

**International Development Research Centre**  
**MANUSCRIPT REPORTS**

**Science and technology for development:  
a selection of background papers for the  
main comparative report of the  
STPI project**

**PART D:**

**State enterprises  
and technological development**

**Contributors**

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SCIENCE AND TECHNOLOGY FOR DEVELOPMENT:  
A SELECTION OF BACKGROUND PAPERS FOR THE  
MAIN COMPARATIVE REPORT OF THE STPI PROJECT<sup>1</sup>

PART D:  
STATE ENTERPRISES  
AND TECHNOLOGICAL DEVELOPMENT

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<sup>1</sup>This series of selections includes four volumes - Part A: Science and Technology Policy and Development (IDRC-MR21), Part B: Consulting and Design Engineering Capabilities in Developing Countries (IDRC-MR22), Part C: Technology Transfer in Developing Countries (IDRC-MR23), Part D: State Enterprises and Technological Development (IDRC-MR24).

A complete key to the full range of STPI publications is given at the end of this book.





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## PREFACE

The STPI project was a large undertaking involving more than 150 researchers in the 10 participating countries. In addition, several consultants prepared background papers on topics identified by the teams. The main results of the project were presented to policymakers in a series of regional meetings held in Africa and the Middle East in 1977 and 1978.

The research, consultants' work, and dissemination meetings resulted in many reports. Some of these have already been published by IDRC, but several of the papers on specialized themes did not fit the general summary publications nor did they fit into the more detailed modules or monographs on the STPI project, also in the process of publication. It has therefore been decided to prepare these selections from STPI in order to ensure that the work receives a wider distribution. It should be remembered that the work leading to the articles was done and most of the articles prepared in the mid-1970s. Nevertheless, the work they report and topics they cover still have relevance for development in the 1980s.

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## INTRODUCTION

This volume is one of a series published within the framework of the Science and Technology Policy Instruments (STPI) Project. The STPI Project, a large collaborative research effort that involved 10 teams from Latin America, the Middle East, Southern Europe, and Asia, was sponsored by the International Development Research Centre. Its principal aim was to examine the ways in which developing countries could ensure the effective contribution of science and technology (S&T) to development.

The central concern of the STPI Project was the process of S&T policy design and implementation. A detailed examination was conducted of the policymaking process, the ways in which policies were transformed into sources of influence through government action, and the impact that various policy instruments at the disposal of government had on the development of S&T capabilities (1). In addition, a number of complementary research topics were chosen for detailed analysis, and two volumes have been published on S&T planning in less developed countries and on S&T policies in China (2).

Other topics chosen for study to complement the central line of research of the STPI Project are the development of consulting and engineering design capabilities, the problems of technology transfer from industrialized to less developed countries, and the role of public or state enterprises in the process of S&T development. The participating teams worked on these topics according to their research interests, and there was not a uniform coverage of these topics complementary to the main line of research.

Volume A gathers a selection of reports prepared by the STPI teams on the above topics. The first chapter contains an overview of the field of S&T policy research for development, written by Geoffrey Oldham, IDRC's Associate Director for S&T policy, as an introduction to a series of meetings organized to disseminate the results of the STPI Project. The second chapter contains a compilation of statements on technological dependence/self-reliance, prepared by Onelia Cardettini on the basis of reports submitted to the Office of the Field Coordinator of the STPI Project. The third chapter contains an essay by Máximo Halty, a former IDRC Senior Research Fellow, commissioned

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(1) Sagasti, Francisco R., Science and Technology for Development: Main Comparative Report of the STPI Project, Ottawa, International Development Research Centre, IDRC-109e, 1978.

(2) Sagasti, Francisco R. and Araújo, Alberto (Editors), Science and Technology for Development: Planning in the STPI Countries, Ottawa, International Development Research Centre, IDRC-133e, 1979 and Dean, Genevieve C., Science and Technology for Development: Technology Policy and Industrialization in the People's Republic of China, Ottawa, International Development Research Centre, IDRC-130e, 1979.

for the STPI dissemination meetings. This was one of the last essays written by Máximo Halty before his untimely death in December 1978.

Volume B contains two chapters written by Anil Malhotra, who coordinated the Indian contributions to the STPI Project, and undertook to prepare a synthesis report of the results of STPI research on the subject of consulting and engineering. Chapter 4 describes a conceptual framework developed by Malhotra, and Chapter 5 summarizes the findings of the STPI teams on the development of consulting and engineering design capabilities.

Volume C consists of four chapters on the issue of technology transfer, written in 1974-1975. In Chapter 6 Carlos Contreras surveys the main problems faced by the developing countries and suggests a policy framework to deal with them. In Chapter 7, Francisco C. Sercovich undertakes a preliminary assessment of the Argentinian system for the regulation of technology imports, and Anil Malhotra examines the evolution of Indian policies on foreign collaboration in Chapter 8. The Mexican Registry of Technology/Transfer Agreements is examined in detail by Alejandro Nadal in Chapter 9.

Volume D contains five essays on state enterprises and their role in technology policies. This was a complex and rather unexplored subject that engaged the preferential attention of the Brazilian team, and in which other country teams also became interested. Chapter 10 contains an essay written by Fabio Erber, describing the main issues involved in making public enterprises more active in promoting technological development. In Chapter 11 Sulamis Dain summarizes some of the key findings of the Brazilian team, and Dulce Marfa Monteiro examines in Chapter 12 the research activities of PETROBRAS, the state's oil monopoly in Brazil. Ignacio Avalos and Rafael Rengifo summarize the findings of the Venezuelan team on this subject in Chapter 13, and in the last chapter Alejandro Nadal describes some features of the technological behaviour of the Mexican oil corporation, PEMEX.

Two criteria have been employed in selecting the essays to be included in these volumes from among the nearly 200 reports prepared in the STPI Project. The first is representativity, in the sense of providing a sampling of the various topics covered by the STPI Project in addition to the main research theme of policy design and implementation. The second is accessibility, in the sense of choosing reports that are not included in other STPI publications.

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## CHAPTER 10

### THE STATE ENTERPRISE AND THE CHOICE OF TECHNOLOGIES

Fabio Stefano Erber

This chapter attempts to make a synthesis of the studies, interviews, and discussions carried out during the preparatory phase of the Science and Technology Policy Instruments Project with members of the Research Group and of other groups of FINEP, experts from the National Development Bank (BNDE), other agencies of the Planning Ministry, State enterprises and sectorial bodies, as well as from the University of Sussex, England; all the work was carried out to determine the choice of technologies for State enterprises in Brazil. It also attempts to incorporate the suggestions contained in three previous working papers from the Research Group ("Sugestões," by Sergio Alves and "Notas sobre a lógica de comportamento das empresas estatais" and "Proposições sobre a escolha de tecnologia nas empresas estatais," by the present author), as well as the criticisms made by members of the Research Group.

This chapter is linked also to a previous paper by José Tavares de Araújo Júnior ("Escolha de técnicas e rentabilidade das empresas governamentais" whose ideas it has attempted to incorporate, and to working papers I and II, by Dulce Vianna, both of the Research Group of FINEP.

The analysis, which is based on the principle that the main decisions about technology (the decisions referring to the choice of the processes of production and of capital goods), cannot be seen in isolation. In order to understand them, they must be placed within the wider framework of the objectives and of the conditioning factors of the performance of enterprises, whether these latter be public or private.

On account of the "derivative" character of the decisions that stem from the interaction of several factors, technological decisions usually cannot be changed, but through an integrated and consistent "package" of policies, acting upon all of their chief determinants, they can be reoriented in the direction or sense of the technological decision (1). As a consequence, the formulation of policies for the change of technological decisions by the economic agents, if they are to be efficient, has to rely on the knowledge of the basic determinants of these decisions; otherwise, by proposing inconsistent measures, it will frustrate the objectives. This is the fundamental aim of the study on the criteria of the choice of technologies by the State enterprises, which are privileged as a focus of analysis by their role in the national economy and, more specifically, by their role in the national technological development, not only by being responsible for the supply of key intermediate

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(1) See, for example, the policy suggestions about the Brazilian capital goods industry. Erber, F. et al. 1973. Criação e absorção de tecnologia na indústria de bens de capital. FINEP.

production goods but also by being the main consumers of the products of the national capital goods industry, as well as of the services of the engineering firms and research institutes.

The ideas suggested here are mainly geared to determining the basis of the choice by State enterprises of three types of providers of technology (processes of production and capital goods): "national," i.e. enterprises under Brazilian control; "foreign" suppliers, i.e. those whose property and headquarters or location are abroad; and local "branches", i.e. those corporations which, though under control from abroad, are simultaneously established within Brazilian frontiers. Obviously, there are differences between the supply of technology directed from abroad and the supply mediated by companies established in the country (for instance, their effects on the balance of payments or the training of local labour); but, as the study is concerned with the development of the national capability for the internal generation of technology and its repercussions in terms of the autonomy of the process of development, the cleavage plane can be considered adequate.

It was necessary, for the process of generating these hypotheses, to rely upon a rather diversified body of theoretical knowledge, related to the main feature of State enterprises: that they are part of the State apparatus, i.e. they have a social role to fulfill, and are organized as large corporations, which leads them to structure their internal and external relationships according to a logic of behaviour that is pertinent to privately owned capitalist enterprises.

In all capitalist countries, the functions of the State have increased greatly since the thirties, from a power arising out of society but placing itself above it for the purpose of solving its conflicts, to much more direct forms of intervention. These diversified forms of intervention have multiple purposes; the main ones are the maintenance of the process of economic accumulation, in view of the limitations of the private entrepreneurs, to undertake some socially necessary activities (from credit allowances to direct interventions); and the maintenance of the social and political prerequisites for this process of accumulation (from welfare services to external and internal security services).

Focusing upon the "economic" aspects of intervention, the State enterprises are probably the most direct form of intervention, whereby the State actually takes the place of the private entrepreneur. The fact that State enterprises control most of the intermediate producer goods sectors (steel, oil, petrochemicals, power generation, telecommunications, railways, iron mining, etc.) in Brazil is a most interesting phenomenon per se, indicative perhaps of some of the limitations of the possibilities of a full-fledged industrial development based on private enterprise in a dependent and peripheral country.

This last point, as well as an attempt to interpret the interests behind the creation and expansion of State enterprises, is developed in this chapter. It seems to be a valid assumption that the conditions and interests governing the creation of the State enterprises would leave a firm imprint on their policies for the use of national or foreign sources of technology, given the importance of the latter for immediate interests and for the pursuit of relative autonomy of the enterprise and of the country. Based on the social and economic role played by the State enterprises in the process of accumulation as suppliers of essential production goods, it is also suggested

what their objective would be, namely output maximization. Financial restrictions are examined, and how they reflect upon the choice of suppliers and on the autonomy of choices of the enterprise. The restrictions on choices posed by the size of the market are discussed and some ideas are suggested for the internal limitations of State enterprises as regards their capacity to criticize and eventually change the orientation imposed by the previously mentioned conditioning factors.

It is emphasized that the following ideas are basically hypotheses for work. The empirical observations that will (or will not) confirm these ideas are to be collected from two main sources: data from projects and documents of the enterprises, and interviews with both members of the boards of directors and the technical staff of the enterprises. The set of data to be collected from projects has already been defined and the instruments for the interviews, as well as the indicators for their assessment, are being elaborated

### The Creation of the State Enterprises

The role of the State enterprise cannot be adequately understood unless it is placed in its historical context, because its function in society varies according to the economic and political structure. The following is not intended as a historical reconstruction of the creation of State enterprises, but is an attempt to stress their main features.

