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Review

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Transfer of technology: the case of the Chile Foundation

*Torben Huss**

Restructuring and the incorporation of modern technology are crucial in order to increase productivity and develop international competitiveness in Latin American industries.

Transnational corporations are the main source of industrial technology in the world, and most countries in Latin America will continue to depend on access to that foreign technology to modernize their industries.

The process of acquiring and assimilating foreign technology is a difficult and resource-hungry business for individual enterprises because it involves searching for the most appropriate technology, bargaining for an optimal agreement with the foreign supplier and adapting the technology to local conditions. The recipient enterprise must learn to master the technology in order to make the best use of local resources and establish an internationally competitive position. This article analyses the ways in which the promotion and creation of local consulting and engineering design organizations can improve and facilitate the transfer of foreign technology to Latin American countries by assisting national enterprises to better select, adapt and assimilate the imported technology.

This is highlighted in a case study of the Chile Foundation, an innovative Chilean consulting and engineering design organization which represents one manner of overcoming the barriers of technology transfer.

* Associate Expert of the ECLA/UNCTC Joint Unit on Transnational Corporations. The author would like to thank Michael Mortimore of the Joint Unit for valuable comments on this article. The information provided by Pablo Herrera of the Chile Foundation is also greatly appreciated.

Introduction

The acquisition of technological capabilities is a basic requirement for the continued growth and development of the Latin American and Caribbean countries. Technological change has accelerated in recent years and the pace of technological progress is now understood to be of crucial importance for international trade and competitiveness.

In most of the countries in the region, however, the demand for technology cannot be met immediately by local technological capabilities. Accordingly, these countries depend on the transfer and diffusion of foreign technologies to transform and modernize their industries.

The process of acquiring technological capabilities abroad—that is, searching for the most appropriate technology, bargaining for an optimal agreement with the foreign supplier, and then assimilating the technology and adapting it to local conditions—is long and very resource-demanding for individual enterprises. This is particularly so when the technology is not fully embodied in machinery and equipment that can be purchased ready-made, or when the technology is new and highly specialized.

Unfortunately, it is very difficult for policymakers in developing countries to solve these problems. Technology is not a homogeneous commodity. The costs, potential benefits and technical characteristics must be dealt with in the context of specific cases. There are few general rules or solutions available, but most research studies on technology transfer seem to agree that those developing countries which have the capacity to search out and evaluate foreign technology are usually able to acquire and apply the technologies they need on satisfactory terms.¹

But how can governments in developing countries strengthen this capacity where it exists or implant it where it does not already exist?

This article analyses the ways in which the promotion and creation of local consulting and engineering design organizations (engineering service firms, ESFs) can improve and facilitate the transfer of foreign technology to developing countries by assisting national enterprises to

¹ For an overview see Vernon, 1988.

better select, adapt and assimilate the imported technology² Special consideration will be given to the question of whether ESFs formed as joint ventures between transnational corporations (TNCs) and national agents carry greater potential to spread and strengthen ESF capabilities in developing countries.

The article begins by discussing, in section I below, the specific meaning which will be ascribed to the terms "technology" and "transfer of technology". Thereafter, different forms of technology transfer from TNCs to developing countries are discussed in order to understand why those forms of technology transfer in which the host country retains majority or total ownership of the investment project or enterprise have been gaining importance. Section I then proceeds to analyse the requirements and constraints that the recipient enterprise must satisfy in order to assimilate, adapt and diffuse the transferred technology effectively.

In section II of the article, ESFs are characterized in order to examine how they can assist national enterprises in the technology transfer process. The section also analyses the constraints on local ESFs in developing countries and discusses the question of whether joint ventures with transnational corporations simplify the difficult

start-up phase and provide the necessary technological capabilities.

In section III, a case study is presented in order to gain further insight into how a national ESF, in joint venture with a transnational corporation, can create such technological capabilities and facilitate technology transfer to a developing country. The advantage of the case study methodology is that it permits the analysis and comprehension of a complex situation in which many variables interrelate. The conclusions drawn may not be of general validity, but they present a specific experience that can be a valuable source for learning.

The case chosen is the *Chile Foundation* (Fundación Chile). The Chile Foundation is a joint venture between the Government of Chile and the US-based transnational corporation ITT, and its aim is to "transfer to Chile those technologies which can improve the utilization of the nation's natural resources and productive capacity and stimulate the creation of new business enterprises based on these technologies" (Chile Foundation, 1986). The case study is primarily based on interviews with Mr. Pablo Herrera, Manager of the Chile Foundation, but it is also based on information taken from annual reports and other publications of the Foundation.

I

Technology and transfer of technology

1. *Technology: a definition*

It is important to clarify from the beginning the concept of technology used in this study. Often technology is understood as machinery and other forms of "hardware". But it is more than that. It has to do with the knowledge needed to produce specific goods or services. Part of this knowledge is embodied in machines, but most of it is not. It is embodied in human skills, in manage-

ment methods, in routines, and in organizational structures. Thus, E. Mansfield has defined technology as "the stock of knowledge (technical or management) which permits the introduction of new products or processes". Technique differs from technology in that "the former is a method of production at a given moment which is defined by the equipment and the management method used, while the latter is the *whole* of the knowledge used in production" (Mansfield, 1968).

2. *Transfer of technology: a definition*

Transfer of technology is best understood as the process of acquiring technological capability

² It should be established from the beginning, however, that this article intends to suggest that ESFs are an important, but not of themselves sufficient, condition for fulfilling development goals as regards technology transfer.

from abroad. It consists of three stages: (i) the transfer of existing technologies to produce specific goods and services; (ii) the assimilation and diffusion of those technologies in the host economy; and (iii) the development of indigenous capacity for innovation (UNCTC, 1987). Hence, technology transfer is not completed by acquiring technical knowledge (information embodied in blueprints or operational manuals) or the means of carrying it out such as capital goods. The technology transfer is only completed when the recipient fully understands the technology or has acquired the technological capability to use it effectively. This requires the ability to adapt and modify the technology to local conditions and improve it through innovation. Technological capability can only be acquired through the formation of human capital, which is related to education, job training, experience, and specific efforts to understand, adapt, improve or create technology.

3. Different forms of technology transfer

Transnational corporations (TNCs) are the main source of industrial technology in the world, and the most important actors behind the international transfer of technology. Foreign direct investment (FDI) has traditionally been the principal mode by which TNCs have transferred technology to developing countries because it involves continuing direct ownership of the technology. According to Richard E. Caves, it is important for a TNC to retain control over its technology because it is considered part of the firms "intangible assets". Such assets (like industrial property rights, unpatented know-how, marketing know-how, etc.) provide the firm with a competitive advantage over other firms (Caves, 1982). This points to a relatively limited technology transfer by way of FDI, because TNCs are reluctant to share their intangible assets. The technology transfer primarily occurs through the establishment of linked industries within the local economy or through the secondment of trained personnel to local enterprises. Since the late 1970s, however, other mechanisms for technology transfer have been gaining importance. TNCs are expanding their use of joint ventures and non-equity arrangements such as: (a) licensing; (b) franchising; (c) management contracts; (d) marketing con-

tracts; (e) technical service contracts; (f) turnkey contracts; and (g) international subcontracting.

