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**Towards a new role for Industrial Technology Institutes in
developing countries. Guidelines for studies**

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Introduction

The changing economic and policy environment that developing countries (LDCs) are facing has created new challenges for institutions born in a different context. This is the case of the Institutes for Industrial Technology (IIT) established to satisfy some technological needs of firms operating in an import substitution industrialization model as that in place in many LDCs until the 1980s.

Although these institutions may have performed useful purposes in the past and are certainly doing certain interesting activities nowadays relying on skilled personnel, rather good physical and technological assets in certain cases and an accumulated collective experience, by visiting any of these institutions one gets the impression of a rather big boat floating in a turbulent sea without any clear direction and with its crew highly demoralized.

As governments have faced shrinking budgets their capacity to support such institutions has declined dramatically with the most extreme example to date being in Colombia, where it has been closed. However, in most cases, despite the fact that the low salaries for the personnel of the IIT, the lack of new equipment and the bad conditions of some of the buildings give the impression that their main problems can be solved either by giving a substantial budget increase or by fully privatizing their services, to be able to find durable solutions to the serious financial problems of these institutions more fundamental issues need to be discussed.

With the changes taking place in the international environment, the serious problems faced by the LDCs since the debt crisis and with the substantial policy modifications that these countries have initiated since the mid 1980s, technology issues and institutions dealing with technology such as the IIT have to be approached in a quite different manner.

In this connection, it is relevant to take into account what are the new technology needs that firms operating in a more open and deregulated environment are facing. Then, to discuss what are the ways used by the firms to fill their technology gaps and what role, if any, institutions like IIT should play in this endeavor.

The main purpose of this paper is to suggest the issues that should be discussed in a set of studies at country level on the role that IIT has played so far and is expected to play in the new economic and policy environment in a number of Latin American countries (and eventually in some industrialized countries). Before paying attention to these issues in section 3, the changing technological and economic environment and the current policy modifications are briefly mentioned in the previous two sections.

1. The changing technological and economic environment

1.1 Technology and global competition

The emergence of a new techno-economic paradigm that is slowly replacing the old fordist paradigm on which the world economy is still largely based has not only accelerated the rate of technological change, the new technologies and organizational changes that are the core of the new paradigm are also becoming crucial factors in shaping the way in which firms and countries compete in the world economy.

In contrast to the old fordist paradigm that put a premium on mass production, scale economies, standardized products, rigid product mix and dedicated automation, the application of some of the new technologies and organizational techniques has giving birth to what has been called "lean" manufacturing (or post-fordism or toyotism).

Such production is called "lean" because "it uses less of everything compared with mass production- half the human effort in the factory, half the manufacturing space, half the investment in tools, half the engineering hours to develop a new product in half the time. Also, it requires keeping far less than half the needed inventory on site, results in many fewer defects, and produces a greater and ever growing variety of products"(Womack, Jones and Roos, 1990, p.13)

Flexibility in equipment and product mix and greater importance of product innovation are crucial elements in "lean" manufacturing. These features make possible to obtain higher quality, more product variety and easier adaptation of products to user's specifications. At the same time, the just-in time inventory system on which "lean" production is based requires close relationship between subcontractors and final assemblers. The increasing need for product and process innovation is not only satisfied within the manufacturing firm but also increasingly relying on contractual arrangements with other firms, research institutions and universities.

In contrast to the earlier approaches in which innovations were treated as single events resulting from a linear research, development to marketing model, innovation is now conceived as a complex process characterized by continuous and numerous interactions and feedbacks, both within the firm and between the firm and the science and technology environment in which it operates (i.e. the chicken-egg model as proposed by Kline and Rosenberg, 1985).

Whereas in-house R & D mainly undertaken by large firms (many of them INCs) operating in certain key industries in few industrialized countries is still the main driving force in the innovation process, important changes have been taking place in the motivation and the organization of the innovation process both within the firm and between firms.

While recognizing the importance of market signals(demand-pull) and of scientific and technological expertise and infrastructure(technology-push), the role of various institutional factors as well as the cumulativeness of technology creation and certain key features of the diffusion process have been acknowledged in recent studies.

The ability to master technical knowledge is something which is developed cumulatively over time via the acquisition of skills obtained through production experience, learning by doing and by using, imitation and R & D expenditures. Since part of this knowledge is tacit(i.e. ill-defined and uncodified), the cumulative nature of technology is to some extent firm-specific.

Since the knowledge created in the innovation process has certain characteristics of public goods, it cannot be fully appropriated by the innovating firms. However, to benefit from the opportunities provided by these research spillovers an absorptive capacity (that often includes R & D) is required in the receiving firms and industries. This absorptive capacity is crucial to be able to identify, track and assimilate knowledge developed elsewhere and to eventually generate new knowledge.

In this way, technology involves fundamental learning processes by the firm initiating innovations as well as by firms which approach the innovation at later points in the development and diffusion process. The importance of learning by using and learning by interacting users and producers has been increasingly recognized in studies on the innovation

processes. At the same time, the proliferation of informal and formal networks in which research institutions and firms are operating and the growing importance of consciously designed linkages through inter-firm agreements are new organizational arrangements in which the process of innovation takes place in industrialized countries.

In this connection, the notion of "national system of innovation" has some times been used to refer to the "network of institutions in the public and private sector whose activities and interactions initiate, import, modify and diffuse new technologies"(Freeman, 1987,p.1).