In the Brazilian case, the context is that of a country whose production was at first organized to provide the world market with raw materials, mainly agricultural ones. Thus, as a function of the international division of labour, there was a profitable expansion of the productive capacity for these raw materials and related activities (transportation, processing, marketing, etc.). However, the development of the capitalist economy from the 1930s, and especially after the Second World War, made this specialization not very profitable, which suggests the need for a reorientation of the investment process into other types of activities. This reorientation could only be carried out if three conditions were fulfilled: the existence of a consumer market; the availability of productive factors; and the existence of economic agents possessing political power, capable of taking advantage of the economic opportunities and of giving them social concretion. The first of these conditions was assured, at least in the initial stages of industrialization, by the existence of a group made up of the large owners of agricultural, commercial, and industrial interests and of upper echelons of the middle class. This group, sufficiently vast and well-paid and undergoing a process of expansion, was geographically concentrated in the centre southern region of the country. It possessed great economic and political power, and its standards of consumption, being imported, were not satisfied by the production already existing in the country, but at the same time it faced increasing difficulties in being satisfied by imports.

If the existence of a repressed consumer market assured the absorption of production, the previous stage of development of the country had made its productive structure inadequate for the fulfillment of the new functions, as it had been endowed with a great capacity for production, processing, and transportation of raw materials (this capacity was then partly idle). At the same time there had been either no development of activities generating inputs, which are basic for industrial production but relatively dispensable for agricultural production (steel, oil, etc.), or the facilities available were so placed geographically as to be inadequate for the new flows of production and

consumption (for instance, the transport network). Therefore, it was necessary to invest in the internal production of industrial inputs such as electric power, steel, and oil. The same conditions that compelled this industrialization - the import difficulties - excluded imports of these goods in the quantities needed.

The specificity, typical of the countries following a process of industrialization through import substitution such as Brazil, in contrast with the European countries and the United States, should be noted. The latter, as they entered the stage of mass production of durable consumer goods, could already rely on a developed industrial structure, i.e. they had adequate sources of supply of inputs for the industries producing consumer goods; the former countries had to cope with a relatively greater effort of accumulation, as they were forced to simultaneously invest in consumer goods and intermediate goods, owing to their previous productive "specialization." It is also important to note that this process of productive expansion and diversification took place in conditions of close interrelation and dependence vis-à-vis the "central" countries, without a special concern for the incorporation and mastering of technology (2), and was different from that of Japan. These two points seem fundamental for understanding the role of the remaining parts of the national productive system and the world outside.

The development of activities for the production of basic inputs presents, however, specific characteristics that make them neither very feasible for Brazilian capitalists nor very attractive for foreign ones, such as: the great volume of financial and material resources for the implementation of projects; the long time taken for their maturation; and the difficulty of charging prices that would assure a rapid return of the resources invested, given the essential nature of these products for a powerful group of consumers.

In order to enter these sectors, Brazilian capitalists would have to overcome three obstacles: organizational, technological, and financial. When organizing or managing enterprises of this size, the previous origin and experience of these industrial capitalists should be considered. They stemmed mostly from the agricultural or the commercial sector, or were immigrants of working class extraction, and they usually ruled their enterprises by themselves or with the aid of family members. The technical staff was normally very small or nonexistent, being restricted to masters and some better qualified workers. This experience was obviously not adequate for the organization and management of complex and large enterprises such as the ones in the intermediate sectors, where management should be carried out with more bureaucratic methods. Although this factor by itself should not have prevented Brazilian capitalists from entering the sector, it was a considerable barrier, as it required a substantial effort to change their operating methods.

Linked to the above-mentioned elements is the technological problem of knowledge of, and access to, the techniques of production in those sectors. With the exception of power generation, where there was previous knowledge available in the country (though controlled mainly by the foreign grantees,

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(2) The negative effect of capital goods on the development of a national technology brought about by this peripheral and dependent situation can be seen in the study, *Criação e absorção de tecnologia na indústria de bens de capital*. FINEP, op. cit.

"concessionárias," of government concessions), the technology for the production of, say, oil and steel was not mastered by the national entrepreneurs, who would have to purchase it abroad, chiefly by means of licenses or through the association with foreign capital. Both these firms of access to technology, however, would imply a substantial effort on the part of entrepreneurs to engage in laborious negotiations with firms abroad. These activities would also require the intensive use of technical advisory bodies, which these entrepreneurs were not utilizing. These factors were made more serious by the prospect that the entrepreneurs would have a subordinate role in the control of the enterprise as a result of the technical knowledge of the foreign partner or, at least, they would suffer a loss in their relative autonomy, even in licensing (3).

Lastly, the financial aspect must be considered. National entrepreneurs had relatively scarce resources of their own, considering the necessities typical of investments in the intermediate sectors, where the enterprises required large immobilizations of capital for long time periods. As they operated in a relatively small scale, the industrial enterprises, even with a high profit rate, generated a relatively small mass of profits, compared with the need for investment in the intermediate sectors.

Because there was no organized capital market in the country at the time in which private savings could be invested, these savings were mostly invested in landed property and urban real estate, which made it economically and politically difficult to mobilize them. There was only the access to public and international credit, the former through the BNDE (National Development Bank), founded in 1952, and the latter through the international agencies (specially the International Bank for Reconstruction and Development, IBRD, also called World Bank), bilateral government credits and suppliers' credits. Despite the fact that the small size of enterprises was in itself a limitation to the concession of credits to any single enterprise (4), all the above means could have been mobilized, specially by a group of united national enterprises. The BNDE was open to the necessity of producing basic inputs in the country, the "basic industries" having been included in its list of priorities, and it did not oppose private property in these sectors, having approved construction

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(3) It was not impossible to carry out a technological policy that would give the national entrepreneur the access and future mastering of technology without subordination - see the case of Japan. However, for Brazil, in order to achieve this, a previous, adequate economic and educational basis was indispensable, as well as internal and international political conditions making a similar development possible. The existence of a group capable of implementing this possibility (see, for example, Technological Development in Japan, UNESCO, Paris, 1971; Criação e absorção de tecnologia na indústria de bens de capital, FINEP, 1973) shows that the process of loss of autonomy as a result of the lack of control of the technology on the part of the national entrepreneur can reach the loss, at least in part, of the actual ownership of the enterprise, as some foreign owners of technology condition the granting of licenses to the transfer of shares by the licensee to the licensor. This problem, however, was not often understood at the time.

(4) The volume of resources an enterprise can raise in the financial market will obviously depend on its ability to pay them back. The profit rates being given, this ability is closely linked to the size of the enterprise (i.e., its previous accumulation).



of the USIMINAS and COSIPA steel plants with private capitals. It made several loans to the foreign grantees of government concessions in the field of electric power (5). The IBRD, in turn, was sympathetic to private investment in these sectors, preferring it to State property (6).

Despite this availability of credit it is useful to recall that the negotiation with these financial institutions is always based on an assessment of the technical, economic, and financial feasibility of the undertaking, a previously elaborated project that requires considerable knowledge to be properly prepared. This process differs substantially from the traditional forms of obtaining credit, where the personal record of the potential borrower and the confidence of the financial agent are the determinants of the credit concession. This negotiation through projects represented thus a substantial change in procedures for the entrepreneurs (7).

Bilateral credits, as is well known, serve two purposes: as instruments of international diplomacy and as instruments for the sale of products made in countries that provide the credits, these products usually being capital goods and know-how of the developed countries (8).

It is unlikely that an initiative as important as a basic industry to be implemented by Brazilian capitalists, given the influence of these latter within the government and the importance of the undertaking itself, would not find government support. Even if some international sources of credit were closed, the government, if it so desired, could certainly find another source (chiefly another governmental one) willing to grant credits which would permit such purchases of capital goods and know-how. Suppliers would be happy to grant credits to Brazilian capitalists, provided that they were satisfied with the guarantees of payments, which could probably be complemented by security

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(5) The BNDE became the largest shareholder in the steel industry, on account of the difficulties of the private shareholders in their repayment of credit commitments. This might possibly be a curious phenomenon of nationalization forced upon the State agent.

(6) Analyzing the IBRD's policy in a seminar promoted by the Bank, Robert Asher made the following comment: "the leaders of the Bank had great faith in private enterprise and private investment as the true engines of growth... (the credits granted by the Bank were conditioned) to the recognition that oil refineries, steelworks, fertilizers plants, National Development Banks and virtually everything, except the main public utilities, should be private property." (Asher, R. 1973. Comment: the Leopard Spots. In The World Bank Group, Multilateral Aid and the 1970's. John P. Lewis and Ishan Kapur (ed), Lexington Books.)

(7) Even today, when the project has practically become an institution, on account of the action of the official credit institutions chiefly after the creation of the BNDE, one still finds considerable resistance and lack of understanding of the function of the project, particularly amongst the most traditional entrepreneurs who were the majority at the time.

(8) Bhagwati, J. 1970. The Tying of Aid. In Foreign Aid, J. Bhagwati and R. Eckaus (ed), Penguin Books.

given by public agencies such as the BNDE or the Bank of Brazil (9). Therefore, in the same way as the organizational and technological problems, the availability of financial resources would not be insurmountable, although it would be a concrete obstacle to the entry of Brazilian capitalists into the sector of intermediate goods.

In order to explain why national industrial capitalists did not go into these sectors, the possibility that they had other activities which offered a more profitable return of their resources must be considered. In the prevailing market conditions, the investment of their capital in the expansion of their original activities or similar ones (i.e. in the production of consumer goods) presented substantial advantages: the amount of resources to be immobilized was much smaller, and both the technology and the market were often already known (chiefly in nondurable consumer goods), which neither required of necessity any great changes in the entrepreneurial structure and forms of management nor represented a threat of loss of control of the enterprise. In this way, the costs of changes in behaviour were avoided (10), the profits on capital were returned faster and in larger proportions (11), and were not divided among partners outside the family. Therefore, if there was someone who could take care of the production of basic inputs, Brazilian industrial capitalists would have "comparative advantages" in developing the sectors where they have been traditionally established, that is, those producing consumer goods.

These "comparative advantages" are not only economic, but they also incorporate elements of a sociological and political nature, such as the resistance to change entrepreneurial performance, the relatively short time horizon that privileges operations with a rapid return of investment, and the difficulty in establishing a joint economic action to face the necessities of

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(9) Depending on the feasibility of the project, this security would hardly ever be denied, given the crucial importance of the undertaking for the country's economy, and the political weight of the industrial groups.

(10) As was suggested, these costs present a real financial aspect - hiring of a technical team, purchase of technology, etc. - but they also have a psychological component of resistance to change, of attachment to usual forms of behaviour, which should not be underrated.

(11) On the one hand, these industries could exploit in depth the advantages of cheap labour and of relatively restricted fixed equipment. On the other, in a situation of repressed demand and inflation, it is usually easier to charge high prices to the consumers of final goods, who are longing for the possession of these goods and whose economic calculations are distorted by inflation, than to entrepreneurial consumers, purchasers of intermediate goods, whose capacity for organization and resistance to price rises is larger than the individual consumer's. The inflationary situation certainly reduces the resistance of entrepreneurial consumers because of the possibility of transferring the rises in costs to the final consumers; but even so one can foresee a stronger resistance on the part of the entrepreneurial consumer. (This last argument, of the difficulty of transferring costs in the production of intermediate goods, is also applicable to the producers of capital goods, who, nevertheless, constitute a minority among national capitalists.)

investment in the intermediate sectors (12). The lack of awareness of their interests as a defined group was probably a serious barrier to the implementation of these common undertakings, so that they left these initiatives to the State or to foreign enterprises.