This broad range of international corporate activities is covered by the term "new forms of investment" (NFI). According to Charles Oman, these new forms of investment have the common denominator that a foreign company provides assets (e.g., equipment and technology) to an investment project or enterprise in a host country but local interests in the host country retain majority or total ownership of the investment project or enterprise (Oman, 1989). A number of factors have caused the growth of NFI. The rapid expansion of TNCs in the late 1960s and 1970s increased global competition among technology exporters, which enabled governments of developing countries to introduce restrictive legislation limiting the establishment of wholly-owned TNC subsidiaries. Many governments saw NFI as a way to enhance host-country control over production and increase technology transfer. But today the trend in most developing countries is to liberalize policy towards foreign direct investment (FDI) in an attempt to attract more flows of such investment. The decline in voluntary bank lending and the acute balance-of-payments problems that many countries face have resulted in a need for investment that surpasses previous concern over ownership shares. FDI is also widely viewed as the principal source of new technology and access to international export markets, both of which are badly needed in order to increase international competitiveness.

Despite this setback for the original policy aims, there is evidence that NFI will continue to gain importance in developing countries. First, some of the larger and more industrialized developing countries have already built up considerable local capacities in management, technology and equipment production and therefore are able to acquire and bargain for specific assets from foreign suppliers. Secondly, many TNCs have realized that a minority or even a non-equity position does not necessarily imply inadequate control of the intangible assets (e.g., technology). In fact, a growing number of TNCs are finding that they can earn attractive returns from selling intangible assets without having to finance the investment projects, because this means reduced exposure to commercial and political risks compared with FDI. According to John Dunning and

John Cantwell, this is the case when the local partner has a valuable contribution to make, the technology is of a mature, standardized kind, or it is of secondary concern to the major activities in which the TNC is engaged (Dunning and Cantwell, 1986). Oman (1989) has also stressed that small- and medium-sized OECD-based firms which do not have the resources to undertake an FDI operation use NFI as a strategy to internationalize their activities and compete with the major TNCs and market share leaders.

The question that arises now is whether NFI can result in an effective technology transfer to developing country enterprises and, if affirmative, what capabilities the recipient enterprises have to absorb the technology. This will be examined in the next section.

4. Technology transfer and technical change in developing country enterprises

The dominant feature of enterprises in developing countries has been that they have remained more or less passive recipients of technology from TNCs. Protected behind trade barriers, local enterprises lacked incentives to embark on an active strategy to raise productivity through innovations. Technology was purchased from TNCs because this was faster than developing it locally and the high costs of imported technology could be passed on to consumers. Early studies of technological development in the Third World focussed mainly on the problems associated with the transfer of technology from richer to poorer countries. These problems were primarily related to the cost and appropriateness of the technology transferred. It was suggested that the recipient countries were paying too much for the technology because of their weak bargaining position *vis-a-vis* technology suppliers. National enterprises lacked information about alternative production possibilities and did not know the true value of the technology. This was due to the special characteristics of the technology market. As pointed out by Arrow, the fundamental paradox of that market was that the value of the technology was not known to the purchaser until he had the information, by which time in effect he had already acquired it without cost (Arrow, 1971).

The technology itself was considered to be

inappropriate to local conditions and resources in the majority of cases, and it was often utilized in an inefficient way by the recipient countries. It was also implicitly assumed that imported technology inhibited and replaced indigenous innovation efforts in developing countries.

In the late 1970s, case studies conducted at the enterprise level suggested a more dynamic relationship in which technology transfer under certain circumstances could induce indigenous innovative activities by the recipient enterprises (Fransman and King, 1987). The case studies of how enterprises assimilated and adapted imported technology revealed that the process of assimilating technology by the recipient enterprise often required problem-solving in which the solution was not given by the technology supplier. These problems were even greater when the conditions prevailing in the recipient country differed substantially from those of the country where the technology was developed. The assimilation of technology, therefore, involved a process of technological change which in some cases led to the appearance of products and production processes that were considerably different from those in the developed countries.³

It was pointed out in the case studies that the process of acquiring technological capabilities is very uncertain and not simply the automatic outcome of production experience ("learning by doing"). It cannot be expected that the mere fact of undertaking a specific type of production will result in a learning process and the development of capabilities to improve the ways of carrying out such production. To some extent, learning by doing is clearly a necessity in many phases of technological development. But it does not seem to be sufficient to maintain progress through all phases. Bell, in particular, has stressed that learning by doing is only one mechanism for augmenting technological capacity.⁴

Equally important for overcoming dis-

³ This has in many cases led to a South-South export of technology (Dahlman and Sercovich, 1984).

⁴ See: Martin Bell, " 'Learning' and the accumulation of industrial technological capacity in developing countries", in Martin Fransman and K. King (1987), pp. 187-209. If this were the case, it would lead to the policy prescription that protection of national enterprises (infant industries) was a sufficient means to enhance learning.

continuities and, perhaps, also for achieving overall efficient assimilation of imported technology, is explicit investment in human capital (training of personnel and hiring of advisors), which will create a capacity for change and adaptation. The development of capabilities to assimilate and adapt imported technology successfully (thus improving productivity) depends on an active strategy for acquiring technology by the recipient enterprise. The optimal strategy will obviously vary across countries, sectors and enterprises, but there seems to be a wide measure of agreement that active technology transfer strategies should involve the following elements/phases:

- a) Assessment of technology.
- b) Assimilation and adaption of technology to local conditions.
- c) Diffusion of technology.
- d) Innovation.

These are considered briefly in the remainder of this section.

a) *Assessment of technology*

In most industries, one sole technology is rarely the best for all circumstances. National factor endowments vary, as does the nature of intermediate inputs. Therefore, when choosing among alternative technologies, the recipient enterprises must find the most *appropriate* technology, that is, the one that makes optimum use of available resources.⁵

The first step to take in assessing and selecting a technology is to identify local needs and conditions. This is essential in developing countries, where the needs and conditions are often very different from those in the countries that supply most of the technology (Dahlman, Ross-Larson and Westphal, 1987). The benefits of such identification seem quite obvious, yet many investment projects in developing countries fail to do this. Specifically, the failure to identify local constraints is a repetitive problem which undermines many investments in developing countries. The typical constraints are in the areas of energy, transport, capital, skilled labour, and the supply of raw materials and other intermediate inputs.

The second step is to search out the available technologies on the international market. This requires extensive information about different technology suppliers and is frequently by-passed because of the significant costs and capabilities required. Needless to say, the failure to do this has costly consequences in the long run.

The third step in assessing new technologies is to evaluate their associated benefits and cost, using prices that properly reflect relative scarcities (Dahlman and Westphal, 1983). This involves essentially economic considerations, but social and environmental aspects could also be analysed.