Although the notion, and more important the way these systems of innovation actually work at national level, are under investigation, what is relevant to bear in mind is that although R&D by the private sector is at the center of the national systems of innovation in industrialized countries other actors and factors are also crucial. Actors such as universities, research institutions and networks of small and medium firms and factors such as the type of inter firm technical co-operation, different types of user-producer relationships and sub contracting linkages and relationships and the type of support firms receive from research and other institutions are among the key elements in the national systems of innovation.

In the new manufacturing and innovation approach, there is a growing need of "synergistic" relations among users, producers, subcontractors and research institutions facilitating the creation of clusters. In this connection, it has been suggested that the firm level competitiveness is rooted in clusters of industries connected through vertical and horizontal relationships.

In understanding the new conditions in which competition takes place between firms and countries not only the new elements of manufacturing and innovation activities have to be taken into account. The pressures towards globalization of production and innovation activities are also a crucial features of the emerging situation.

Although the concept of globalization is generally used as a catchword, it is reflecting a new set of processes and relationships that have been well summarized as follows:

"Globalisation refers to a set of emerging conditions in which value and wealth are produced and distributed within world-wide networks. Large multinational firms operating in concentrated supply structures are at the hub of these conditions. During the 1980s two main factors have accelerated the changes in earlier patterns of internationalization and have led to globalisation. The first factor is financial deregulation and the increasingly marked character of financial globalisation. The second factor is the role played by the new technologies which have acted both as an enabling factor and a pressure towards yet further globalisation. Globalisation is marked by a new ranking of the factors creating interdependences. Today in manufacturing and services investment rather than trade is leading internationalisation and is influencing strongly international location patterns for the production and exchanges of goods and services" (OECD, 1991, p.349).

The transition from internationalization to globalization has not only led to greater competition through reduced prices and shorter life cycles of existing products and services. Although in some cases the new technologies have even given rise to the emergence of new competitors, it has also been accompanied by an acceleration of the process of concentration at world level (mostly via mergers and acquisitions).

While it is certainly true that economies of scope are becoming more important than economies of scale and that small and medium size enterprises have a more significant role to play in "lean" production and in the innovation process than before, economies of scale are still important in research and development, production and marketing in some branches.

Furthermore, although new technologies have been breaking established oligopolies in mass producing branches, the entry barriers to new comers are considerable in many high tech branches and in this way oligopolistic structures are consolidated (Ernst & O'Connor, 1989).

The appropriability of technological innovations is one of the key assets of the innovating firm and a main source of the ownership and internalization advantages that characterize the TNCs. However, even though R & D activities within TNCs remain mainly centralized in the home country, R & D is increasingly done in other locations (mostly in industrialized countries) and through international inter firm agreements.

Furthermore, if some innovatory activities or even proper R & D take place within subsidiaries, it is likely that spillover effects via suppliers and customers of the foreign affiliates, mobility of labour and/or competitive pressures on their indigenous competitors may become significant.

While the above mentioned changes in the way firms and countries compete on the basis of new manufacturing and innovation activities are mostly taking place in industrialized countries, some Asian IBCs like the republic of Korea and Singapore are already involved in these changes. It is likely that other IBCs in Asia and Latin America are going to be also increasingly involved in the near future, reverting the marginalization process of these countries from the world economy that was accentuated in the 1980s.

1.2 The difficulties faced by LDCs

With the emergence of the debt crisis at the beginning of the 1980s, the economic performance of most LDCs deteriorated enormously.

Domestic production stagnated and production per capita was generally lower in the 1980s than in the 1970s. Investment rates, that had a sustained growth in the 1960s and 1970s (led by the public sector but with significant participation of private entrepreneurs) collapsed in the 1980s.

Macroeconomic imbalances contributed to high inflation rates and to wide fluctuations in economic activity. The burden of servicing the external debt, along with the growing difficulties in taxing incomes due to capital flights and other factors, led to a continuous fiscal crisis. Such a crisis affected not only public investments but also crucial expenditures in health, education and science and technology, as well as the level of remuneration and of efficiency of State firms and of the public administration.

In the case of Latin America, the export performance of in the 1980s was one of the few relatively positive economic indicators in what has been referred to as a "lost decade" to illustrate the magnitude of the setback suffered in terms of development (ECLAAC, 1993).

However, the performance in the export front was not generally accompanied by the creation of new capacity and was mostly done to counteract the contraction of domestic demand.

Export growth of manufactures was not only due to the recessive conditions in domestic markets that led to excess capacity. It was also a result of the continuous process of devaluation of domestic currencies and reduced costs of labour. High exchange rates and extremely low wages gave international competitiveness to a number of branches that

were built in the import substitution era and that due to the new conditions in domestic markets had substantial idle capacity.

In this way, most Latin American exports of manufactures have achieved international competitiveness in a rather regressive way. Although it is true that the structural deficit in manufactures trade was reduced, it was mostly a result of exports substitution.

What is more important is that the growth in exports has not generally led to a growing physical and technological capacity. Most resources generated during the export growth seem to have been diverted to consumption, financial investments or transferred out of the country rather than being channelled towards the absorption of technical change via investment. This is the sort of competitiveness that has labelled as "spurious" (ECLAC, 1990).

