may help its development and growth: tax rebates to manufacturing organizations if CEDOs form a part of them; use of these

groups for evaluation of technology being offered for new plants; fiscal incentives for indigenization of components; development of local codes and standards; operation and maintenance services to form part of contracts.

4. The "Total Consultancy" Strategy

Here the CEDO is responsible for the entire project from concept to commissioning. In some cases it will supply services for maintenance and operation.

These CEDOs are missing in most developing countries. Most small CEDOs cannot provide comprehensive services even to medium-scale projects, while the larger CEDOs that can are either not interested in the smaller projects or are too expensive. The technology would come from local R&D institutes, and the emphasis would be on developing a turnkey package based in local R&D.

Successful CEDOs of this type will be medium-level organizations, independent or a part of an R&D institute, serving small and medium scale process plants or the medium-scale manufacturing sector.

Policies for their development would be: restrictions on import of technology in areas where local R&D is available; fiscal incentives to CEDO if project is based on local R&D; support to projects through credit schemes, protective tariffs for products, backing of guarantees to the CEDOs by insurance companies; easier movement of personnel from R&D institutes to CEDOs.

5. The "Foreign Collaboration" Strategy

The CEDO may be a joint venture or a fully owned subsidiary of a foreign CEDO, which will be pressured to employ and train a maximum of local personnel. This CEDO will rely heavily on the name, expertise and marketing efforts of the parent company. It may offer guarantees and trouble-shooting services free as extra inducements to prospective customers. During the actual project foreign participation may be limited to some supervisory personnel, standard designs and blueprints, manuals on similar jobs, etc. The parent company may also try out new solutions or experimental technologies and train its own staff at the expense of the local company and its clients.

These CEDOs will usually be medium-scale, in the private sector, they will cover a number of sectors and attempt to provide the full range of services, often on a turnkey basis.

Policies favouring their development include: lack of restrictions for their functioning, for profit-repatriation, for subcontracting of services to parent company on the latter's contracts; relaxation on double-taxation laws on expatriate personnel; favouring the training of local personnel at the parent company; incentives for increased local personnel; incentives for export of services; Government guidelines for absorption of parent company technology.

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These are the key strategies that will be employed in the development and growth of CEDOs, sometimes with minor variations according to the country and the sector. Often the same CEDO may adopt one strategy in its early days of growth and move on to other on maturation. Some successful CEDOs may adopt different strategies in different sectors at the same time. Malhotra feels that this conceptual model may help in identifying clearly the alternatives available to a CEDO at a particular stage in its growth, and in designing suitable policies in favour of CEDO creation and development.

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