The fourth step is to decide if the capabilities that can be acquired from experience with different technologies will enable the enterprise to make future improvements and innovations in order to increase productivity, or move on to new activities. Some technologies open up more possibilities than others.

b) *Assimilation and adaption of technology to local conditions*

Once the different technological possibilities have been properly assessed, then, ideally speaking, the enterprise should move on to the phase of assimilating and adapting the selected technology to local market conditions. Often, enterprises will experiment with more than one technology before making their final technology choice.

The aim is to understand the technology and 'fit' it to local conditions. The challenge is to take advantage of local demand and supply conditions to improve productivity and international competitiveness. This phase will most likely involve minor innovations or modifications of the technology to increase productivity, reduce costs, stretch capacity or improve quality. Many enterprises fail to achieve a sufficient understanding and effective adaption of the foreign technology before initiating full-scale commercial production. The consequences can be low productivity, loss of competitiveness and inadequate development of technological capacity to innovate and overcome production-related discontinuities. The constraints on enterprises during this important phase of the technology transfer process are, typically, lack of qualified personnel and absence of proper laboratories and test plant facil-

⁵ This is the definition of appropriate technology used by Dahlman and Westphal (1983).

ities. Another problem is that adapting technology can be a very long and therefore costly process because the initial production output with the new technology is low. Many enterprises do not have the economic resources to invest sufficient time in this process.

c) *Diffusion of technology*

When the enterprise has gained sufficient knowledge of the technology's potential and some experience in its use, the technology can be diffused on a larger scale. Additionally, efficient diffusion requires knowledge of capable construction companies, relevant management capabilities, sufficient capacity to bargain with local authorities, and economic resources to acquire an appropriate production site.

d) *Innovation*

As mentioned earlier, the efforts to assimilate and adapt technology to local conditions can lead to minor innovations (invention of new devices, products and production processes or improvements of the existing technology). It would be correct to speak of an 'incremental' or 'evolutionary' innovation process, to distinguish it from the more radical innovations (Herbert Copley, 1989, p. 10). But as revealed in the above-

mentioned case-studies (see Fransman and King, 1987), the innovation process (technical change) does not proceed at a constant rhythm or in a uniform direction. Innovations will often be the result of efforts to overcome constraints on the enterprise's production capacity.

5. Conclusion

It should be stressed that a successful transfer of technology usually depends on a conscious decision and effort by the recipient enterprise to invest time and economic and human resources in assessing and testing the technology, training personnel and contracting technical assistance. Even so, the process is very uncertain and the acquired technology may not necessarily increase the technological capacity of the enterprise.

The problem is that many enterprises, especially in their formative years, lack the experience and financial resources to conduct the necessary assessment, adaption, diffusion and modifications of the imported technology.

In the next section the characteristics and types of services offered by engineering service firms (ESFs) will be defined in order to see how they might offer a solution to the barriers to technology transfer.

II

Characteristics of Engineering Service Firms (ESFs)

There is no hard-and-fast definition of ESFs. Here the definition is chosen on a functional basis and, accordingly, ESFs can be defined as organizations that gather, organize, co-ordinate and apply knowledge for purposes of investment and production. They are characterized by a flexible and multidisciplinary approach to that activity. The services provided for the formulation or execution of an investment project can be of a technical, economic, financial, legal, environmental, or organizational character.

According to Roberts (1973), engineering service activities can be defined as "the set of methods and organizational structures which allow relevant scientific, technical and economic

knowledge to be gathered and converted into designs and instructions for the construction of specific projects". Hence, the role of ESFs is to keep up to date with international scientific advances and accumulate technological knowledge for the design and implementation of national investment projects. The discussion of ESFs below proceeds to define limits for the range of activities that can be described as technical engineering services.

1. Types of services offered by ESFs

A.K. Malhotra (1980) has summarized the services offered by ESFs under the headings of pre-investment services, process and technological

services, project implementation services, procurement and inspection services and, finally, operation and maintenance services. This classification is useful because it reflects the different phases of an investment project, and Table 1 has been prepared in line with it (it should be noted that in that table "procurement and inspection services" was modified to read "inspection and quality control services"). The aim of the table is to describe the purpose of the services offered, the type of information required, and the source of such information. Additionally, the table shows how these services correspond to the different stages in the technology transfer process.

a) *Preinvestment services*

The first stage of an investment project requires economic and technological engineering feasibility studies. Studies of the social impact and environmental consequences of the project will also often be relevant.

The performance of these services requires an interdisciplinary team, with a knowledge of the technology available to the project, information on economic optimization methods, and the ability to carry out market and product analysis. The output typically will be a report evaluating different technology choices and also taking financial, economic, social and environmental issues into consideration. The report constitutes the basis for an investment decision, usually in the form of a recommendation to test specific technology alternatives. In the technology transfer process, this phase corresponds to the initial assessment of the technology available on the market.

b) *Process and technological services*

These services involve the development of manufacturing process capabilities and the accumulation of knowledge of production methods, through research and tests of different technologies in laboratories, pilot plants, etc. Process and technological services may be conducted "in-house" by the ESF or in collaboration with outside research institutions. In the technology transfer process these services correspond to the assimilation and adaption of technology to local conditions, culminating in the final choice of technology.

c) *Project implementation services*

These services transform the project from a concept/proposal to an actual installation. The purpose is to acquire technology for large-scale production and execute the project proposal. The tasks involved are "preliminary engineering for selection of major equipment and materials, preparation of bid documents for suppliers, detailed engineering, including calculation and fabrication drawings, design and award of contracts, fabrication and supervision services" (Malhotra, 1980, p. 14). The engineering services will go hand-in-hand with construction supervision.

Project execution requires substantial human resources, management capability, detailed knowledge of technology, knowledge of equipment suppliers, etc.

In the technology transfer process these services correspond to bargaining with technology suppliers and the diffusion of technology.

d) *Inspection and quality control services*

The purpose of these services is to improve and standardize the quality of production to satisfy requirements of both export and domestic markets. This involves factory inspection, testing of products and quality control according to established standards. Inspection and quality control services demand familiarity with the relevant inspection codes and the standards required, detailed knowledge of equipment, suppliers and their specifications, and the availability of experienced inspectors. As part of the quality control activities, the ESF can provide process and technological services if the product does not comply with standards.

e) *Operation and maintenance services*

These services concern the effective functioning of plant and the elimination of production-related problems. This involves training of personnel, trouble-shooting, adaptation of technology, etc. The provision of operation and maintenance services requires experience, knowledge of similar plants, and "learning by doing".

This short summary of the services offered by ESFs shows that they have the potential to assist national enterprises in all aspects of an investment project, and likewise during all phases of the technology transfer process.