The analysis has explored the case of national industrial capitalists in more detail. Agricultural capitalists would count upon more available resources of their own, because of the lower degree of immobilization in their activities. However, their willingness to enter into intermediate industrial sectors would still be less marked than that of the industrial capitalists, owing to their previous experience and to the possibility of reinvesting their profits in land, consumer goods industry, or urban real estate. In a similar fashion, the same elements would affect capitalists involved in the tertiary sectors, chiefly commerce and finance.

Brazilian capitalists were interested in someone else making the investments for the production of basic inputs: they themselves had neither the conditions nor the interest. For the large international enterprises, the mobilization of organizational capability, technical knowledge, and financial resources adequate for these investments would have been possible in most cases, provided that there was sufficient interest. It must be noted, however, that in the 1950s the great flow of investments of American capital to Europe began, which presented a market and conditions of production much more attractive than those of Brazil, and also that the European and Japanese capitals were still in the process of post-war reconstruction. If the low profitability of these intermediate sectors and the possibilities of nationalization are also considered, it can be understood why these sectors were not very attractive to foreign capital.

Foreign capitalists were not interested in these sectors, but they preferred to concentrate their resources in the production of consumer goods or services. In the electric power sector, foreign private groups (LIGHT and AMFORP) operated the distribution, while the State was responsible for the generation. It is also symptomatic that LIGHT should have given substantial support to the creation of the Furnas hydroelectrical plant, with massive participation in its initial capital, exerting pressure upon the World Bank for the granting of a credit to Furnas at a time when the relations between the Bank and the Brazilian government were under stress. Then, after having assured the production of the power that it distributed, it should later allow its participation in the capital of Furnas to fall to a negligible level (13). (In the sphere of generation of power the characteristics of low profitability mentioned above are remarkable.)

In the same way, it should be noted that in the sector of steel production the only capital resources invested were from Japan, and that they placed in the Brazilian State the greatest responsibility for the investments and remained as minority partners; also, they only maintained their participation in the investment after much pressure.

The exception to this pattern of low profitability in the production of basic inputs is oil, in the spheres of refining and distribution. It is worth noting that, among all State enterprises, PETROBRAS was the one with the strongest opposition when it was created, as the great international groups

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(12) Cardoso, F.H. 1964. *Empresario industrial e desenvolvimento economico no Brasil*. Difusao europeia do livro.

(13) Tendler, Judith. 1968. *Electric Power in Brazil - Entrepreneurship in the Public Sector*. Harvard University Press.

saw their plans frustrated in the fields of exploration and refining. The State monopoly of the distribution was barred and not made law.

The seizure by the State of these sectors that produced basic inputs interested all industrial producers established in the country (both national and foreign), and only clashed with the aims of some international producers in the case of oil, where they saw themselves pre-empted by the State.

State intervention also counted on the support of several socioeconomic groups, particularly those with university education (liberal professionals or those belonging to the bureaucracy, chiefly within the State apparatus), and those from the existing State bureaucracy (such as the Armed Services), who saw in the State enterprises the accomplishment of a project of national development and their own professional fulfillment, particularly if they were technicians or administrators. Working class organizations also supported the creation of State enterprises, as they provided new jobs and were in accordance with the ideals of national development prevailing at the time.

This support was not unanimous, chiefly among some groups belonging to the "middle class," who saw with fear the State presence in the intermediate sectors as a sign of an increasing State intervention in private property, or of the loss of previously conquered positions. The middle class is defined here as those with incomes from property and labour. Industrialists and tradesmen who work in their own enterprises, liberal professionals (doctors, lawyers, etc.) and technicians employed in the public and private bureaucracy, whose move or transit to the liberal professions is easy and frequent, are included in this group. The other members of the bureaucracy, though not possessing property, control it to a large extent and extract from this control not only material incomes or benefits but also elements of identification, and therefore are included in the same group (14). As small owners, these groups are constantly threatened by absorption by the great public or private capital and, as technicians and administrators, their own position and that of the bureaucracies they belong to are threatened by the creation of new institutions whose functions come to superpose themselves on them. (See, for instance, the loss of importance in several sections of the direct administration, chiefly in the spheres of what is today the Ministry of Mines and Power, after the creation of the State enterprise.)

Agricultural producers had not only kept links of alliance with the industrial producers, whose majority was favourable to the State enterprise (links stemming from financial, commercial, and even family relations), but also had none of their interests damaged by the creation of the State enterprises. Although the economic benefits were probably small in the beginning (with the possible exception of the extension of electric power supply to the rural areas), the creation of State enterprises did not represent a threat to their interests (mainly centered around the possession of land) and would have been a bargaining point in the prevailing political process, where their support for the creation of these enterprises could have been bargained for, with other groups more directly interested in these enterprises, in exchange for other concessions. Therefore, the creation of the State enterprises, though not carried out amid a general consensus, seems to have satisfied the great

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(14) Ossowsky, S. 1963. *Class Structure in the Social Consciousness*, Routledge and Kegan Paul.

majority of the prevailing interests, with the exception of Petrobras (15).

By taking responsibility for these enterprises, the State thus assured the viability of the existence of a great part of the private system of production, allowing the latter to concentrate on the most profitable activities, and, at the same time, it spread or diluted the costs among most of the country's population, collecting resources either by taxation or by inflation. On the other hand, using its technical staffs and its capacity for international negotiation, the State assured the international credits that were capable of complementing the internal resources of the country.

In the Brazilian case, the entry of the State into the intermediate sectors satisfied most of the politically active interests, so that the obstacles to the creation and expansion of State enterprises were and still are of a wider economic nature; they are related to the national capacity of investment itself. This will be dealt with in more detail in the following sections, where the prevailing obstacles to the expansion of these enterprises, specially their financial problems, will be examined.

Although the creation of State enterprises was of general interest, conflicts arose when decisions had to be made on the location of these productive units and on the orientation of their purchases. The size of Brazil made it practically impossible to set up units that would serve the whole country; the nearer the State enterprises to the capitalists, the more benefits they would obtain in terms of ease of access and transportation costs. The struggle for the location of these enterprises in several states became a reason for conflict among regional interests, and there is evidence that in some cases these interests organized themselves and began undertakings so that they could present the Federal Government with a fait accompli, or at least with an irreversible situation, in view of the amount of resources already spent. It is interesting to note that the subsequent control of these undertakings by the Federal Government was not a great evil, since the main regional interest, the setting up of units producing inputs in the State, had already been assured.

This ulterior control of undertakings by the Federal Government took place in the sector of steel production, in the cases of USIMINAS and COSIPA, and it was caused by the incapacity of the regional interests to accomplish the enterprises that had already begun. It is also worth remarking the conflicts existing between state power companies (i.e., of the member states of the federation) and the ELETROBRAS (federal) for the control of construction works, now subject to ELETROBRAS' previous approval; also the decision by CEMIG (of Minas Gerais state) to build a local transmission power station ("sub-estacao") in Pocos de Caldas in order to occupy the site before Furnas (federal enterprise) and CESP (of Sao Paulo state) did so; and still the controversies

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(15) It is curious to remark that K.H. Raj, in analyzing the development of the State's entrepreneurial activity in regimes whose structure of production is different from that of Brazil (Asian and African countries) but which had in common a heterogeneous political basis, with strong middle class support, with an opening for the rest of the world and a nationalist orientation, concluded that "there will probably be no direct political limitations to the growth of the public sector in these regimes." (Raj, K.H. 1973. The Policies and Economics of Intermediate Regimes. Economic and Political Weekly, July.)

about the occupation of border rivers between these companies (16).

Nevertheless, the control of a State enterprise by a Federal or State Government is not indifferent to the local producers of capital goods and to the contractors engaged in the construction of these enterprises. The State Government, in view of its local commitments, will probably tend to favour the entrepreneurs established within the state territory, as this means an economic push for the state, a general increase in revenue for the State Government, and a political reinforcement of that specific state leadership. In contrast, the Federal Government, on account of its own composition, usually has to adopt more "universal" (in this case, "national") criteria, which would assure a relative equality of competition between producers of the several federal states. This "universality," which results from a multiplicity of pressures, generally manifests itself in criteria of technical and economic assessment, usually expressed in a quantitative form in terms of productivity, price, conditions for payment, and time of delivery, so that the most "efficient" producers tend to have an advantage in the competition. The use of these criteria often leads to a situation in which projects implemented in a state are supplied with capital goods produced in another state, to the obvious annoyance of the local producers, for whom the federal control can be damaging if the criteria of the competition are "universal" and if they are not the most "efficient." In this case, the purchase of their products would have to follow practically explicit political criteria. In the Brazilian case, however, due to the concentration of the production of capital goods in Sao Paulo state, these regional conflicts would be somewhat restricted.

However, the phenomenon described above repeats itself in an amplified scale when the competition occurs in the international sphere and the margin of protection given the national producer is not political (as happens with the World Bank funds, where the protection is only 15 percent), and where the national producers compete with large international firms.

There are, therefore, three points to stress in this aspect: first, the difference, in behaviour between companies under state or federal control in the purchase of equipment from the state, from the country, or from abroad (the comparison between CESP and Furnas is enlightening); second, the influence of the financial agencies, when they require, for example, international competitions (this issue will be dealt with again in more depth in another section of this paper); and lastly, that these values of "competitiveness" and "universality" are often introjected into the technical staff and the administration of the State enterprises, so that they might well not represent an imposition from outside (for instance, by the financing agent) on the enterprise, but be incorporated in its technical staff and administration. Therefore, it is logical to search for a source of financing appropriate to the type of behaviour intended by the State enterprise in terms of a purchase oriented towards foreign or national suppliers. Those enterprises whose criteria of assessment are the most "universal" are oriented towards the international agencies (specially the World Bank), and those whose criteria are the most "particularistic" towards other agencies.

It was implicitly suggested above that there would be a contradiction between the "universal" technoeconomic criteria, which would lead to the purchase of equipment abroad, damaging the Brazilian industry but maximizing

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(16) See: Tendler, J. op. cit.

short-term economic growth, and the "particularistic" criteria, strongly influenced by local interests (state or federal as might be the case), the obedience to which would be contrary to this short-term maximization, but which could lead to a greater economic and political autonomy whose results would be felt in a longer term range.

It is, however, possible, according to José Tavares (17), that the enterprises that buy more in the country maximize their profitability and the benefits to the national suppliers at the same time so that there would be in such cases a convergence of economic and political criteria and, in certain cases, even of state and national interests.

Finally, it is important to note that the political, technical, and financial support given by the foreign enterprises to the creation of the local State enterprises, though undoubtedly having made their creation easier, may have had negative consequences in terms of nationality and autonomy, including technological autonomy, by reducing their need for an identity of their own. The relation established by Furnas with LIGHT, and through the latter with the World Bank, has probably contributed substantially to its orientation towards technology from abroad. In contrast, the initial struggle of PETROBRAS to set itself up, and later on to survive, has undoubtedly sharpened its conception of a national identity (of itself and of its suppliers), orienting it more towards the national technology, as it took into account the aim of achieving a greater autonomy.