In contrast with the crisis faced by LDCs in Latin America, Africa and West Asia, a number of countries in East and South Asia managed to have a good performance in the 1980s. In the case of the Asian NICs and some ASEAN countries, a process of manufactured exports led growth continued in the 1980s, especially after the recovery in world demand since 1983. The sharp expansion of exports from these countries was accompanied by continued increases in investment and by stronger domestic consumption. The growth in exports and in investment, induced buoyant import growth.

The fiscal crisis and the slowdown in economic growth and productive investment have had serious repercussions on the resources available for education and for R & D.

In this connection, the contrast between selected Asian and Latin American countries in R & D expenditures in the 1980s is worth sharp. While Mexico was devoting 0.6 per cent its GDP to R & D, and Argentina, Brazil and Chile 0.4-0.5 per cent, India and Singapore allocated 0.7, Taiwan, 1.1 and the Republic of Korea 1.2 per cent (UNCTAD, 1991).

It is important to bear in mind that the serious crisis that 1980s faced in the 1970s had not affected the competitiveness of all enterprises in the same way and not all firms have reacted to the new conditions in the same manner.

The new conditions have increased the structural heterogeneity of enterprises regarding branches, size, ownership, market orientation and technology. Such growing heterogeneity is, to some extent, a consequence of the different strategies followed by domestic and foreign firms as a response to the new conditions.

Despite the lack of data and studies comparing the situation at the end of the 1980s with that prevailing before the crisis, it is likely that some of the following changes have happened with different intensity in each country:

i) manufacturing output is not only smaller but also more concentrated and with significant sectoral differences. Manufacturing branches producing intermediate and consumer products may have augmented their participation in the reduced output, while engineering branches' share declined. In other words, branches based on low wages and natural resources and/or producing industrial commodities on the basis of subsidized fixed assets have increased their relative share, at the expense of branches based on skilled labor.

ii) the share of exports in manufacturing output is higher while the degree of local integration of production is probably lower.

iii) within a global picture of low productive investment and higher technological gaps vis a vis industrialized countries, productivity levels, technological and organizational efforts, reliance on imported technologies and modernity of the physical and technological stock (including the incorporation of microelectronics based machinery and equipment) are widely different not only between branches but also inside branches- and apparently regardless of size and ownership of the firms.

iv) with the fiscal crisis, State enterprises and institutions that had an important role in a number of manufacturing branches and influencing others through their purchasing policies, are generally in very bad shape and in process of privatization.

v) the participation of foreign affiliates in production is probably lower due to reduced foreign direct investment flows, although it is very significant in key branches of the manufacturing sector and in total exports. However, towards the end of the 1980s foreign direct investment flows have increased in a number of Latin American, though in a less significant way than in East Asia. This reversal of the earlier trend is suggesting a growing interest by TNCs in some countries undergoing structural reforms and stabilizing their economies.

vi) nationally owned firms, and especially those belonging to the large private groups, have increased their importance. These groups, which in some cases originated in the 19th century, have quickly grown in recent years and participated in extractive and agricultural activities and in manufacturing and services (mainly financial). Although these groups have very diversified activities, with a growth path highly influenced by the need to augment the value of their financial assets, in some cases they have well equipped

factories with highly qualified personnel making high value added goods or delivering sophisticated services not only for the internal market but also for export. At the same time, these groups have had joint ventures or technological agreements with partners from industrialized countries to strengthen their productive and marketing skills and to obtain relatively modern product and process technologies (Sacualdo & Fuchs, 1989).

To be able to capture the growing heterogeneity of the manufacturing sector, it is important not only to pay attention to the activities of large domestic firms and key foreign affiliates but also to selected medium and small firms. It seems that in certain branches small and medium sized firms have acted in an offensive manner and have been actively engaged in technological development, especially when operating as subcontractors of large foreign and domestic firms.

Despite the fact that they have hardly participated in the significant transformations taking place in the industrialized countries and the wide differences among countries and branches, not all the firms emerging from the crisis suffered by LDCs in the 1980s are in bad technological shape. In some cases they were able to modernize their facilities and keep some skilled personnel and have even begun to adopt some elements of "lean" production.

However, in most cases the pending technological upgrading in the manufacturing sector is quite significant and becomes an urgent task, especially with the most strict requirements of the new policy environment.

2. The on-going policy modifications

2.1 Policy changes in industrialized countries and Asian NICs

The changes taking place in technology generation and diffusion in industrialized countries and the growing trend towards globalization of economic and technological activities have led to new approaches in the way industrial and technology policies are applied in the OECD and East Asian countries.

The more defensive policy actions at sectoral level aimed essentially at restructuring existing industries, have been combined with some offensive policies for emerging branches (eg certain high tech sectors). The trend seems to increasingly apply horizontal activities aimed at encouraging firms to upgrade their competitiveness, through the use of a variety of technological and organizational assets.

Following the first oil shock and the competition from the NICs, there was a spate of direct or indirect government intervention to the productive system. Subsidies to industries in trouble, jointly with non tariff measures to protect such industries, have been widely used in OECD countries throughout the 1970s and peaked in the early 1980s.

Although measures in declining and emerging industries are still applied in most OECD countries, a clear shift in the policies related to industry is visible. The new policy directions are clearly oriented to increase the international competitiveness of the whole economy through the support for investment in know how and by fostering the process of internationalization of enterprises (OECD, 1990).