Table 1
ESF SERVICES

Services	Purpose	Type of information required	Sources of information	Stages of the technology transfer process
Preinvestment services	Technological feasibility Economic feasibility Social and environmental impact	Information on state-of-the-art technologies Ability to differentiate between alternative techniques Information on economic optimization methods; ability to carry out market and product analyses Knowledge of law, ecology, architecture, etc.	Recruitment of personnel with up-to-date knowledge External consultants Prior experience Relations and collaboration with R & D institutions Systematic flow of information on changes in technology Information from suppliers	Identify needs, local conditions and constraints Technology search Assess different technological possibilities
Process and technological services	Development of process know-how and manufacturing process technology	Knowledge of fundamental technologies in area Optimization studies	Laboratory testing Pilot plant testing Relations and collaboration with local and foreign research and development institutions Learning by searching Core personnel and external consultants Meetings, seminars, academic and professional associations Information from suppliers Feedback from clients	Bargaining with foreign technology suppliers Assimilation and diffusion of technology Assimilation and adaptation of technology to local conditions Innovation Final choice of technology for large-scale production
Project implementation services	Acquisition of technology Elimination of problems and efficient execution of project	Job experience Knowledge of technology involved, to enable on-the-spot elimination of bottlenecks Knowledge of local supply conditions	Core personnel and external consultants Recruitment of able personnel Records of earlier jobs Information from suppliers Learning through collaboration System performance feedback Learning by doing	Bargaining with foreign technology suppliers Assimilation and diffusion of technology
Inspection and quality control services	Improvement and standardization of quality of product to satisfy requirements of export and national markets	Knowledge of international quality standards Knowledge of quality control technologies, handling and transportation technologies Knowledge of suppliers and their specifications Knowledge of equipment	Feedback from clients Meetings, seminars External consultants Core personnel Laboratory testing	Learning by doing Innovation
Operation and maintenance services	Trouble-shooting and elimination of production-related problems	Job experience Knowledge of technology involved, to enable on-the-spot elimination of bottlenecks	System performance feedback Learning by operating Long experience, low turnover of personnel	Learning by doing Adaptation of technology Innovation

Source: Part of the information in this table was developed from Cartiene Brenner and Celik Kurdoglu, *Mastering Technology: Engineering Service Firms in Developing Countries*, OECD, 1988, and A.K. Malhotra, *op. cit.*, 1980.

2) *Technological capabilities and learning in an ESF*

ESFs can develop technological capabilities in one or more of the five categories of services. Many will only specialize in certain areas, but it is important to emphasize that, potentially, ESFs can cover all aspects of an investment project.

Development of technological capabilities through ESFs depends on five factors. They are i) the quality of the national and international *network* of research institutions and suppliers of technology. This network ensures the up-dating of technological knowledge and access to external consultants (Figure 1 indicates the links between the ESF and the national and international technology market which allow different national and international sources of scientific, technical and economic knowledge to be gathered together and transformed into specific projects); ii) *experience* from prior projects; iii) the quality of *human resources* and the capability to broaden the knowledge of key personnel through missions, seminars, training programmes, etc.; iv) sufficient *economic resources* to hire qualified personnel on a permanent basis and/or as consultants, install laboratories, pilot plant facilities, etc.; and v) sufficient *demand* for their services.

The advantage of ESFs over manufacturing firms is that they are able to build up technological capabilities faster. This is because ESFs can be selective in their learning process and because of the "disembodied" nature of their services.⁶ Knowledge in ESFs is "person-specific", that is, closely related to qualified personnel with a specialized domain. In manufacturing enterprises, in contrast, knowledge is "firm-specific" and dictated by the system of production. Knowledge has to be worked into the memory of the organization, routines, machinery, and process blueprints, which is a slow and costly process.

The remainder of this section will discuss the specific benefits of local ESFs for industrial de-

velopment and technology transfer in developing countries and the reasons why there are so few capable ESFs in developing countries.

3) *ESFs and developing countries*

ESFs can play a crucial role in industrial development. Their strategic position in the economic system links producers with both technology suppliers and research and development institutions in such a manner that optimal investment decisions can be achieved.

In a Third World context, competent domestic ESFs with a knowledge of local conditions can help to obtain more appropriate technological solutions, clearly delineated investment packages and efficient absorption of foreign technology and foreign consultancy inputs (Aráoz, 1981, p. 11). Bargaining power *vis-à-vis* foreign technology suppliers may be strengthened, and a reduction in overall costs of projects is also likely, as a higher proportion of cheaper local inputs can be used.

This will give favourable long-run socioeconomic impacts that go beyond the limits of a specific project. The greater use of local inputs creates demand within the country for capital goods, components, technology and services. Knowledge may be spread more effectively among enterprises. The fact that ESFs themselves provide a wide range of services for numerous technology users and suppliers also makes them specially relevant in a Third World context because it ensures full utilization of scarce qualified human resources. Nevertheless, the truth of the matter is that in many developing countries domestic ESFs tend to be weak, so that demand is geared to an important extent towards foreign ESFs (UNCTC, 1989, p. 19).

The reasons usually cited to explain why foreign ESFs are given preference in developing countries are:

i) local ESFs have comparatively little experience. For the local investor there is a high element of risk in contracting local ESFs, as they might provide poor or inefficient consulting services, and consequently the greater experience of the foreign ESFs puts them in a stronger competitive position. As a result, domestic ESFs easily get caught in a vicious circle where no contracts are granted because they lack capabilities and

⁶ Disembodied technological change refers to change in productivity through the application of new information to an existing stock of capital, whereas embodied technological change is that associated with new investment and the introduction of new or different machinery and equipment. See Moore (1983), p. 9.

credentials and, without contracts, the ESFs are blocked from acquiring experience and developing technological capabilities through learning by doing.

ii) the learning process and buildup of technological capabilities is long and costly. As pointed out by Cooper, if the local ESF had a sufficiently long time horizon, it might decide to compete against foreign competitors by offering lower prices and extensive guarantees. Doing this would involve heavy losses in the short run, but as the firm gained experience through learning by doing it would eventually be able to compete profitably (Cooper, 1980). The obvious problem with this is that few ESFs in developing countries are in a strong enough financial position to sustain losses for the duration of the difficult start-up phase.

iii) for local ESFs the lack of qualified local personnel is often a bigger problem than the lack of experience. This underlines the need for sufficient financial resources both to attract foreigners and to train locals.

iv) there is a certain amount of mistrust in the private sector with regard to local consulting

capabilities. Such attitudes may take a long time to change.