Further light on this issue of the development of a national identity by the enterprise, as a result of political birth pains, and its consequences for its technological policy, can be gathered by comparing the cases of the Companhia Siderúrgica Nacional (CSN) and PETROBRAS (see Chapter 11), as both were the result of a political process of national affirmation. The CSN was the result of a hard-fought struggle to set up a large steel plant in Brazil at the time of the war, and its construction was opposed by United States Steel Co. This resistance was overcome only by the combined pressures of both U.S. and Brazilian governments, and to the possibility that German technology and capital would intervene, adding weight to the pro-Germany interests in the country, at a time when the U.S. government badly needed bases in the Brazilian northeast for the campaign in Africa. However, having removed its resistance, U.S. Steel was responsible for implanting CSN, which, until recently, has been dependent on U.S. Steel-based technology, and has not called attention upon itself as an enterprise oriented towards technological autonomy, despite a relatively long existence. PETROBRAS was the result of a long political struggle, with wide popular participation and long-time opposition from affected interests. Probably, herein lies the difference. While the CSN struggle was conducted mainly at government level, with practically no popular participation, PETROBRAS was the result of a wide national movement from which emerged a clear consciousness of its political and economic role as promoter of national autonomy, which is reflected in its technological policy.

## Financial Restrictions

### Introduction

When the State created public enterprises, it was fulfilling one of

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(17) José Tavares de Araújo Jr. 1973. Escolha de técnicas e rentabilidade nas empresas governamentais, FINEP.



its most important functions: that of creating general conditions of production, while assuring the historical coexistence of different interests. Yet, when the State creates its institutions for the production of intermediary goods as corporations, it does not transcend market relationships, but rather penetrates them, although in an ambiguous form, because State enterprises will always have an ambivalent behaviour: an "entrepreneurial" behaviour, concerned with profits and capital accumulation, and a "government" behaviour that makes the enterprise try to reconcile the interests of different social groups, although giving them different evaluations, according to its political basis. The conflict that underlies this double character of the public enterprise is more evident in market relationships, when it buys and sells, and in financial relationships.

#### Production Maximization

As in several other countries, State enterprises in Brazil concentrated in the capital goods producing sector, because of the historical process, that is, they are the suppliers of goods and services that constitute essential inputs to the production of the other units of the economic system, which generally are privately owned. This kind of coupling of the State enterprises with the rest of the productive system leads them to play, first, the role of making feasible the existence of other economic activities, supplying the inputs that are the necessary conditions for the functioning of the remaining enterprises. Without these inputs private enterprises could not operate and the actual investments could not have been made. In this sense, State enterprises permit the backwards integration of the productive system, allowing various opportunities of investment to take place and, at the same time, creating, by means of their installation and operation, a sizeable demand on the private sector, specially in the field of capital goods, industrial inputs, and engineering.

In a growing economy, both the creation and expansion of these enterprises are of general interest, in view of their function of producing basic inputs almost without competing with private producers. The growth of their production will allow more enterprises to have the necessary basic inputs; all consumers will probably benefit from reductions of costs (scale economies are usually large in the sector of intermediate goods); the suppliers will benefit from orders; jobs will be created; and the level of the demand in general will be favourably affected (18). Therefore, there is wide-spread interest in the growth in production of State enterprises.

A State enterprise is interested in growing to the largest possible size because its influence and prestige depend on its contribution to the productive effort of the system, which depends largely on its relative and absolute size. It is interesting to note the observation of Judith Tendler (19

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(18) The bulk of human, financial and material resources called upon by a State enterprise for its operation and expansion, associated with a certain autonomy in relation to the composition of the final demand suggests that it can play an important role in anticyclic policies and in the maintenance of the present composition of the final demand. (For instance, it is probably indifferent for a steel mill that the steel that it produces will be used for another mill or for the production of automobiles.)

(19) J. Tendler, Op. cit.

who analyzed the behaviour of electric power production enterprises. She claims that they entered in competition in terms of projects and would frequently try to occupy "empty areas," in a clearly "pre-emptive" policy, with emulative effects.

It is worth noting that the size and contribution of an enterprise to the industrial system constitute not only a symbol, but also an instrument of power and that, in the case of a bureaucracy originating mainly from the middle class in a partially open society (as in Brazil), the prestige and progress of the bureaucracy are associated with this power and cannot be ignored by the management of these enterprises. Therefore, there would be strong personal or group reasons to make the enterprises as large as possible. Other elements that add to the prestige of an enterprise (and its management) are productivity, low costs, etc.

This behaviour does not seem to be the exclusive realm of State enterprises. When analyzing the behaviour of the management of large corporations in the use of resources, Ulmer reaches the conclusion that a corporation is basically conditioned by the search of power and prestige that derives from its size, and these motivations make them follow emulative strategies (20). It could be a behaviour derived from the aspect of "large enterprise" of State concerns, associated, in the Brazilian case, to the small number of opportunities for social and political mobility for members of the middle class outside government structures. If the management of the enterprise obtains advantages in prestige and promotion to higher jobs, based both on the present dimension and on the volume of investments made, technical and bureaucratic staffs will also benefit from working in a large institution, in terms of professional experience, training, and prestige. Therefore, it can be suggested that State enterprises would follow a strategy of maximization of their production to the limits of the market and the financial resources that they have at their disposal, because of internal and external pressures.

Without taking into account the effect of these restrictions, the consequences of production maximization as a strategy to be followed by the enterprise should be examined. This can be done in a simplified form, where the enterprise can be considered in a short-term perspective, selling its products at a given price and operating according to a classical production function, which generates U-shaped marginal and average cost curves. In spite of the clear distance between these conditions and reality, this conventional form is adopted because of its usefulness for the exposition of the phenomenon to be treated.

Economists who deal with large modern enterprises that operate in conditions of oligopoly or monopoly (21) or who study the Soviet economic system (22) are interested in enterprises that follow objectives different from those classic

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(20) Ulmer, M. 1971. Economic Power and Vested Interests. In Power in Economics, K. Rotschild (ed) Penguin Books.

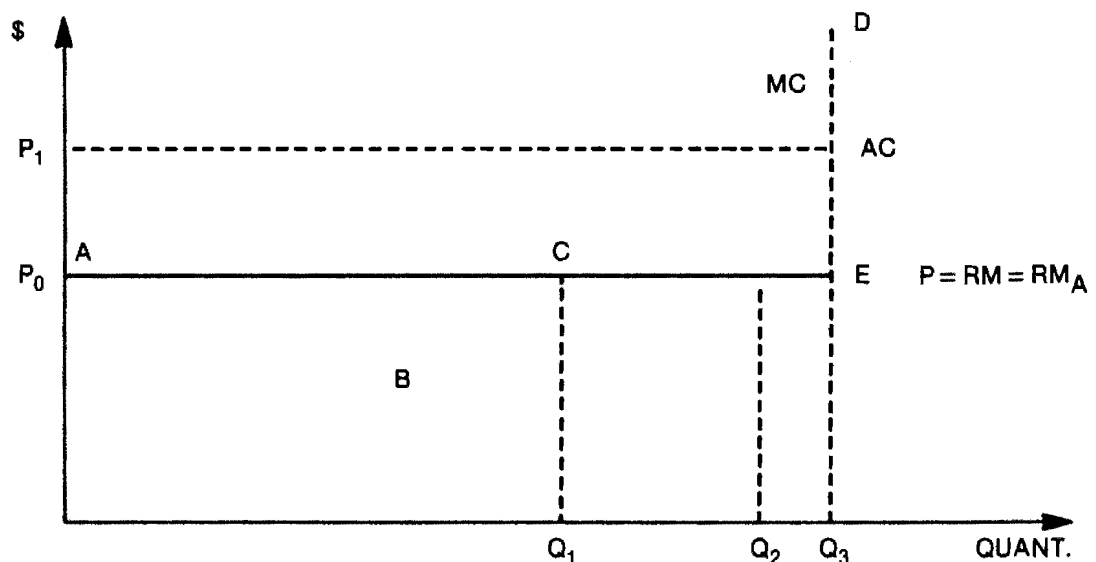
(21) Baumol, W.J. 1971. On the Theory of Oligopoly. In The Theory of the Firm, G. Archibald (ed), Penguin; Eatwell, J. 1971. Growth, Profitability and Size: The Empirical Evidence. In The Corporation Economy, R. Marris and W. Wood (ed), Macmillan and Co.

(22) Ames, E. 1971. The Economic Theory of Output Maximizing Enterprises. In The Theory of the Firm, G. Archibald (ed), Penguin.

goals of profit maximization, but that they try to maximize production (or sales) (23). There are certain common conclusions in the results shown by both cases (cf. Baumol and Ames). The Brazilian State enterprise has common aspects with both cases, operating under monopolistic or oligopolistic conditions and being, at the same time, state-owned.

The difference between the production of a firm that seeks to maximize its profits and one that tries to maximize its production (or sales) can be seen in Figure 1, where MC and AC are, respectively, marginal costs and average costs curves, and where P is a price straight line, considered, at this point of time, constant and known (marginal revenue = average revenue). Being a short-term curve, there is a point ( $Q_3$ ) that represents the maximum possible production in this scale of production.

Figure 1.



This figure shows that an enterprise operating under a strategy of profit maximization, equalizing its marginal costs and marginal revenue (in this case, the price), will produce a quantity ( $Q_1$ ) smaller than the quantity produced by an enterprise that is maximizing sales, i.e. that produces till the point from which onwards the selling of an additional unit would diminish total revenue. This is  $Q_2$  point, where average cost equals price, and sales are at a maximum point. After  $Q_2$ , costs will exceed revenues and total revenue will drop.

In the preceding pages attention was drawn to the common interests of a State enterprise and its consumers in the maximization of its production. This production is transmitted through market relationships between the

(23) In more sophisticated models the objective function usually incorporates more than one objective (see Ames, above), or they are expressed by means of restrictions (like minimum level of profits, or market value of shares, stock) (see Baumol and Eatwell, above).

enterprise and its buyers, that is, through prices. The specific nature of the relationship introduces an element of potential conflict that gets stronger when the State enterprise is more "enterprise" than "state", that is, when it is more profit-oriented and its relationships are equated in terms of market values.

Selling prices of State enterprises, euphemistically called "administered prices," are the result of a complex process of decision making, where the enterprises themselves, government authorities in charge of price and inflation control, and sometimes, representatives of the buyers of the products, usually participate.

In the process of change and periodical adjustments, it is possible to foresee that, being present representatives of the "pure" State, that is, authorities that control prices and that are generally subordinate to direct government control and even to the consumers, the enterprise is subject to great pressures to keep its prices as low as possible. A rise in the prices for the government, given the implications of the role played by the State enterprise, will be transmitted to the whole system, forwarding a rise in the general index of prices. The lower the prices for the consumers, the lower will be their costs and, probably the higher their profits. It is worth noting that the same insertion of the State enterprise in the productive system, which gives it general backing for its creation and expansion (that is, relationships at the productive process level), makes all interested parties fight against price rises (that is, at the market relationships level). The conflicts that arise from these contradicting tendencies in the growth of a State enterprise can only be solved either by means of stressing the capitalist aspects of the enterprise, searching higher profits that can be reinvested, and making it ever more similar to private enterprises, or through the socialization of the expansion costs by the use of public resources.