A variety of programmes aimed at providing support for intangible investments have been put in motion in many OECD countries, jointly with a number of activities for promoting the application of microelectronics and of advanced manufacturing technology (OECD, 1987). Government policies have been significant regarding information and awareness of such technologies, especially in the early stages of diffusion, the provision of advisory and consultancy services and setting up of different training schemes.

While in most European countries different types of well defined programmes mostly to assist small and medium size firms in the adoption of new technologies and organizational techniques have been established, in the case of the United States State and Federal technical extension services have been operating for such a purpose. In a recent study on the experience of these institutions is quite encouraging to find how flexible these institutions are becoming to satisfy the changing needs of the environment. At the same time, it is clear that even in a country so industrially advanced as the United States very few of these institutions have been able to match the success of similar institutions in the agricultural field (Chapman et al, 1990).

The way IIT or similar institutions have been modifying their role to face the new challenges raised by manufacturing industry are being studied by the OECD secretariat and other institutions like the World Bank, as part of the efforts being made to evaluate the different government programmes aimed at promoting innovation (see in this connection the December 1987 issue of Research Policy). However, we did not find a similar study for Europe to that made by Chapman et al for the United States.

In East Asia in which industrial and technology policies have been selectively applied especially in the case of South Korea, the experience of a leading IIT, the Korea Institute of Science and Technology (KIST) has been recently assessed.

It is very interesting to learn the way this IIT, created in 1966, has been changing its role in accordance with the new needs of the Korean economy and the new government science and technology policies (Lee et al, 1991).

Another interesting case in Asia is that of the Industrial Technology Research Institute (ITRI) in Taiwan. The main function of this institute, established in 1973, is to help upgrade the level of industrial technology in Taiwan serving as an important workstation for the introduction and development of new technologies and for their adaptation and transfer to industry. It is also engaged in technology transfer, in the dissemination of the results of technology research and in rendering a variety of technical services (Dahlman & Sananikone, 1990).

Finally, Martin Bell of SPRU has prepared a report which outlines a project which would identify the ways in which the Thailand Institute of Scientific and Technological Research (TISTR) could enhance its interaction with the industrial sector in Thailand (Bell, 1990).

2.2 Policy changes in LDCs

In contrast to what is going on in industrialized countries and some Asian LDCs, significant policy changes are taking place in other LDCs without due attention yet to technology issues.

Given the magnitude of the imbalances that most LDCs economies are experiencing, it has become clearer that the different types of short run stabilization policies that concentrate so far most government attention are not sufficient to face the problem. Some structural changes are needed to ensure the closing of the external and fiscal gaps, to resume growth and foster productive investments.

Based on the view that the roots of the present situation in many LDCs lies in the inward oriented model of growth and the misallocation of resources, especially because of the pervasive role of the public sector, a number of policy recommendations to modify the current situation have been suggested and implemented with the support of the World Bank and other multilateral agencies. They include strict fiscal policy, tax reforms, positive interest rate, competitive foreign exchange rates, trade liberalization, encouragement of direct foreign investment, privatization, deregulation and securing property rights.

In what is becoming the conventional wisdom in many LDCs, it is generally assumed that once trade liberalization and internal deregulation measures are applied, firms will react to the new competitive conditions by reducing costs, introducing new products and production processes and improving the quality of their goods and services. In other words, it is assumed that through the operation of the market forces firms will react in a positive manner to the new conditions.

The main problem with this approach is that ignores the crucial fact that the process of upgrading the technological capacity of firms is clearly riddled with all kinds of market failures.

Since private firms have difficulties in fully appropriating the fruits of the resources allocated to knowledge creation (such as training, design, research and development and other technological activities) they will usually underinvest (or not invest at all) in these activities. At the same time, since the innovations incorporating new technologies and organizational techniques are not simply embodied in physical

commodities the market in which these innovations are diffused is very imperfect. To be able to take advantage of these innovations recipient firms need also to allocate human and physical resources whose costs may not be fully internalized.

In these conditions, it is crucial to bear in mind that to be able to reach in a positive manner to the new competitive conditions, firms do not only require the "sticks" of liberalization. They also need some well designed "carrots" to be able to upgrade their technological and organizational capacities. Hence, the need for specific institutions to fulfil such role clearly arises.

Although the existence of strong externalities and imperfections in factor and product markets creates a clear case for government intervention, many government failures cannot be ignored either.

Once it is accepted that the significant externalities as well as the market failures involved in the process of creating structural competitiveness on the basis of technological efforts justify government intervention, the challenge is how to design and implement such intervention, taking into account that the on-going process of reforming the State is constrained not only by the fiscal crisis and the tremendous deterioration of the public administration but also by the prevailing "hands off" philosophy.

In these conditions, governments should have technical capacity to propose and implement selective and well defined proactive policies while relying, as much as possible, in the competitive forces that may operate through the market to mobilize the private sector capabilities, i.e. market-based solutions.

"Good policy requires identifying (market failures), asking which can be directly attacked by making markets work more effectively (and in particular, reducing government imposed barriers to the effective working of markets) and which cannot. We need to identify which market failures can be sanctioned through non-market institutions (with perhaps the government taking an instrumental role in establishing these non-market institutions). We need to recognize both the "lower cost" strengths of markets, as well as the strengths, and "costs", of government interventions aimed at correcting market failures" (Lund, 1991, p.102).