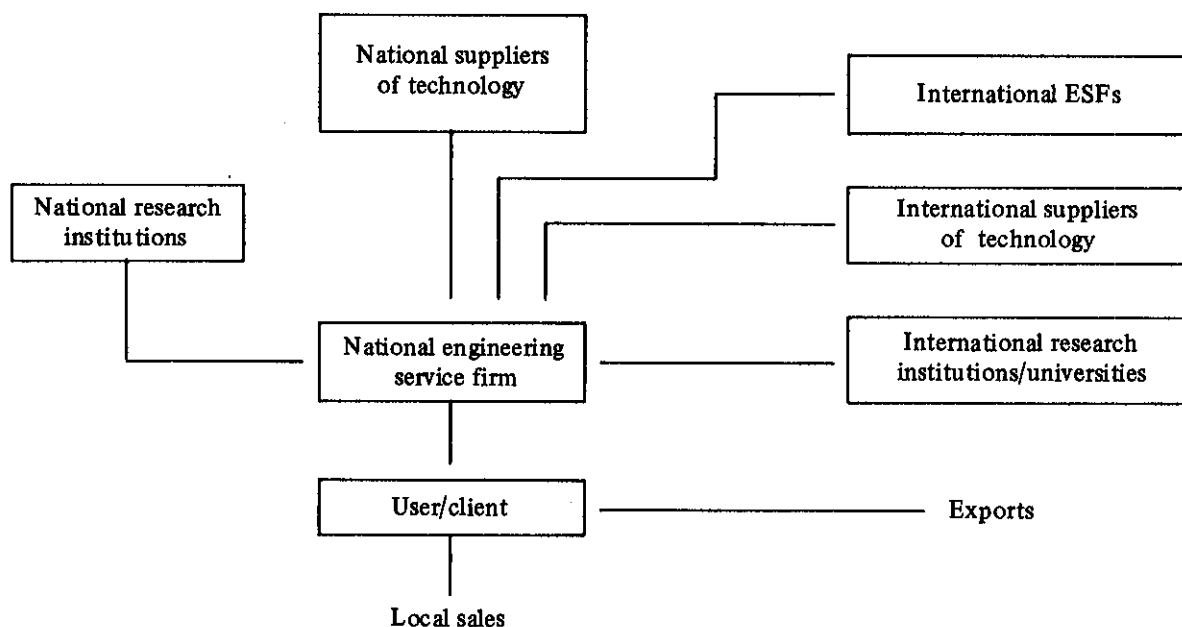
v) It is difficult and resource-demanding to build up an international network of research institutions and technology suppliers.

vi) the attitude of financial and development agencies in the industrialized countries favours the use of established ESFs from their home countries.

As mentioned earlier, there are strong arguments for building up national capacity in the field of consulting and engineering. Without it, the consequences are often inadequate technological solutions, high imports of capital goods and production inputs, and a continuing dependence on foreign know-how. Thus, many governments in developing countries have adopted legislation favoring local ESFs and giving preference to them when awarding contracts (UNCTC, 1989). On the other hand, excessive reliance on domestic ESF capabilities can cause inefficient solutions and act as a barrier to the use of more productive technology. Such a policy may burden the local ESFs with tasks which they simply are not capable of solving.

Figure 1

ENGINEERING SERVICE FIRMS AND THEIR LINKS



The fact is that there are advantages to be derived from transnational corporations in the ESF industry. They have easy access to different technology sources and invaluable knowledge, skills, experience, and international contacts that can help developing countries achieve a better performance.

The challenge to government policy is to balance the use of transnational ESFs with suitable promotion of local ESFs. This can be done, for example, by granting adequate credits to local ESFs, research institutions and equipment makers. Foreign ESFs should be used as a complement to, rather than as a substitute for, local ESFs. Mechanisms of co-operation between the two should be sought in order to make full use of local sources while utilizing the advantages of foreign consulting to transfer technology and train national consulting personnel. A possible solution is to create ESFs as joint ventures between

transnational corporations and national agents. In this fashion, the ESF can take advantage of the experience, know-how, network and prestige of the transnational corporation during the difficult start-up phase. The issues here are very similar to those that have been debated in relation to foreign capital participation in manufacturing enterprises. Accordingly, there may be disadvantages involved in joint ventures, such as solutions imposed by the parent company, unwillingness to train local personnel adequately, and reliance on foreign inputs without making a deliberate effort to adapt technology to local conditions.

The next section will be devoted to a case study of the Chile Foundation, with the aim of analysing empirically (i) how an ESF can facilitate technology transfer, and (ii) the impact of a transnational corporation on the establishment and functioning of a joint venture ESF and the development of its technological capabilities.

III

A case study: the Chile Foundation

1) *Objective and background*

The Chile Foundation (Fundación Chile) was created in 1976 as a joint venture between the US-based transnational corporation ITT and the Government of Chile. The Chile Foundation is a private, non-profit organization whose objective is "to transfer to Chile those technologies which can improve the utilization of the Nation's natural resources and productive capacity and stimulate the creation of new business enterprises based on these technologies" (Chile Foundation, 1986). The origin of the Chile Foundation goes back to the nationalization of the ITT subsidiary, the Chilean Telephone Company, during the presidency of Salvador Allende (1970-1973). No agreement on compensation could be reached, until the Government of Chile proposed to split the difference of US\$ 50 million and create the Chile Foundation as a mutually beneficial activity with both sides investing an initial capital of US\$ 25 million in the joint venture. The US\$ 50 million were made available to the Chile Foundation

according to the following schedule: first three years, US\$ 8 million annually; next six years, US\$ 4 million annually; with the remaining US\$ 2 million payable in 1985. The aim was that the Chile Foundation should gradually become self-financing by selling its services to the private sector and creating profitable production enterprises utilizing new technologies.

2) *ITT and the build-up of technological capabilities*

After its creation in 1976, the Chile Foundation was faced with the typical problems of an ESF in its start-up phase. The Foundation had no experience, lacked appropriate technological capabilities, and was mistrusted by the Chilean business community, especially because of its association with the public sector.

This section attempts to show, in a general way, how the Foundation, with the assistance of ITT, succeeded in overcoming these barriers to developing technological capabilities and gaining credibility. It focuses on the aforementioned es-

sential elements behind the technological capabilities of an ESF: human resources, experience, network, laboratories and test-plant facilities.

a) *Human resources*

The initial staff of the Foundation consisted of five experts from ITT: a food research and development executive (the first Director-General), a food technologist, a nutritionist, a chemical engineer with background in the United States Department of Agriculture, and an ITT telecommunications specialist (Meissner, 1988, p. 12). Qualified Chileans were also recruited, and by the end of 1976 the Foundation employed 17 persons full-time. A big advantage for the Foundation has been the availability of well-qualified local technical personnel with international experience, and Chileans now constitute the vast majority of the permanent staff. By 1990 the professional staff had grown to 90 (excluding staff in subsidiaries). Engineers make up the largest single group (see Table 2 below). It was decided from the beginning that Chileans should gradually manage all activities of the Foundation, and in-house training programmes are provided by ITT to prepare qualified candidates for key management positions (Meissner, 1988, p. 12). Learning-by-training is generally given high priority, and continuous development of the staff's technical and management capabilities is undertaken. Thus, during 1987 the professionals received a total of 4,100 hours of training, and 38 management-level employees undertook missions to overseas companies and technology centres which collaborate with the Foundation (Chile Foundation, 1987).