Let us suppose that, in an extreme case, the enterprise is not looking either for revenues or for profits, but only for physical production, which could be expanded to the full capacity of the plant (point  $Q_3$ , in Figure 1). If at this point line  $P$  is so low that the area  $ABC$  is smaller than the area  $CDE$ , the enterprise would be suffering substantial losses. An enterprise can only cope with losses for a limited time, unless it has means of tapping resources from outside, and these sources do not adopt commercial criteria for the concession of these resources, like those used by private resource sources (financial system and stock market). It can be seen that, at a certain level of prices, the enterprise will only maximize its physical production if either the level of prices is, be it by coincidence or by common consent, at  $P_1$  (the level of prices compatible with both maximization of sales and of physical production) or if the enterprise can resort to a financing scheme that is independent of its profitability, that is, it can resort to public financing sources.

Baumol suggests (24) that oligopolies can maximize their revenues, subjecting them to a minimum level of profits, and from then on they can manipulate production so that prices and profits can be raised. In the case of a State enterprise, given the administrative profile of basic inputs prices, it is more probable that the struggle will take place at the moment of determining the price level, as this will define profits that will be obtained at a given

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(24) W. Baumol, Op. cit.

production level. It is also probable that enterprises attempting to maximize their production and, at the same time, endeavouring to have internal resources for their expansion policies, will fight for prices that will meet both these objectives, or even better, both the objective and the restriction. This last restriction (generating profits to meet expansion policies of the enterprise) is all the more dependent on its own profits for expansion purposes, that is, its strength depends on its financial pattern. Therefore, it is possible to have a strong correlation between the price level that the enterprise endeavours to obtain, the price level acceptable to it, and its financing pattern, that is, the sources from which it obtains the funds needed for its expansion plans.

Once the price level is established, the enterprise will increase production up to a level compatible with its objective. Probably this objective will be one of maximizing revenues, because it is the one that better fulfills the role played by the enterprise in the productive system and its own role of entrepreneur, allowing it to maximize present production without damaging future production. Furthermore, it is also probable that there is a potential conflict between the enterprise's function of increasing the production of basic inputs and its function as a government instrument in inflation control. There is also a potential conflict between its first function and the one of keeping high profit levels in the rest of the system, by charging low prices to the rest of the system. Both these conflicts will be greater in the same proportion as the enterprise must rely on its own profits in order to increase its productive capacity, depending therefore on its financing pattern. It can be said, then, that the strategy adopted for the development of an enterprise and, accordingly, the criteria for choosing technologies, rely very much on its financing pattern.

#### The Financial Pattern

Attention has been drawn to the fact that financial restrictions, that is, the availability of resources at the enterprise's disposal to achieve its expansion, constitute a limitation to its ability to operate at full capacity because it requires profits for its own expansion program. It has also been said that the price desired by the enterprise, and the minimum price that it can accept when faced by pressures to keep prices at a low level, depends also on its financing pattern, that is, the kind of resources that it can count on for its expansion program (25).

(i) The Price of Equipment and of Production Processes (26): The most direct manifestation of a financial restriction to the purchase of equipment is its price. The higher price of one set of equipment in relation to another will imply higher fixed costs, and accordingly an increase in average costs. As it can be seen, once the price has been set, an increase in average costs will make the curve of costs intercept the price line (maximizing the sales) at a lower production level and will reduce the total profit of the enterprise, therefore

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(25) In this sense, the work of Raj (op. cit), which focuses attention on the problems of price determination and price relationships, would be taking the most apparent problem (the price) for the most important, without reaching the real problem (the financing pattern).

(26) Although the explanation below emphasizes the problem of costs of equipment, it is also valid for the price of producing processes.

going against its own and the system's interests (27).

Evidently, if the enterprise can transfer this increase in costs to the consumers through an increase in prices, changes in production will depend on the elasticity-price of the demand. If it is completely inelastic there would probably be no changes in the quantity produced, and that could be seen in Figure 1 as a vertical movement of the curves of costs and prices. An elastic demand would probably reduce sold quantities and profits. Nevertheless, not only is a completely inelastic demand unlikely, but also the ability of an enterprise to transfer all its costs' increases to the consumers is even less probable. Prices charged by State enterprises are agreed through a process of political and technical negotiations where resistance to actual increases in prices is very strong.

It can be seen, therefore, that the price of equipment or of a productive process is, obviously, one of the main defining elements of its choice, besides its reliability (see internal restrictions). But, for the enterprise, the price of equipment or of a process is not only the price itself, but this price weighted by the sales conditions (financing time, total time, and time for repayment, besides financial costs). If the world financial system worked under free competitive conditions, that is, if all buyers and sellers knew and could use all credit sources, the price alone would be the financial element used to define a choice. But as financial sources discriminate in relation to suppliers of technology, working usually with only one of these groups, financing conditions are of critical importance at the financial level, and are even more important than the price itself (28).

(ii) International Financing: The financial sources that operate both in the national and international markets follow rules that are generally clear and have more or less explicit and strict ties with groups of suppliers, so that when a State enterprise contracts a financial institution to obtain credits, it already knows the conditions. For example, it is known that most credits granted by governmental agencies (such as the Eximbank, in the United States, and the Export-Import Bank of Japan), that is bilateral credits, usually tie the granting of credits to purchases from suppliers of these countries. It is also known that selling prices tend to be higher because suppliers charge the FOB price at the level of their internal market, while in international biddings they would give lower prices in order to be competitive (29). Of course, in these cases, there would be no purchase from national suppliers.

International agencies that operate on a multilateral basis (in the Brazilian case, the Interamerican Development Bank and the International Bank

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(27) Of course, one has to take into account that it is not the price of a single piece of equipment that usually makes the curve of costs of an enterprise move, although there are certain cases when some pieces of equipment can be responsible for large shares of the total cost of a project. This suggests that special attention should be given to the more expensive pieces of equipment in the project.

(28) As an example, see, for instance, bilateral purchases through USAID, where availability and conditions of financing almost always force the purchase of American equipment, which is frequently more expensive than that of other suppliers.

(29) J. Bhagwati, *Op. cit.*

for World Reconstruction and Development) adopt a position that apparently is more "neutral," usually demanding that the purchase be made through public competition, where national producers enjoy a 15 percent protection margin. Nevertheless, this margin is usually not sufficient if the equipment is new to the national supplier and foreign competitors are committed to win the bidding. It is worth noting that when foreign firms enter a bidding to supply equipment (or process) to Brazil, they are usually using know-how already developed for similar projects, so that part of the costs are really insignificant; but the Brazilian competitor has frequently to cover the whole cost of the project, and this allows a foreign competitor to charge much lower prices. Furthermore, the practice of pre-classification in international biddings, where possible candidates must "show" their capacity, usually based on similar experiences, also tends to put aside national suppliers that cannot prove "tradition." This perpetuates a vicious circle of having always the same suppliers or narrowing the choice to traditional suppliers that are, for the most part, foreign firms from developed countries (30).

It must also be pointed out that the patterns used by the technical staff of international institutions to evaluate propositions presented to them are developed in industrialized countries, and that the major part of the technical staff and specialized personnel of these institutions (specially in the IBRD) come from these countries. Naturally, all these circumstances work against national suppliers, because they are unknown to the analysts, who are familiar with traditional suppliers (31). This will depend, of course, on the kind of relationship established between the institution asking for financing (the State enterprise) and the international agency, especially on the former's freedom of judgement and on its capacity for justifying the decision made.

Finally, one must take into account that even international agencies are essentially banking institutions, that is, they are worried about the rational use of the resources that they lend, which makes them interfere in the process of resource allocation (32) and, at the same, makes them worry about the backpayment of these resources, or the profitability of the projects that are given financial aid, and the guarantees offered (33).

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(30) See: "Creations and use of technology in the Industry of Capital Goods" chapters 3 and 4 - FINEP and page 33 of this chapter.

(31) See the opinion of Carl Ohman, former Substitute Director of the IBRD: "The bias in favour of technical perfection is reinforced by the fact that specialists, for their most part, come from industrialized countries and naturally tend to prefer techniques they are already used to." Ohman, C. 1973. Comment: A Social Radicalism. In: The World Bank Group, Multilateral Aid and 1970's, J. Lewis and I. Kapur, Lexington Books; Balogh, T. Multilateral v.s. Bilateral Aid. In: J. Bhagwati and R. Eckaus, Op. cit.

(32) This is normally rationalized as technical aid, even though it is sometimes really an aid depending on the country and on the time.

(33) "A hard or soft loan from the World Bank is based on the hypothesis that the borrowing country will be in conditions of paying it at the right time. Multilateral and bilateral aid programs base loans on concepts of efficiency, return rates and waste... which are today and probably have always been inadequate to less developed countries." Richardson, Richard W. Comment: The Raising of Resources. In: J. Lewis and I. Kapur, Op. cit.



The case of the World Bank is especially complex because financing is given after an evaluation of the national economic and financial policies, associated with banking criteria. The evaluation of national policies is usually made together with the International Monetary Fund and favours monetary stability, inflation control, equilibrium in the balance of payments and in government budget, besides a "favourable climate" to private investment, specially a foreign one (34). To that evaluation is added an analysis of the technoeconomic viability and profitability of the project, besides the guarantees offered by the borrowing country (35). The emphasis on banking aspects given by the World Bank, which goes against its work as a development institution (36), has been criticized (37), but also defended in the light of the Bank's need to tap resources in the world market and, accordingly, to maintain a high level of safety in its operations (38).

The granting of credits by international agencies, based on the approval of national policies, reduces sharply the freedom of action of borrowing enterprises, because it ties the granting of funds for specified projects to the performance of the government. Furthermore, according to the established rules seen above, it is foreseeable that, in the credits granted by these agencies, foreign suppliers will usually be in an advantageous position. Suppliers of technology from foreign countries tend to be preferred in bilateral or multilateral financing, although more so in the first case.

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(34) Notice this statement by J. Burke Knapp, Senior Vice-President of the World Bank, "In the case of the Bank, the distribution of resources (among countries) is to a large extent determined by where banking opportunities of making money at our lending rates can be found". In: J.B. Knapp, Determination of Priorities and The Allocation of Resources; in: J. Lewis and I. Kapur (ed) Op. cit and Richardson statement above.

(35) See: R. Asher, Op. cit. and T. Hayter, Aid as Imperialism, Penguin 1971, for criticism to the World Bank (the last one is very strong) and M. Hoffman, The Challenges of 1970s and the present Institutional Structure. In: J. Lewis and I. Kapur, Op. cit.

(36) As it can be seen from a statement by J.B. Knapp, Op. cit., "Argentina is not on this list (these of the big borrowers from the Bank in Latin America) because of the difficult and unstable present conditions of the country." It would be logical to suppose that a development agency would give priority to such a country, although it is normal that a banking institution cannot act in this way.

(37) See: R. Asher, Op. cit.

(38) "The first priority of an institution like the World Bank Group is to raise resources," J.B. Knapp, Op. cit. It has been argued that this emphasis in fund raising would increase the subordination of the World Bank to the government of the developed countries (that already control the majority of votes), thus representing a menace of the Bank's "demultilateralizing," transforming it into a mere instrument for selling these countries' goods. See: W. Gaud; Comment: High Profile, Better Target; and R.W. Richardson, Op. cit., in: J. Lewis and I. Kapur, Op. cit.