Although the design and implementation of the new set of policies on financial regulatory activities within the manufacturing sector is still pending in many cases (see Chudnovsky, 1991) one of the ways to contribute to this task

is studying the role to be played by an important non-market institution that has been until now mostly supported by governments, i.e. the IIT.

In undertaking such studies it is quite important to bear in mind the different context in which these institutions were created. Within import substitution industrialization, although the higher technological requirements of entering into the production of intermediate, capital goods and modern consumer durables were often met through licensing agreements and the establishment of subsidiaries by IITs, in some cases manufacturing enterprises played an active role in adapting the received technology to the different environment. Furthermore, some minor product and process innovations were usually generated in these activities.

Scale down activities, modifications in the original basic and detailed design to include local inputs to be able to meet the higher local content rules imposed by many governments, certain adaptations of the equipment to use more labour, changes in the product design and quality parameters to take into account the particularities of the domestic market, etc. are the type of activities to which indigenous efforts were concentrated. Most of these efforts were made within the state projects and public manufacturing enterprises and were concentrated in:

However, some pre-competitive activities like standards, laboratory tests and certain product and process developments required expertise and personnel that were beyond the reach of many private firms or were too expensive to be supported by private financing. To fulfill these tasks the IIT were created.

As established and with the higher technological requirements involved in shifting from manufacturing only for the domestic market to export part of the production to external markets and the advances in import substitution especially the tough requirements imposed by the procurement policies of some State enterprises, the scope and variety of activities of these IIT were enlarged. To meet the growing costs of the new services and activities some forms of private financing to the projects were introduced but the main financial source of IIT activities has always been the State.

As reflected in a joint UNCTAD/UNEP evaluation of industrial research and services undertaken at the end of the 1970s, the policy objectives of many of the institutes were very noble, though most of them had neither the capacity nor the capability to achieve these objectives and had spread their resources too thinly. Although engaged in some R & D activities mainly as result of in-house initiatives and with limited commercial potential, the strength of the IIT had

in some supporting services(i.e. certification of products, standards, quality control, etc) they were able to provide. However, critical extension services(i.e. trouble-shooting, process improvement and rationalization, quality improvement, etc) were usually not due primarily to inadequate knowlwd in industry and knowledge of the problems themselves (IMIC, 1979).

Although it is not clear what role is to be played by the IITs, use of several and many proposals to improve their performance made (see notes by Poch, 1979; IMIC, 1979; Delak, 1981), so far no serious attempt has apparently been made to redefine their role and only taking into account as in the past their internal problems but also and fundamentally the changing economic and technological environment in which they operate.

While there is no doubt that much can be learnt from the experiences of some industrialized countries and of some LDCs like South Korea, Taiwan and Chile (with the unusual example of the Chile Foundation as shown in Hies, 1981) and even from the experiences of the Institutes for Agricultural Technology in several Latin American countries, there is also an urgent need to tackle the problem of the IITs in several Latin American countries by seriously studying their current situation. Only on the basis of a thorough study of actual experiences it is possible then to propose a redefinition of their role and functions.

3. Guidelines for studying the role to be performed by IITs

The main objective of the proposed study is to learn about the structure and functions of the IITs, to document the main problems these institutions are facing and to detect the ways they have already been adapting to meet the new requirements of industry in countries in which deep changes are taking place. From this study it will be possible to suggest a number of proposals for the restructuring of the IITs.

The focus of the study is towards restructuring the IIT to meet the requirements of the new environment. Hence, it is important to learn how far the IIT has already reacted to the new context and whether this reaction reflects the feelings of the IIT's personnel, the availability of funds and/or guidelines from the government.

In what follows we summarise the study to be proposed. If budget and time constraints permit a more restricted study, it is suggested below with an interest which aspects should receive special attention in a restricted study.

With this general objective in mind the proposed study should contain three main chapters. The first chapter should pay attention to the internal structure and the way the IIT has been basically operating in recent years. The second chapter should contain some information on the relationship between the IIT and the environment in which it operates. The main lines to be proposed for reconverting the IIT should be included in the last chapter.

4.1. Structure and operation of the IIT

Policy Objectives

It is quite important to learn about the explicit and implicit objectives for which the institution was created and whether these objectives were modified during the evolution of the IIT. The usual objectives are improvement of existing industries, transfer and adaptation of technology, development of new technology and of local materials and human resources.

In this connection, it is useful to learn whether criteria such as the following were taken into account in one way or the other in defining the actual objectives:

-*Technology was conceived in a narrow way (i.e. as a production technique) or in a wide manner (i.e. taking into account organization technologies, marketing, sourcing, management, etc)

-*Given the importance of technology imports in the countries to be studied, efforts by the IIT were supposed to be mainly directed either to substitute technology imports or to complement such imports (scale down activities, modifications in basic and detailed design, adapting the product and processes to different degrees of local integration). It is also possible that efforts have been concentrated on materials, processes and products that have been bypassed by the mainstream of industrial expansion and the associated inflow of imported technology (see Bell, 1990 pp.54-59 for a good discussion of these key issues).

-*Clear decisions about which industries were considered to have priority in multi-branch institutions (eg chemistry, paper and pulp, metalworking, etc)

In a deeper study, besides paying attention to the historical circumstances in which the IIT was created, it would be interesting to compare the explicit and implicit objectives with the main projects implemented by the IIT to detect gaps between objectives and performances and find possible explanations of such gaps.