The Foundation encourages its staff to attend international conferences and seminars, both to gain knowledge and make personal contacts, and it is a very active organizer of seminars in Chile, which is also a way to introduce new ideas to the Chilean business community and promote the Foundation. Finally, the Foundation makes extensive use of external consultants to provide knowledge and know-how that its own staff do not possess themselves.

b) *Experience*

The initial projects of the Foundation were primarily oriented towards improving the quality of processed fruits and vegetables, providing

Table 2
PROFESSIONAL STAFF OF THE CHILE
FOUNDATION, APRIL 1990
(EXCLUDING SUBSIDIARIES)

	Number
Postgraduates	
Non-engineers	21
Engineers (in the fields of agronomy, food, fisheries, forestry, chemicals, industrial technology and business studies)	38
Subtotal	59
Technicians with a university degree	31
<i>Total</i>	90

technical assistance in the area of industrial sanitation and hygiene for food processing plants, and giving technical assistance to the edible oil industry, including ways to refine fish oil and to improve the utilization of other by-products (Chile Foundation, 1985). These early ventures were characterized by vagueness of objectives and a lack of focus on the technological aspects. The Foundation had difficulties in winning the confidence of the private sector, and few projects were carried beyond the exploratory stage. In view of these problems the Foundation decided to gain experience and build up its technological background by initiating entrepreneurial projects itself. The idea was to identify new production activities that could benefit from new technologies, then acquire and adapt the technology. Once the technology was assimilated the Foundation would undertake the commercial production and marketing of the products through a subsidiary. When the subsidiary became profitable it would be sold, thereby completing the technology transfer process. By demonstrating the viability of the technology and the business opportunities to the private sector, the Foundation would subsequently find it easier to sell technical, management and marketing assistance. In this way the Foundation has established 7 subsidiary enterprises, mainly in the area of agriculture and fisheries. One project, *Salmones Antártica S.A.*, has completed the technology transfer cycle and was sold in 1988 to the Japanese consortium Nippon Suisan Kaisha for US\$ 21 million. As soon as *Salmones Antártica* proved to be success-

ful, the Foundation's technical assistance branch began promoting other ventures making the technology available to interested firms. In the next section of this article, the Salmenes Antártica project is studied in detail in order to analyse how the Foundation approaches technology transfer, builds up its technological capabilities and provides technical assistance to the private sector.

c) *Network*

The association with ITT has provided access to a worldwide network of consultants and technology suppliers. Upon request, a liaison officer at ITT supplies the Foundation with information on technology suppliers, bibliographies, consultants, etc. A formal technical assistance contract has been established between ITT and the Foundation, whereby the Foundation undertakes to i) reimburse ITT for all direct costs incurred in providing technical information (such as travel and subsistence of the personnel providing technical assistance at the Foundation's premises); ii) keep data confidential until otherwise authorized by ITT; and iii) inform ITT of any invention, discovery or improvement that may result from research using substantial amounts of ITT technical information. ITT is free to use such new knowledge, reimbursing the Foundation for all direct expenditures related to the transfer of the information.

d) *Laboratory and test-plant facilities*

The Foundation has devoted substantial resources to the establishment of laboratories and test-plant facilities. This has also been an important source of knowledge.

It is difficult to assess exactly why the Chile Foundation has been able to develop up-to-date technological capabilities in different fields of activity. Predictably, a number of projects have failed, but generally speaking the organization has been very enterprising, and most of the projects have had a substantial creative content and been successful in transferring new technologies to Chile. According to the Foundation itself, five important reasons can be cited to explain why the Foundation has been able to develop its technological capabilities:

i) The educational preparation and experience of both the staff transferred from ITT to

Chile and the professionals available in Chile itself.

ii) The ample financial resources at the Foundation's disposal during the initial stage of its existence. This allowed for investment in human resources by recruiting highly-qualified permanent staff, making extensive use of consultants, ensuring continuous updating of the capability of its personnel through training and study courses abroad, and installing laboratories and pilot plant facilities. Furthermore, this solid financial basis made it possible to pursue a bold entrepreneurial strategy and gain the necessary experience.

iii) Access to the ITT network, and the assistance of ITT in negotiations with technology suppliers and the private sector in Chile.

iv) The management principles used, which are largely based on the ITT Research and Development Case Method. The fundamental pillar upon which this case method rests is management-by-objectives, with the basic principles of flexibility and control. In the Foundation, the system is implemented in the following way:

The period from project idea to implementation is made as short as possible. When a staff member receives an outside request for technical assistance or wishes to pursue an idea, a project proposal is elaborated, which is presented to the Board of Directors and the Department of Finance and Administration. If the project is approved, a detailed budget for all resources needed is authorized. The staff member is granted considerable autonomy during project implementation, but management-by-objectives involves strict budget planning and control. In the Chile Foundation, each project or case manager must make a monthly report on the advance of the project and the resources used on personnel, travel, consultants, materials, laboratory work, machinery, telephone/fax communications, seminars, and miscellaneous items. The system implemented at the Chile Foundation allows for some flexibility in changing the authorized case budget, if this can be justified convincingly to the Director-General or Board of Directors.

v) The Foundation is business oriented in the sense that the projects undertaken must be profitable. Due to the special circumstances sur-

rounding its creation, the Foundation as a whole is a non-profit organization, but the specific projects have to be economically feasible. Thus, a big effort is also made to seek out joint venture entrepreneurs willing to risk capital and to transfer new technologies to Chile.

A marketing department was established to strengthen staff capabilities in developing and implementing strategies for the marketing of the products and services offered by the Foundation. Among the tools used are short courses, workshops, seminars, publications, visits to the Foundation headquarters and enterprises, and public relations with the mass media.

It should be reiterated that ITT was of fundamental importance in the development of the Chile Foundation's technological capabilities. The provision of ample financial resources, transfer of personnel from ITT headquarters, introduction of ITT management methods and the access granted to the ITT network made possible a rapid build-up of capabilities. The outcome has been the recruitment and continuous training of qualified Chilean personnel, use of consultants, construction of laboratories and test-plant facilities and, finally, development of the Foundation's own national and international network through missions and the organization of seminars in Chile.

In the next section the Salmenes Antártica project will be analysed in detail to show how the Foundation has transferred technology and built up technological capabilities in a specific field. The project will be analysed through the different stages of the technology transfer process: a) preinvestment studies (problem identification); b) choice and adaptation of technology to local conditions (process and technological studies); and c) assimilation and diffusion of technology (project implementation).

3) *Salmenes Antártica: an example of effective technology transfer*

a) *Background (preinvestment studies)*

Chile is one of the most important fishing nations in the world, with a catch of around 5 million tons a year, but most of the catch is transformed into low-grade fish meal for animal consumption. Consequently, the Chile Foundation

decided at a very early stage to explore the possibilities of transferring fishery-related technologies to increase the degree of processing of maritime resources, making the sector more productive and profitable.

One of the first projects of the Foundation was to explore the feasibility of establishing salmon fisheries in Chile. Salmon is one of the most highly-appreciated fish in the world and, therefore, could be an important source of income on export markets.