There are two kinds of international sources of resources that have not been seen yet: loans in cash and the issue of stocks from the enterprises in international markets. Both would represent transactions based primarily on the profitability of the borrowing enterprises, without ties, even if they are government sponsored. When this pre-condition is met, the first approach seems much more feasible, at least in the short term (see the loan made at the beginning of the 1970s by The Bank of America to PETROBRAS). In addition, it gives more freedom to the enterprise in controlling the use of resources inside and outside the country.

Two conditions that are very important for obtaining loans from abroad are: government support, and profitability, either of the project or of the enterprise. This necessity of profitability creates a certain degree of conflict between the buyers, who would like to be subsidized by low prices from State enterprises, and the authorities, who want to keep inflation rates at their lowest. The recent history of the State enterprises seems to prove that it is possible to find an intermediate position that makes everyone (or at least a part of the interested parties) happy.

When buying technology, the more the enterprise is dependent on foreign resources, the greater will be its tendency to use sources abroad or those of subsidiaries in the country (in that order). Also, the more it is dependent on suppliers' credit or bilateral governmental credits, the greater will be this tendency. The critical role played by the patterns of financing when choosing appropriate technology can be seen. Nevertheless, the decision to look for resources abroad cannot be considered independently without considering the use (and availability) of domestic sources that can be more closely treated. But it is fundamental to remember that the greater the difficulty for State enterprises to have access to resources abroad, either because of problems with the balance of payments or because of limitations in the international credit market (including the international agencies), the greater the tendency to buy inside the country (from national suppliers or from domestic branches of foreign suppliers).

(iii) Internal Resources: State enterprises have access to a large gamut of internal sources because of their double character: at the same time government owned and entrepreneurial. The relative importance of these sources is reflected in the criteria of choosing technologies and in the orientation towards acquisitions from domestic suppliers. Consequently, if the enterprises depend basically on access to the banking credit system in order to foster their expansion programs, they will have to base their decisions on criteria similar to those used by this system; that is, besides elements of technical reliability they will have to worry about the profitability of their operations, and consequently with the price of goods and services used.

The Brazilian banking institutions that can finance projects from State enterprises are official development institutions, particularly the BNDE (Nation Bank for Economic Development), which usually works on a project basis. Such projects are analyzed from a technical, economical, and financial point of view, and the capacity of repayment of the loan is carefully examined. On account of this preoccupation with the repayment of the resources, banking institutions, the world over, tend to be conservative, and it is foreseeable that they will tend to prefer, in their analysis, traditional technologies that have already been successfully applied, which tends to favour foreign suppliers and/or their

domestic branches (39).

The enterprises can also use the domestic stock market, through the issuing of bonds, which has the advantage of bringing in non-tied resources. Nevertheless, this market is still small and its behaviour is erratic, and so it cannot be considered a reliable source of resources for expansion programs. The acceptance of bonds of these enterprises in such a market will depend greatly on their profitability, aside from speculation. If the enterprises are interested in using this market they must be always concerned about profitability. Therefore it is suggested that when enterprises base their expansion programs on "private" sources of funds, foreign suppliers and/or their domestic branches will be preferred to national ones, either because of scale of operation or experience, or because they cannot match the prices of the foreign suppliers (40). This disadvantage in the price could be offset if national producers could count upon exclusive financial sources that are more advantageous than any other offered by their competitors (41).

As part of the government organism, the enterprises can also count on public sources, mainly budgetary assignments and tax resources, besides governmental contribution to the enterprises' capital. Budgetary allocations are resources bound only to a specified objective, and as they are granted according to the objective of one project only they do not bind their use to specified suppliers. But State enterprises do not like being dependent upon such resources because they are normally given in fractions and generally granted for short terms, besides being subjected to political influences outside their control. On the contrary, resources obtained from taxes, on account of their legal instruments, can usually be obtained in large scale for a long time and have normally a sectorial destination and are neither determined in terms of projects nor bound to suppliers (see, for instance, the tax on fuel that goes to PETROBRAS and the tax on electric energy that goes to ELETROBRAS).

Evidently, capital increases, although sometimes motivated by a project, are not bound to suppliers. Therefore, a more intensive use of public resources seems to further a more intensive use of domestic suppliers, at least in binding them, because the sources are not bound to suppliers and because the enterprises could use profitability criteria more macroeconomically oriented, without giving undue weight to prices and payment conditions accorded to goods and services bought. Besides, they do not have to show high rates of profitability in order to receive these resources, which would be granted more on the economic necessity of the project than on the financial performance of the enterprise. In this way, it could be said that a lesser degree of autonomy of the enterprises in relation to the government would give them greater freedom regarding the suppliers. Nevertheless the above possibility seldom becomes real. Some reasons can be suggested for this fact.

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(39) This tendency in official credit institution can be proved by interviews with the staff on State enterprises.

(40) Official credit institutions can be counted among "private" sources because they use evaluation criteria where microeconomic aspects of the projects are stressed.

(41) This is a field where official credit agencies, such as the FINAME, can act in a very positive way. See also, Erber, Tavares, Alves, Reis and Redinger, Op. cit.

First, in Brazil, legal determinations about the use of public resources tend to reduce discrimination in favour of national suppliers. But that reason seems to be the least important, since conditions for qualification are set by the enterprises themselves and there are indications that sometimes they exclude these national suppliers (42). This fact is related to the internal conditions of the State enterprises, that is, their choice of criteria. It is probable that, in many cases, they prefer not to use this relative freedom of action because of the difficulties involved in changing usual patterns and of risk aversion, and so they continue to prefer foreign suppliers and/or domestic branches. Finally, public resources can be insufficient and the enterprise is forced to use other domestic or international sources. Although these other sources are indispensable to the financing of the project, the buying conditions that they impose (which, as it was already seen, lead to a preference for foreign suppliers) can be extended to the whole project and not only to the part that is financed by their resources. This result, which is very common for equipment, is one of the most significative aspects of the influence (leverage) of the international financial agencies.

It is suggested that the internal availability of public resources for the financing of expansion projects of State enterprises is fundamental for the preference of buying from national suppliers. A detailed analysis of the availabilities cannot be given here, but it is worth noting that the elimination of a certain rigidity in the allocation of public resources, which allows certain sectors to immobilize resources while others lack funds, could contribute to the lessening of that problem. It is possible that this problem can only be solved by a real redistribution of resources, through institutional changes that would make State enterprises better served than other sectors that nowadays receive the bulk of public allocations.

The importance of the certainty of resources for the enterprise should be stressed: that these resources are not only abundant, but also guaranteed, because the projects of these enterprises usually involve long terms of construction, so that the interruption (or the reduction) of the flow of resources can lead to large delays in the production of basic inputs - the objective of the enterprises. It is possible that they prefer resources with more certainty but with higher costs than other less expensive resources with dubious supply. On the other hand, the relative lack of freedom of the enterprise that depends on public resources can have a serious consequence on the use of domestic suppliers. They can be used by the government as an instrument for international commercial and financial policies, making them buy from countries where, for some reason, there is interest in buying. For instance, this is the case of the bilateral agreements with countries from Eastern Europe, according to which capital goods are exchanged for primary products from Brazil (43).

(iv) Internal Resources of the Enterprise: Finally, besides the sources already mentioned, the internal resources that can be used by the enterprise should be considered. They will depend basically on its past profitability from previous financial years. The bigger the profits, the greater the enterprise's autonomy in relation to financial sources, widening its choice of sources and suppliers. Nevertheless, if an enterprise is very profit-oriented, it is probable that it will tend to prefer foreign suppliers and branches, under the present circumstances, on account of prices and financing conditions, and

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(42) Erber, Tavares, Alves, Reis and Redinger, Op. cit.

(43) See: Erber, Tavares, Alves, Reis and Redinger, Op. cit., chap. 3.

security.

As already noted, there are strong pressures, at the price setting level, to keep profitability rates from raising too much. Even though the enterprise reaches high levels of profitability, it seems unlikely that it can call on its own non-distributed profits to meet the resource needs of its projects, which are usually very large. It will tend to use external sources and, depending on the relative share, to become similar to one of those described above. Nevertheless, it is interesting to note that the enterprise that is based on its own profits will usually try to increase its profitability, in order to finance its expansion programs, through an increase in productivity, since it is forbidden to gather profits from higher prices. This would probably lead it to give more attention to technical problems, first, and then to research and development activities. This attention, coupled with a greater financial freedom, could lead it to prefer in the future the supplier best suited to its specific necessities. It would be difficult to say if they would be domestic or foreign suppliers, but the national producers depend much more on State enterprises than foreign ones and, in this way, they would be more pliable to answer to the specific needs of the enterprises.

A possible correlation can be verified between the technological development effort of an enterprise and its financing pattern, in which the greater the subordination to internal resources, the greater the research and development effort.

(v) Operational Costs: Financial restrictions exist during the execution of a project and the operational costs of the chosen technologies implicit in the use of various kinds of equipment should be taken into account. There are technologies that, by using more intensively manpower and taking advantage of its low cost in Brazil, could use national equipment with lower operational costs. This would balance the disadvantage of financial costs and would be more attractive to State enterprises, even from a strict microeconomic point of view. The comparison between the operational costs of these two kinds of supply could also serve to indicate, given the difference between the relative weights of capital costs and manpower in the total costs, which would be the reduction necessary in the financing costs of the national suppliers to make them competitive (44). The data obtained from projects of State enterprises will serve to prove the validity of these suggestions, although they should be supplemented by information gathered in interviews.

### The Market

The Brazilian State enterprise was forced to maximize its sales, on account of the situation surrounding its creation, when subjected to financial and market restrictions. The market influences the scale of production foreseen by the enterprise. In static terms, it can be said that the larger the scale of the project, the stronger the financial restrictions and the greater the possibility of choosing foreign suppliers, because it is difficult to cover all expenses with internal resources and because they already have similar experiences and so are more "reliable." In this manner, the market would help to choose between alternative techniques made different by the dimension of the equipment and types of process. (There are processes which are economic only "till" (maximum scale) or "beyond" (minimum scale) certain scales.) When the

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(44) J. Tavares de Araújo, Jr. 1973. The Choice of Techniques and the Profitability of State Enterprises. FINEP. It gives an elegant exposé, on which the ideas above are based.

technically defined scale is the minimum one, the national market depends on the size of the market considered for the elaboration of the technology. If the technology is imported and the dimensions and conditions of the two markets (the national and the foreign) do not coincide, the national market will suffer, because, on account of the indivisibility of the scales of production, it will have to pay for the idle capacity or for the lack of supply.

In terms of profitability it would always be more interesting for the enterprise to have a repressed demand for its products than to have idle capacities because, in the former case, they could charge higher prices and in doing so gather more profits. But, from the point of view of the system, it is better to have plenty of supply, even with idle capacity in State enterprises. It is revealing that the enterprises themselves prefer this idle capacity situation. This could be ascribed to the fact that size (capacity of production) and prestige go hand in hand in State enterprises; but this higher evaluation of production, in comparison with profits, tends to confirm the preponderance of its public nature over the private one.