It can be easily expected that when the objectives of the institution have not been modified or a sort of inertia prevails in large organizations, self defined objectives start to flourish. Some of them may have gone in the right direction while others clearly not, and hence contributing to the isolation of the institution from the surrounding environment.

On the other, the functional structure is to some extent dependant on the objectives of the institution.

The IIT were generally conceived as organizations to be related to the main productive sectors, without time limits in their tasks and in function of very general objectives. Alternative approaches would have been more reduced though stable institutions acting as brokers or subcontractors with the universities or other institutions for the performance of well defined programs with precise time limits. It would be useful in any case to explore the factors explaining the adoption of one or other functional structure.

Functional activities, users and impact

‡ Current relative importance (in terms of personnel and incomes and whether this is though to be correct) of the following large functional activities:

-Research and Development (eq. product and process development, new materials, new applications, prototype development, product design and/or evaluation, etc)

-Supporting services (eq. product/process testing, technical information, techno-economic evaluation, preparation and issuance of industrial standards, quality control and certification testing, etc)

-Extension Services (eg. trouble shooting, process improvement, process rationalization and industrial engineering, quality improvement, joint venture/partnership counselling, networking & referrals, technical counselling, technical data services, technical literature dissemination/review, user request and response)

-Training of industry personnel (with the aim of either improving the existing technology level or introducing new technology)

Certain activities may be classified under one or other main heading and this classification may have changed. In a deeper study it would be useful to compare the relative importance of the above activities in several points in time.

* It would be important to learn whether in addition to the above large functional activities, other activities such as incubators, research parks, more general business assistance, seed capital and research centres are undertaken. If this is the case it would be very important to learn what is their importance and results achieved.

* It is extremely important to learn which are the main users of the work programmes of the IIT. Although it can be assumed that small and medium size firms are main clients of these IIT, it is also possible that State enterprises, large domestic and foreign firms are also relying on their services. If this is the case it would be important to learn in what sort of projects the main users are large firms.

* marketing and diffusion mechanisms for the results of IIT activities mainly used

* A preliminary assessment of the impact of their work in terms of direct application of research results, publications and contributions to the solution of specific technical problems among users. A short description of some successful examples would be very useful.

In a deeper study, a more detailed evaluation of the impact of the IIT work should be made by relying on users and experts' opinions. It would be also important to have description and evaluation of successful and unsuccessful examples.

Organizational and managerial aspects

* It is important to pay some attention to the way the IIT was organized and how this organization has been modified in the evolution of the institution. Regarding the participation of the private sector it is important to be specific whether the private sector is represented by trade associations, individual firms, private foundations, etc and what actual influence it has in policy decisions and allocation of funds.

It would be useful to get information on the following aspects:

-* a chart with the internal organization of the IIT and its affiliated institutes. It would be useful to have an idea of the main departments and functional divisions with the number of employees in each one and the hierarchical roles.

-* the main changes in the internal organization in recent years and their reasons

-ii the division of tasks and the type of relations established with the affiliated institutes and/or specific programmes. In a deeper study, it would be useful to learn why they were created, their main activities and resources, criteria used to define their programmes, how the assets and facilities are shared between the main and affiliated institutes, etc.

-iii calculation of present level of the main and affiliated institutes, present accounting for such trend.

How is the Directorate organized (relationship with the heads of departments, composition of the Board of Directors, etc.)? How priorities are established? What criteria are used to assess the results of the activities?

-iv usual channels of relating the IIT technical personnel and heads of programmes and departments and users.

Human resources

This is a central aspect to be examined to verify to what extent and in what areas the skilled personnel employed by the IIT is an asset or a liability for restructuring the institution.

The professional profile of the skilled staff of these institutions is generally quite good, although perhaps biased in favour of certain skills and without adequate skills in other areas such as preparation of pre-investment studies, in consultancy work to deal with restructuring process, in marketing and management of technology, etc.

However, the low salaries (as compared with the private sector) has not always been compensated by other intangible benefits such as work environment, incentives for publication, possibilities for retraining, etc. In many instances the IIT became the young centres for technical personnel that is then used by the private sector without any previous contribution to reward the institution for such efforts.

It would be useful to obtain information on the following aspects:

-The personnel employed with their main professional qualifications (scientists, engineers, economists, technicians, other professional staff, etc.) and main functions (administration, research, consultancy, etc.).
 -Average salaries paid and comparison with what is paid in the private sector for similar jobs.

-Internal and international training schemes (courses followed, attendance to seminars, scholarships, etc)

-Labour relations (trade union organization, extra payments for consultancy activities, etc). Issues related to personnel that work jointly in the IIT and in the university.

-Evaluation systems for promoting the personnel (publications, external or internal jury). Promotion schemes (additional income to be obtained out of consultancy activities and intangible research title issues, academic distinctions, etc).

Stock of equipment

The physical assets of the IIT are a big item to be taken into account in any assessment of their potential contribution.

In the same out-of-focus of machinery and equipment that are in operation in an IIT, it is possible to find in some stores thousands of high-priced tools and instruments, some of which are individual in design. Like valuable analysis and quality control. In other cases, a few specialized scientific equipment items only for specific R & D activities are found. In between many kinds of equipment are available and in many offices and departments.