Fish of the salmon family are not native to the Southern Hemisphere, but Southern Chile's climate and coastal geography, with fiords, islands, and protected bays, is very similar to the conditions prevailing in the Northern Hemisphere, where salmon live and reproduce naturally. Furthermore, the southern waters of Chile are clean, unpolluted, clear, fresh and oxygen-rich. Water temperatures and climatic conditions are also milder than in the Northern Hemisphere, where the winter growth rates of salmon are low and living conditions severe.

In short, Chile seemed ideal for raising salmon on a commercial scale. Two technologies were available for the acclimatization of salmon to Chilean waters.

The first is "*Ocean ranching technology*". In the Northern Hemisphere salmon spawn in fresh waters and spend the first part of their life in the streams or lakes where they were born. When a salmon fry (called a smolt) reaches one year of age it migrates to the ocean, where it grows and matures. When ready to reproduce, a powerful instinct of the salmon forces it to return to the streams where it was born in order to mate.

This circuit is utilized in the ocean ranching technology. Initially, eggs are hatched and the salmon are raised to the smolt stage in fresh water under controlled conditions. Afterwards the salmon are released to mature in a natural oceanic environment. When the adults return to their original place of release to mate the fish are captured.

The ocean ranching technology is widely used along the west coast of Canada and the United States. In 1980, salmon landings in these areas totalled 400,000 tons. With a coastline of 5,000 km., an average of 80 tons of salmon was produced per kilometre. If the Chile Foundation could achieve a production of 40 tons per linear

km., the 1 700 km. of "salmon coastline" could produce 68,000 tons of ranch salmon annually. At a price of US\$ 3 per kg., that would amount to over US\$ 200 million (Meissner, 1988, p. 21). There are, however, three problems related to ocean ranching: i) it is slow; ii) it is risky, because 1-1.5 per cent of the mature salmon must return merely in order to pay for the raising of the smolts, and iii) the returning salmon are in the public domain, so that anybody with a fishing license can go after them.

The second technology is "*cage cultivation*" or "*salmon farming*". Salmon farming involves the continuous rearing of salmon in enclosures throughout their life cycle, from eggs to harvest. The eggs are obtained from abroad, from a local hatchery, or by the artificial fertilization of self-owned brood stock. The latter requires the forming and keeping of brood fish and genetic selection. When the newborn salmon reach the smolt stage and start swimming they are transferred to a floating cage where they mature. The growth rate will depend on the salmon species farmed, the genetic strain, the amount and quality of fish feed, cage type and "fish management".

Over the last 25 years, commercial cage cultivation of salmon has been well established as a viable business in several countries around the world. In 1985, Norway (now the largest producer), harvested 28 000 tons of farmed salmon. Japan and the United States, for their part, harvested approximately 7,000 tons (Lindbergh, 1987). Cage cultivation has primarily been successful because high-quality fresh fish can be provided at times of the year when freshly captured ocean salmon are scarce or unavailable. Furthermore, the growers of farmed fish can grow the most sought-after species and to a significant degree configure the fish to the preferred color and fat content.

Initially, the Chile Foundation tried ocean ranching and released salmon on several locations in the Tenth Region of Chile. For as yet unknown reasons, however, the rate of returned salmon was very low. It was then decided to change to cage cultivation. The general advantages were also considered to be higher and the technological content was more challenging.

b) *Choice and adaptation of technology (process and technological studies)*

In 1981, the Chile Foundation decided to carry out a pilot project on the cage cultivation of salmon in fresh water with the aim of studying the technical and economic feasibility of salmon farming in Chile. Among the problems that had to be solved were: choice of specific cage design and technology, production of feed, identification and control of diseases, the study of currents, oceanography, site selection and supply of salmon eggs.

The first step taken was to acquire the technology and installations to produce salmon eggs and grow salmon fingerlings to the smolt stage.

In order to gain time, this was done by buying Domsea, a small United States-owned hatchery in Curaco de Vélez, in the southern part of Chile. There, salmon fingerlings were grown in fresh water to the smolt stage and then released, with the company seeking their return via the ocean ranching technology. Under the ownership of the Foundation, the company was renamed Salmenes Antártica, and used as a pilot project site for cage cultivation.

The next step was to choose a production system and adapt the technology to Chilean conditions. First, staff members were sent on international missions to visit different salmon farms and attend seminars to make contacts and search for the appropriate technology. Several options were available. The most advanced and capital-intensive cage technology was found in Norway. But the technology was very costly and, furthermore, the Norwegians were reluctant to sell their equipment and know-how to a potential competitor. The choice fell on net pens or cages developed in the United States. The nets are normally hung from a square or rectangular structure that is supported by floats. Sizes vary from a few m³ to 50 m³. United States consultants from Seattle were hired to assist in the assimilation and adaptation of the production system to Chilean conditions. A major change in this respect was to make the fundamental structure out of wood instead of steel, in this way utilizing a cheap and abundant natural resource of Chile.

To achieve good quality and high growth rates, special attention had to be given to the feeding of the fish stock. Feed is the highest single

cost item involved in rearing salmon in cages and accounts for up to 40% or more of total costs up to harvest time (Lindbergh, 1987). The predominant constituents of standard salmon feed are fish meal, fish oil, carbohydrates, vitamins and binding agents (Romero, 1988). With the increased production of farmed fish, the animal feed industry has expanded and developed a number of fish feed manufacturing processes which involve the making of different forms of feed and sizes of feed particles. If salmon ranching was to be profitable in Chile, it was necessary for the Foundation to develop fish feed that made use of the large volumes of low-cost fish meal and oil available in the country. Through experiments with different fish feed mixtures at the Foundation's pilot plant, a mixture was found which used exclusively local resources. The colour of the salmon meat is a result of the diet, so a special problem for the Foundation during the pilot project was to develop feed that would produce the attractive pink colour of salmon filet. This was solved by mixing Antarctic krill into the fish feed.

During the pilot project a number of other problems were solved, such as fish feeding techniques, disease control, changes in currents and water temperature, handling of eggs and smolts, selection of species and fish behaviour in cages. The appropriate technologies relating to cage cultivation were adapted and modified by way of experiments (learning-by-doing), use of national and international consultants (learning by hiring) and training of permanent staff at ranch farms and fish technology centres abroad. The Foundation had an average of 10 staff members working on the salmon pilot project.

c) *Diffusion of technology (project implementation)*

In 1983, the success of the pilot project encouraged the Foundation to expand the import substitution production of salmon eggs and initiate commercial cage cultivation. Due to the favourable demand for Coho salmon, the internal rate of return was estimated to range from 36% with an annual output of 100 tons to 33% for an output of 600 tons (Meissner, 1988, p. 22).