In addition to indivisibility of scales of production already mentioned, there are other elements that contribute to the creation of scales of production (temporarily) bigger than the market. Firstly, the enterprises tend to minimize risks of facing demands greater than production, preferring always to overestimate the size of the market because of its monopolist or oligopolist nature, that is, because of the weight that it has on the final supply of the sector or region and, in consequence, its social responsibility, its external and internal pressures. Second, the implementation of new production units demand lots of planning time and large sums of human, financial, and material resources. Therefore, to the difficulty of forecasting is added the rigidity of decisions, leading to the natural tendency of overevaluation of the necessary scales of production.

It can be seen that the assessment of the market by the State enterprise stresses the need for planning and the role of minimum restrictions to the production capacity, which will define the financial needs of the project according to the chosen technology. The derived financial restrictions will then be the main restriction under which the enterprises work.

### Internal Restrictions

Financial and market restrictions and conditions only become real through the effective action of the staff of the State enterprises, specially directors and senior technical staff, and they appear either through economic and financial criteria (for instance, to prefer the supplier with lower prices) or through technical criteria of analysis. These technical criteria can, in fact, hide internal deficiencies of the enterprise in criticizing received information and in changing its behaviour. It is stressed that domestic technological development should rely on the initiative of the State enterprises themselves. Finally, some problems of "weltanschauung" of the board of directors of the enterprise and their reflexes on the choice of technologies are given in the following section.

### Reliability, Learning Capacity and Criticism

It was suggested above that economic and political pressures on the State enterprise lead to production maximization once the financial and market restrictions are met. Nevertheless the guarantee of production is as important to the economic system as volume; that is, the enterprise should be able to play its role as supplier of basic inputs in the correct timetables and condition

This element of reliability of the employed technology (process and capital goods) can be seen under three different aspects:

Delivery time: The basic design and the details of the capital goods must be delivered at the scheduled time. The non-observance of these schedules can provoke delays in the investment plans of buyers or force imports. In this aspect it seems that the previous relations between the enterprise and its suppliers (or, to a lesser degree, information from other enterprises about suppliers) will be the determining factor in evaluating suppliers. It is probable that there would be a certain unwillingness to change suppliers if the relations are good (that is, if delivery times are kept). This unwillingness is probably due to incertitude (theoretically the greater the lack of knowledge, the greater the incertitude about a decision) and to the difficulty in changing patterns of behaviour. The investigation on the persistence of suppliers in different projects of the enterprises and the stress on elements of "tradition" and "good relations in the past" can be deepened through interviews. Inasmuch as the initial relations of the State enterprises are established with foreign suppliers, these elements of uncertainty and difficulties in learning will hinder a shift to national suppliers.

Sustained Operation: It was discussed earlier that the State enterprise would prefer technologies that could assure the maintenance (non-interruption) of the production (45). This emphasis in "reliability," that is, the assurance that the production would not be interrupted, would have as a probable consequence a preference for foreign suppliers. This is due to the fact that this stress on reliability in the operations is translated in preference for experience, by the use of process and equipment for a certain time in the enterprise itself or in similar place. Foreign firms, on account of their tradition and international characteristics, usually have more experience and would be preferred. Another point is that the operation of the system already known is evidently easier, reduces errors, learning difficulties, and operational losses.

Technical Assistance: This aspect, which normally appears together with the preceding one, reinforces the preference for enterprises of large tradition and size that have already faced with success many technical problems. The capacity of giving technical assistance swiftly, on the spot, and by specialized people is an element that helps to define the reliability of a supplier. The presence in the country of branches of foreign firms can reduce the advantage of national suppliers in swiftness of assistance. They have also the disadvantage of being enterprises of lesser economic and organizational size and, consequently, having sometimes smaller teams of technical assistance, which reduces the swiftness of the assistance.

Without neglecting the actual limitations of the national suppliers of technology, it was suggested in the preceding paragraphs that the preference for foreign suppliers would be determined to a large extent by the criteria of high reliability used by the State enterprise, undoubtedly justified if we take into

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(45) The fact that State enterprises are usually monopolistic or oligopolistic, that is, they are responsible for the whole, or a sizable portion of, the offer, and the fact that their products are essential for the working of many important units of the productive system, make them easily identifiable in cases of interruption of supply, and stress the tendency among directors and technical staff of preferring "reliable" technologies.



account its economic role and the pressures for performance, but also influence by the difficulty of criticism and of learning of the State enterprises themselves. Once these difficulties are solved through internal measures, they could increase their buying from national suppliers.

An additional factor, which would help to explain the (non-optimal) keeping of the same suppliers, is the lack of renewal in the staff of the enterprise, either among the Board of Directors or among the technical staff. The continuity in certain jobs for long stretches of time could allow some people to crystallize their practices and, at the same time, to develop greater resistance to change. When the continuity starts at the beginning of the operation of an enterprise, it is very significative, because a major part was created with the help of foreign capital and know-how, and this tends to reduce the tendency towards a definition of the enterprise as an autonomous national entity also in terms of technology. The continuity of the same Board of Directors and of the more important members of the technical staff can have the advantage of assuring technical and administrative continuity, free from conjunctural political fluctuations, which is very important for the functioning of the enterprise; but it can be a drawback as it may perpetuate situations of subordination to foreign know-how, which probably was necessary at the onset, but not anymore.

A behaviour that would be opposed to this (maintenance of suppliers) would be the permanent preference for the most "modern" in technological terms. There are several possible motivations for such behaviour: desire of projecting internally and externally to the enterprise an image of modernity; pressure from suppliers; imitation of other enterprises in the sector; and so on. The consequences in terms of choice of suppliers are similar to those of the traditional behaviour, leading to the preference for foreign suppliers.

The opposition of the two behaviours that could fit the classical division between "traditional" and "modern" is more apparent than real. Both have in the background the characteristic of lack of (or a partial incidence of) criticism by the enterprise of the knowledge offered from abroad, which could be translated, in its extreme positions, as blind faith in what is already known, or faith in the fact that what is more recent has to be better. Therefore, the technological dependence from abroad, rationalized in terms of safety or of modernity, would have the same result: that of reducing the use of national suppliers.

It can be suggested that, when the influence of these factors on the behaviour of the enterprise is verified they would have a satisfying behaviour towards technology, or once certain conditions and objectives are met, they would not look for other alternatives (46). In the case of a satisfying behaviour it would be logical to determine which of the conditions and objectives should be met, and the criteria for establishing them.

It is possible that the choices of technology obey rational criteria, based on a broad search for sources of supply of the technology and on the comparative analysis of those sources, representing an optimizing commitment to the technological search. In this case, when there is an optimizing permanence of suppliers, we would be obliged to admit that either the technology of the sector has not changed or that, in spite of the changes, the traditional

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(46) Baumol, W.J. and Stewart, M. On the Behavioural Theory of the Firm. In R. Morris and A. Wood (ed), *Op. cit.*; and Lindblom, C. 1971. *The Science of Muddling Through*. In *Business Strategy*, H. Ansoff (ed), Penguin Books.

suppliers are still the more adequate suppliers to national conditions. The same could happen in the case of options for more modern technologies. This point can only be verified through interviews in the enterprises about criteria of suppliers' choice (specially in case of change) and by verifying the availability of an infrastructure of information (libraries, archives, participation in technical congresses, etc), and by the level of criticism of the received information.

A factor that could favour the national supplier to break this closed process, where process and equipment are preferred today because they have been there yesterday, is the specificity of the Brazilian conditions. Brazilian suppliers know more about them, and so they would have a relative advantage. This specificity can refer either to the national raw materials substantially different from the foreign ones (for instance the coal from Santa Catarina and the imported coal), or the manpower (forms of relationship, ways of working, etc.). The particularities of the local conditions can be avoided through various means: ignoring them altogether (which will probably lead to losses of productivity); trying to avoid them through the artificial reconstruction of the original conditions, even importing what is lacking; and finally recognizing them and trying to overcome them by adapting foreign process and equipment, or by using national suppliers (47).

The projects of the enterprises can reveal some of those elements when they compare alternatives and keep the same suppliers, but the bulk of information about this phenomenon must be obtained through interviews in the enterprises.

#### Planning and Research

The size of State enterprises determines not only great volumes of immobilized resources but also fairly long terms of installation, which require financial planning in the long term. When the enterprise depends on public resources there will be a closer interdependence between the broader governmental planning level and that of the enterprise. This interdependence restricts both parties, for if the enterprise needs governmental resources for its projects the government cannot reduce these resources to the point of paralyzing the project without facing serious political and economic damages. Therefore, the grant of these resources is no longer optional for the government, but it becomes an operational restriction (48).

In second place, the size of the producing units and the rather extended time of building introduce a strong rigidity in the decision system, since the cost of changing them would be very high and, after a certain time, the changes possible would be very small. This means that the enterprises have to be technically capable of making fairly accurate forecasts of demand and supply. This ability is immanent to the function of the State enterprise of supplying the rest of the economic system with inputs at the correct time and in the required amount. Consequently, both the production and financial planning will probably exist in all enterprises, although at different levels.

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(47) For a tentative typology of these behaviours, see the working papers by Dulce Vianna.

(48) The enterprises are aware of these phenomena and exploit them, See, for instance, the use made by some electric power enterprises of stopping their project if the BNDE did not grant resources, mobilizing in this manner newspapers and other sources of pressure in their favour. Also: J. Tendler, Op. cit.

But in order to make this planning more directed to national suppliers, it is necessary that it works in tandem with the governmental level and national firms, the producers of capital goods. The decisions about what can effectively be produced internally and what must be imported require a minimum delay of preparation and mutual consultation necessary to increase the national industry's share in technological supply, thus furthering its development. Therefore, planning is of fundamental importance for a larger use of national technology. When decisions within the State and within the enterprise are not taken with the necessary advance and there is a pressure from the buyers of intermediate goods for an increase in the supply, the persons responsible for the suppliers will tend to opt for integrated "packages" of investment, which, taking into account the limitations of the national industry of capital goods, usually leads them to import equipment.

For autonomy of the enterprise, economic and financial planning seems to be the necessary condition for decision making. However, it is doubtful that they are also sufficient conditions, for they tend to obey technological developments carried out outside the enterprise. However, there are several problems, beginning with what is understood by "technological planning." Although there are technical procedures for planning in the economic and financial fields, which are widely known and already in operation, there are none for the technological field. In spite of the development of several techniques, like the recent "Delphic Method" and the "Cross-support matrices," (49) the knowledge about them is still very restricted, and its operational usefulness is doubtful (50). In any case, it seems clear that a greater autonomy and the basis for a technological planning require from the enterprise a knowledge, if not a direct involvement, of what has been made in terms of planning and research in its field of operation. This knowledge will imply a greater capacity of specification of the process, and capital goods adequate to its own conditions, and a criticism of the process for any capital goods offered, besides the capacity for orienting national suppliers to supply goods and services. Given the prevailing conditions of lack of capacity of planning in the national industry of capital goods (51) and the almost complete lack of engineering enterprises with know-how in basic design, it seems that the State enterprises will have to be the initial point for the development of this kind of knowledge in the country.

It was suggested earlier that it is probable that the enterprises that intend to increase their profits, without having resources to increase in price, will tend to make studies of the most simple operational savings, which later can be developed. Research is even more important for enterprises that intend to be free from foreign influences. There is, at this point, a convergence between the mechanisms of expansion of the enterprise and the broader national interests.

It is important to verify in the research whether the technological

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(49) See: J. Martino, *Technological Forecasting for Decision Making*, American Elsevier Publishing Co., 1972; and M. Cetron and J. Goldhar (ed), *The Science of Managing Organized Technology*, Gordon and Breach Inc., 1970.