In addition to the traditional issue of obsolescence and likely obsolescence of equipment, a number of economic issues have started to be raised in view of the financial difficulties of these institutions. How the amortization and maintenance expenses are estimated when the equipment is shared among several internal departments and even more complicated when external users are also using it? How priorities are found for the use of the equipment when the same equipment can be applied for both for research & D (included in the permanent budget and of uncertain profitability) and for certain development activities or simply sale of services with a tangible profit?

Although no detailed analysis should be needed to get information on the following topics:

4. An estimate of the value of the stock of equipment. In a more detailed study, the distribution of the stock between main departments and affiliated institutes should be estimated, trying to point out equipment or joint use for several departments.

-The weak and strong points in the equipment. Idle capacity.
Main missing equipment. Problems of maintenance.

-Equipment resulting from international cooperation grants.
Security, value and degree of adequateness to the needs.

The priorities are determined for the use of the equipment and for the equipment to be acquired according to the program and the type of responsibility, possible, from the company, public authorities, etc. (see para. 1.10).

Financing

The way of approaching the financial issue depends to a large extent on the role assigned to the III in public policy.

Two all-rositive theoretical positions are usually put forward. On the one hand, given the externalities to be provided by such an institution for a large number of users and giving the difficulties in establishing a market price system for most services, the scheme normally used is an item in the national budget to finance the III.

On the other hand, the resources provided by the III should be paid by the users. The State should help in realizing the tasks to be fulfilled by the III and in articulating the different private agents to be able to fully utilize the human and physical resources of the institution. If that is the case, only a small part of the financing of the services to be rendered should be supported by the III. The users should pay most of the costs involved in providing the services in question. In this approach, not even the III should provide the services. It may act as a subcontractor and organizer of services to be rendered by third parties.

Between both positions, a number of intermediate solutions are possible. It is important to take into account that given the current crisis, the financial criteria are not normally considered in these terms. It is basically the cash flow needs of the institution, the main deciding factor.

While working with a request for specialties in financial management in this type of institution, a related question is how to improve the way of financing. For some time, some have advocated the possibility of financing by receiving, either in a permanent or temporary way, equipment and other personnel or other goods from the private sector. Some have also noted that one often found in affiliated institutes where the private sector has normally more influence in decision making than in the central institution.

To assess the financial issues information on the following issues should be obtained:

-* Sources of funds for the activities of the III and affiliated institutes (public, private, grants). Main trends and composition of the sources of funds.

-* The allocation of funds in terms of personnel, equipment, training and other items.

-* In the remaining aspects, the different services are sold and priced and how the common equipment is allocated to these services.

-* In general, the private sector has been participating in decisions and decisions on allocation of funds not only for resources to immediate commercial value but also for long term investments.

Evaluation mechanisms

In the case of the III it is not only to evaluate the way the human and physical resources involved are allocated. The fact that several projects cannot be normally made use of that purpose has not prevented the use of other criteria.

It is also interesting to know what kind of evaluating system the different countries are following. In this regard, the fact that the different countries have different departments or institutions that have been set up to evaluate projects should have been previously. It has been stated that such institutions should be used for evaluating the efficiency of the resources allocated by these institutions.

It would be interesting to know what kind of evaluating system is used for evaluating the efficiency of different projects taking into account both private and social costs and benefits.

It is also interesting to know what kind of evaluating system (internal and external and with what kind of evaluators) has been applied for the different levels of the institution (i.e., for the units III, for some departments or affiliated institutions, and some programmes, etc.)

10. The relationship of the III with other institutions and with national and technology policy

The III and the national system of innovation

Although in our countries there is available a study on the way the national system of innovation works, some information of the main components of this system normally exists (e.g., institutions dealing with currency, research laboratories, and universities, etc.).

In so far as the IIT is part of the national system of innovation, it is very important to have a idea of where it stands within that system.

Some of the topics that should be investigated are:

-the amount of resources devoted to R & D (legally defined and the budget and personnel employed by the main institutions

-the specific functions fulfilled by the main institutions of the national system and the possible overlapping with the functions performed by the IIT. If possible, detect some missing functions that are not performed by any existing institution.

-the way the different institutions relate to each other through formal and especially through informal channels. Attention should be paid to formal agreements, joint programmes and joint use of facilities as well as to personnel working in more than one institution, trainees, secondments, etc

Relationship with foreign technology institutions and international cooperation activities

This is a very important topic, especially taking into account the changes taking place in industrialised countries in this field.

Beyond learning with what foreign institutions the IIT is already in touch and what type of joint activities are performed, it would be important to learn the interaction in several directions (in fixing joint programmes, exchange of experiences, personnel, information, etc)

Taking into account the revival of subregional integration agreements, special attention should be paid to the relationship with similar institutions in neighbor countries. In this connection, it is useful to learn via their steps have been already taken in formulating joint programs or in discussing the restructuring needs with respect to regional development strategy.

The experience of recent cooperation in various areas has been partially applied to another region or country. Important agencies like UNCTAD, ITC have often allocated funds and resources for technical cooperation by the IIT. It would be useful to exchange the experiences with these foreign institutions and find ways of expanding their actual contributions.

The IIT and the industrial and technology policy

What has been the role, if any of the IIT in shaping the industrial or technology policies of the country at national or state levels.

Even if the IIT has played no role in the respect, it is important to learn whether nowadays or in the past any degree of coordination has existed between industrial and technology policies, rather explicit or more frequently implicit or non-existent and the IIT activities.