The Foundation (Salmones Antártica) acquired four new farm sites and a large-scale expansion plan was initiated at these sites. In addition, Salmones Antártica built three new

hatcheries, a new feed plant and a salmon packing complex. The first commercial harvest of 200 tons was projected for 1986-1987, increasing to 400 tons thereafter. Accumulated losses were expected to peak at some US\$ 1 million by 1985, and the first positive cash flow of about US\$ 100 000 was projected for 1988, to be consolidated at US\$ 2.5 million annually by 1990 and thereafter (Meissner, 1988, p. 22).

The implementation of commercial cage cultivation was carried out according to the project objectives, and in 1988 profits were generated. Thus, the technology transfer cycle was completed, and when the Foundation offered Salmones Antártica for sale it was bought by the Japanese seafood processing firm Nippon Suisan Kaisha for US\$ 21 million (Lichmann, 1989, p. 72).

d) *Technical assistance*

The Foundation's pioneering salmon project received a significant response in Chile. Between 1983 and 1985, 24 new salmon farms were initiated and total Chilean salmon production increased from 94 tons in 1983 to 1,144 tons in 1986, reaching 4,208 tons in 1988 (Wurmann, 1990). The technological capabilities developed at the Foundation were such that it was possible to provide technical assistance to more than half of the new projects. The Foundation is still developing engineering and technical plans for several firms and encouraging others to become interested in salmon production. These technical assistance projects can be summarized as follows:

- i) assistance in the technical and financial aspects, design and start-up of salmon farming projects.
- ii) assistance in the design and building of feed plants.
- iii) assistance in the design and start-up of salmon packing plants.
- iv) assistance in the control and prevention of disease.
- v) assistance in the development of quality standards for Chilean salmon.
- vi) organization and sponsorship of seminars to inform the private sector and stimulate investment in the industry (Chile Foundation, 1987b, p. 207).

e) *Conclusion of the case study*

The Salmones Antártica project is a very eloquent example of effective technology transfer. It shows how the Chile Foundation first of all identified a potential business opportunity: the application of new technology to develop salmon farming in Chile. A conscious strategy was followed to search for the most appropriate technology and invest the necessary time and resources in assimilating and adapting it to local conditions. This was of fundamental importance, because it was during the adaptation process that the comparative advantages of Chilean salmon

farming were developed. For example, the use of cheap and abundant local resources for fish feed and cage construction have contributed significantly to the international competitiveness of Chilean salmon. Another important lesson to be derived from the Salmones Antártica project is the feasibility of investing in the development of technological capabilities and then selling the know-how (intangible assets) to third parties. Once the Foundation had built up technological capabilities in salmon farming and successfully diffused the technology, technical assistance provided to new projects became a major source of income and a way to expand activities.

IV

Conclusions

In many developing countries, extensive use has been made of imported technology as a basis for the establishment of new industries. Licenses and other forms of technology transfer have fulfilled a demand for technology that could not be met immediately by local technological capabilities.

The present study has emphasized that if foreign technology acquisition is to induce technical change and raise productivity of the recipient enterprise it requires an *active* technological strategy on behalf of the recipient. First, the enterprise must carry out an active search for alternative technology sources in order to track down the most appropriate technology and diminish the vulnerability that comes with overreliance on a single or few sources. Second, time and resources must be invested in skill formation and organizational changes in order to assimilate and effectively adapt the technology to local conditions. The latter is essential in order to develop comparative advantages and make the production internationally competitive. Third, in order to implement the technology for large scale production the enterprise must develop contacts with appropriate suppliers of equipment and materials, improve management capabilities and increase its own capacity to bargain with local authorities.

As mentioned in the introduction, it is very difficult for policy makers in developing countries to directly help national enterprises to accomplish all these requirements in order to transfer foreign technology effectively. The task of governments is, first of all, to create a macroeconomic environment that induces local enterprises to undertake an active technological strategy. The exposure of local enterprises to a certain degree of foreign competition is a good thing in this respect. Perhaps even more important, governments should support the development of a local scientific and technological infrastructure. The technological effort of local enterprises relies above all on the existence of a pool of trained workers and technicians and on publicly-funded R & D centres.

In the area of direct assistance to local enterprises receiving foreign technology, this article suggests that one solution is the creation of design engineering capabilities (engineering service firms). Their experience and strategic position in the economic system links producers with both technology suppliers and research and development institutions to ensure optimal investment decisions. Competent local ESFs with a knowledge of local conditions can also help enterprises to absorb and adapt foreign technology more efficiently. In many developing countries,

however, there are few domestic ESFs because of the many barriers to entry into the engineering services market. This is because many developing countries do not have the human resources to conduct engineering services, and it is a costly and lengthy process to hire and train the most qualified personnel. It is also costly and resource-demanding to build up a useful national and international technological network. Another barrier to many Third World ESFs is the difficulty of gaining private sector confidence and obtaining the credentials and necessary experience to further develop their capabilities. An ESF formed as a joint venture between a national agent (possibly the public sector) and a transnational partner that possess the needed skills and experience could be one solution for overcoming these barriers.

In the present study this idea has been ratified by analysing the achievements of the Chile Foundation: an ESF joint venture between ITT and the Government of Chile. The Foundation has successfully carried out projects in various fields related to technical assistance, information services and quality control, and it has also initiated full-scale commercial production through subsidiaries. The latter is not an activity normally associated with ESFs, but it has provided a way of gaining experience and promoting new technologies in the Chilean private sector. The philosophy has been to identify new business opportunities that could benefit from foreign technology, transfer that technology from abroad, learn how to master it, and finally demonstrate the viability of the new technology by undertaking full-scale commercial production. Once profitable, the Foundation encourages the private sector to utilize the same production methods and provides the needed technical assistance.

The experience of the Foundation has confirmed that it pays to invest time and resources in adapting the technology properly, because it is mainly during this crucial phase in the tech-

nology transfer process that the comparative advantages of the project are developed. As shown in the case study, ITT played a decisive role in the development of the Foundation's technological capabilities by transferring personnel from ITT headquarters, introducing management methods, granting access to its global technological network and, finally, training local personnel. ITT also provided the Foundation with the necessary credibility and support in negotiations with third parties.

It has become an "explicit policy goal" to gradually make the Foundation independent of ITT, and now, 15 years after its creation, the Foundation primarily relies on its own contacts and technological capabilities. Apart from ITT's support, other important factors in the development of technological capabilities were the ample financial resources available during the start-up phase and the quality of the educational background of the professionals available for recruitment in Chile.

The final question to be addressed is the general validity of this case study: that is, whether the same scheme can be copied in other developing countries. The special circumstances surrounding the creation of the Foundation, and the interest of ITT in improving its reputation in Chile, make the Chile Foundation a very special and exceptional case. It may be difficult to convince other TNCs to invest US\$ 25 million in a joint venture with the dubiously lucrative objective of transferring technology to a Third World country. But an obvious lesson to be learned from the case study is that a Third World government and a TNC *can* enter a mutually beneficial arrangement. In this case, the skills, experience and contacts provided by a TNC, together with the availability of skilled local personnel and a long-term investment in the development of technological capabilities, did result in effective technology transfer, together with the creation of profitable entrepreneurial projects.

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