There is an important issue especially relevant to advanced the world that most countries face of not only restructuring the IIT but also of defining and approaching industrial and technology instruments in more open and deregulated economies.

It is quite possible that a wide gap has developed between the actual performance of the IIT and the goals of industrial and technology policy (in clear contrast to the Korean experience) because of the relative isolation of these institutions, especially when they were forced to get part of the financial resources from the private sector, on the one hand, and the growing problems faced in implementing traditional industrial policies in developing countries, on the other.

A possible way to approach this issue in a more systematic way is to examine the time period covered by the period of the main IIT projects and the public measures taken at sectoral level and their contribution to the sectoral development and see if any relationship is actually found between them.

External evaluation

It would be useful to learn if any external evaluation has ever been made on the linkages between the IIT and its main users, on the one hand, and on the other, between the IIT and other nodes of the national system of innovation.

In contrast to the other evaluations mentioned above, this type of evaluation is often less externally oriented.

3.4 Proposals for strengthening the IIT

The starting point for preparing the proposal for an industrial system building of these institutions is that:

- (a) they have an important stock of human and technological resources that should be fully utilized by clarifying their functions, structure and mode of financing;

b) that once due attention is paid to the changing needs of industry, they have a useful role to play in the new circumstances and it is out of the question to eliminate them;

c) the restructuring of the IIP is part of the process of modernizing a new set of industrial, technology and innovation policies, which is to be developed and implemented in a way that does not cut off proposals for restructuring in IIPs and, at the same time, a useful input for a more general discussion of that new set.

In addition to the findings of the previous two chapters, to prepare the proposals for restructuring the following additional aspects should also be taken into account:

The new demands and constraints

The emerging situation in which macroeconomic imbalances in some countries are becoming less severe and the structural changes in progress by which new roles are given to private and public agents are the crucial factors in the domestic picture.

Trade liberalization measures, commercial reforms, privatization programmes and substantial modifications in State procurement policies are changing the framework in which manufacturing enterprises have conducted their activities in the past.

In view of the new conditions, the large enterprise groups and subsidiaries of IICs are redefining the strategies followed in the different areas in order to be able to compete in more open and free State regulated economies. The technological requirements of the emerging strategies are being defined but they will be contained partly in programmes on such matters as, flexible manufacturing equipment, higher quality,

These developments at the domestic level are certainly in line with some of the changes taking place at international level. It can be expected that foreign direct investment flows and different forms of technology transfer are finding strategic partnerships in some specific cases may increase the supply of high technology to some IITs.

However, one should keep in mind that the State is planning in the medium and long term financial and fiscal definitions consistent with the possibility of applying economic policies of the type used in the past (based on fiscal restriction and fiscal and financial incentives). Even in this situation, some basic definitions of public policies should be discussed.

Public Policy Issues

Taking into account the fiscal constraints and the generally vague manner in which industrial and technology issues are mentioned in public policy definitions, it is important to pay attention to some key issues.

First, to visualize the different roles to be played by other agents in the national system of innovation, it is crucial to define clearly the specific role to be played by the IIT. What sort of supporting services should continue supplying? Should extensions services be strengthened and within them which type of services receive priority? Is it going to have a wider role in promoting the dissemination of innovations across the manufacturing sector? (i.e., international search of technologies and of suppliers, identification of technology needs of local users, assistance in the absorption and adaptation of imported technologies?) What type of R & D activities, if any, should be undertaken?

Second, once the type of institution that seems more adequate in the current policy approach is defined and on the basis of previous experiences and present constraints the functional structure of the institution should be discussed.

Third, the main manufacturing branches for which the IIT would be created should be clearly defined and decisions should be taken regarding the profile of the proposed agency to be created, i.e., small and medium size firms, independent large domestic firms, large domestic conglomerates, State firms, multinational firms or IITs, private research institutions,

Fourth, what type of technology needs should be covered within a wide definition of technology in which not only production but also management, marketing, before and after sales services must be included.

Fifth, the ways of financing the IIT and the mechanisms guiding the appropriability of research results.

Sixth, the time dimension and methodology of implementing the IIT and technology programmes.

Finally, on the basis of the previous definitions a more accurate proposal of the organizational aspects of the restructured IIT should be made, including issues such as internal structure, sources of financing, evaluation systems, internal production versus subcontracting, etc.

Methodological questions

The guidelines suggested above are aimed at having a serious and forward looking study of the IIT at national level. Although there are many peculiar aspects to each country, it is important that several common topics are covered in each study to facilitate further comparisons and exchange of experiences.

In each study it is important to provide some basic quantitative information and a qualitative assessment of the person or team in charge of the study of the numerous issues involved. Although an important part of the study requires access and good dialogue with officials working in the IIT to be investigated, it is indispensable to have interviews as well with government officials, different types of users, trade associations and especially those representing small and medium size firms, industry and technology experts and university professors.

The proposed set of studies should received the benefit of not only doing them jointly with one or more studies of the experiences of IIT in more advanced industrial countries. If possible it would also be useful to make available to the person in charge of each national study of copies of the studies made by Lee et al on KIST, the sections on ITRI of the Dahlan and Saranikone study on Taiwan, the Kosi report on Thailand, the study made by Chapman et al on the United States and any other relevant material.

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