(50) For criticism about the use of the last method in the Brazilian conditions, see: F.S. Erber & J.V. Bautista Vidal, Report by the Coordinators of the Activities of Application of Methodology of Scientific and Technological Planning Proposed by UNACAST, Ministry of Planning, 1972.

(51) See: Erber, Tavares, Alves, Reis and Redinger, *Op. cit.*, chapters 2 and 4.

activity is seen as something in itself (whether there is a budget for technology and a department or centre in charge of technological activities); the intensity (number of persons according to their educational level, seniority of those persons, physical and material resources, etc.) of the technological effort; the purpose of this activity (problems of production, projecting, development, research, etc.); and whether there is any kind of planning or technological forecasting for the future. However, it should be noted that technology is one of those magical words of today and that it is trendy to adore it, even though this is a form of exorcizing it. It is also important to note the role of groups involved in technological decision making for processes and equipment, because they can either be integrated in the investment decisions and therefore influencing the decision making or be left in an academic "no man's land," without contact (and influence). The interviews will clarify these points if it can be determined who takes part in the decision making, and to what sector he belongs.

#### "The Weltanschauung" of the Board of Directors

The decisions about the choice of technologies are the result of various determinations. Among those stressed are: the role of the enterprise in the economic system; the limitations in the availability of internal financial resources; and, in the two preceding sections, the internal conditions of the enterprise in changing the direction of these conditionings. It was suggested also that there would be, internally, a tendency to give more weight to the largest possible size of the enterprise.

Nevertheless, these conditioning factors inform, and are also interpreted by the direction of the enterprises, through a "weltanschauung," that will also give these conditionings a specific sense, which will be translated as norms of action of the enterprises.

This complex process of continuous feedback cannot be discussed more accurately here, but it is important to recognize its existence and, looking into the future, try to determine its characteristics, mainly: autonomy of the country - economic, political, and technological; the contribution of the enterprise; autonomy of the enterprise, in relation to the government, suppliers, consumers and financial institutions; size of the enterprise; preference for technology "from abroad" vs. technology "from inside" the country; and technological policy of the enterprise.

It must be determined how these various levels are articulated, either internally or between themselves. Even though reports from the enterprises and other documents can help in this research, the interview with the board of directors seems to be the most effective element in the gathering of this information.

## CHAPTER 11

### STATE ENTERPRISE AND TECHNOLOGY POLICY IN BRAZIL

Sulamis Dain

The analytical framework for this chapter originated from work (1) done by the Brazilian team on behalf of the STPI project.

In terms of science and technology policy, the basic assumption of the Brazilian team is that State enterprises producing goods and services constitute an adequate locus for technological behavioural analysis. For the Brazilian case, this assumption seems to be correct, not only because of the weight and strategic importance State enterprises have had in economic development, but also for their mediating role in the country's technological policy. Through their demand for capital goods and engineering services (basic nuclei of embodied technical progress) State enterprises have been increasingly affecting the Brazilian pattern of technological development. Besides, as technological policy in Brazil has been, up to now, an outcome of industrial and sector policies in which State enterprises have placed an important role, the analysis of such policies only reinforces the arguments in favour of studies on technological policy centred on State productive enterprises.

However, the justification that legitimates both general guidelines and conclusions of Brazilian work for STPI does not apply as strongly to other countries involved in the project, for two reasons: Firstly, the analytical framework for Brazil has influenced other countries' choice of State enterprises that would fit the model. Unless there is more information to confirm that their behaviour is representative of State enterprises in these countries, no generalizations can be made. Secondly, even the choice of a State enterprise as an adequate locus for grasping science and technology policies must be questioned, since other instruments in many STPI countries have played a more important role in defining technological policy.

This report should be taken, therefore, as an effort to integrate information from case studies presented by Brazilian, Argentinian, and Mexican teams on technological behaviour of State enterprise, and not as a comprehensive study of the subject. It aims to provide evidence on how State enterprises have influenced technological policy, and to set up an analytical background for evaluating the potential use of State enterprises as instruments of science and technology policies.

The framework proposed in the Brazilian report concentrated on three dimensions of State enterprises' technological behaviour: (i) choice of techniques (purchase of equipment units, contracting of engineering firms and selection of industrial processes); (ii) research and development activities within the State enterprise; and (iii) pattern of financing as connected to expansion programs.

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(1) Tavares de Araújo Jr. José. 1974. The Choice of Techniques and the Profitability of State Enterprises. In Pesquisa e Planejamento, June; and Erber, Fabio. 1974. The State Enterprise and the Choice of Technology. In Ciencia e Cultura, December.

Information was obtained on the general economic performance and institutional framework. Technological behaviour of State enterprise was then examined according to the three basic parameters, taking into consideration the following set of external and internal factors affecting them. External Factors: (a) form of ownership - majority shareholder; (b) use of State enterprise as an instrument of general economic policy; (c) budget decisions at national level, reallocation of surplus; (d) general pattern of financing; (e) foreign pattern of financing imports and exports; (f) factors affecting the rate of profit-price formation and market conditions; (g) general planning of local production; (h) coordination at sector level - control of investment plans; (i) conditions of supply and demand of equipment units and engineering services - price, time, reliability; (j) quality of services of products supplied by enterprises; and (k) integration of research and development within State enterprise to technological policy. Internal Factors: (a) short- and long-term planning, technological forecast; (b) integration of research and development with other departments within a State enterprise; (c) level of efficiency of the enterprise itself; (d) capacity for taking risks; (e) origin of enterprise; and (f) political environment.

The research carried out by the Brazilian team for the STPI Project had a sectorial approach, concentrating upon the branches of petroleum, steelmaking, and electric power. This sectorial approach was basically due to the impossibility of covering in a satisfactory way the multiplicity of aspects related to the participation of the ensemble of State productive enterprises in the national economy. The choice of the sectors analyzed was based upon the greater weight of State enterprises on them, as well as upon their economic importance in the country. It is hoped that, with the criteria adopted, the study of the enterprises analyzed will legitimate the conclusions reached in this work for application to a wider set of enterprises and sectors.

#### Technological Behaviour of State Enterprises in Brazil

The report of the Brazilian team concentrates on the above dimensions of State enterprise's technological behaviour. In the choice of techniques, emphasis was given to aspects related to the purchase of equipment units, the contracting of engineering firms, and the selection of industrial processes in the sectors analyzed, in an attempt to isolate the set of external and internal restrictions that condition the establishment of parameters for such activities. The study of research and development activities inside the State enterprises made it possible to examine their own process of creation of technology, as well as to relate this process to the other factors, whereby public enterprises influence the national economy's technological pattern.

By comparing several forms of performance, it can be concluded that the internal generation of technology has played a secondary role in State enterprises, in view of the weight of the technology supplied from abroad, which has been justified by the microeconomic rationality of the enterprises.

An attempt has been made to show the relationship between the patterns of financing observed in public enterprises and their technological behaviour, by analysing the process of capital accumulation and the expansion plans of public enterprises. The results of research on the patterns of technological behaviour observed in the productive State enterprises reflect the historical period conditioning such behaviour. In the upward stage of the economic cycle beginning in the late 1960s, the growth of Brazilian industrial production became more and more dependent upon rising levels of fixed investment, as preexisting productive capacity was being fully utilized. As a result, the

indirect action of economic policy instruments was geared to the encouragement of capital investments, whereas the State's direct action materialized in massive government investments in basic subsectors and in infrastructure. On account of the simultaneous rise in the purchasing power of exports and in the net capital inflows that took place during that period, the investment effort raised imports of equipment units in a more significant way than the domestic production of capital goods. For the same reasons, the purchase of capital goods by productive State enterprises was made mostly abroad, increasing the technological dependence of these enterprises. The patterns of financing in force in the period reinforced foreign dependence, as equipment imports were usually made tied to suppliers' credits.

In the present situation, with economic recession and restrictions on importing capacity, the State enterprises' choice of techniques tends to favour national equipment production. This change in the pattern of technological behaviour will be the more significant when these enterprises are utilized more as an instrument of economic policy directed simultaneously to the control of equipment imports and to the planning of the expansion of the domestic capital goods industry. The problem of domestic production of such goods is often associated with the delivery terms. In the recessionary phase of the business cycle, it is possible to program over the long term the expansion of the productive capacity of the national capital goods sector.

In the research, the ambivalent character of the State enterprise as a productive unit and as a powerful instrument of State action emerges as a recurrent theme, in its multiple impact upon the technological behaviour of State enterprises. On account of their participation and strategic position as producers of basic inputs and buyers of goods and services the State enterprises represent a powerful policy instrument, not only in technological development but in the articulation of the industrial system. The autonomous character of this segment of the State administration renders flexible the decision-making process in the enterprises that compose it, such a process being oriented by the same criteria of microeconomic rationality that guide the activities of private enterprises. As a result, the options adopted by State enterprises do not adjust themselves, in many cases, to government decisions, which were made in the collective interest with a wider and long-term perspective. On account of the above-mentioned ambivalence, State decisions made at the level of its system of enterprises are often distorted in referring to the establishment of a technological pattern directed towards the encouragement of Brazil's capital goods industry and research institutes.

The dichotomy of the State enterprise/economic policy instrument also manifests itself - and is studied in the research - in the financing structure and in the pricing system. As a policy instrument, the State enterprises should support the growth of other productive sectors by providing basic inputs at low, generally subsidized, prices. On the other hand, as productive units, the public enterprises should operate at acceptable levels of profitability, in order to finance with their own resources at least part of their expansion programs. It is not intended here to present solutions for this dichotomy and contradiction, which are implicit in the functioning of State enterprises, but to bring attention to these circumstances and their impact upon the choice of techniques, thus revealing an essential aspect of State enterprise dynamics.

#### Main Characteristics of State Enterprises and Sectors Analyzed

The Brazilian report covers the sectors of electric power and steelmaking and more briefly, oil and petrochemical branches. Differences of behaviour are

observed, not only among sectors but also among State enterprises within each sector.

### General Sector Characteristics

The main characteristics of the sectors covered are described below. The electric power sector has presented in the last decade a well-defined and centralized organizational structure, with a financing system of its own and with limits to the action of State and private enterprises well outlined; whereas, the steel sector has showed precisely how the setting up of such a structure takes place and for what reasons the roles of State and private capital are defined. Oil refining, prospecting, drilling, and sea or pipeline transport are State monopolies, with very efficient financing systems and centrally planned organizations. The petrochemical subsector, on the other hand, is the setting for merging of State, local private, and foreign private capital, through a new form of joint venture initiated by the State (2).

### Characteristics of the State Enterprises

The characteristics of the State enterprise in each sector are given below:

Electric Power: In the electric power sector there are two groups of enterprises actually generating power. The first is State-owned and is made up of enterprises owned by the Federal Government, which are subsidiaries of ELETROBRAS, the holding enterprise, and of enterprises owned by the federated States, in whose capital ELETROBRAS is minority shareholder. The second group is composed of private enterprises, and can also be divided into two others: enterprises whose main activity is the generation and distribution of electric power, and enterprises whose main activity of industrial manufacturing consumes electric power in such a scale as to render more economical its production by the industrial enterprises themselves. In this last case, the industrial enterprise might or might not have a concession to commercially exploit the surplus of its own production of electric power. This subgroup is placed under private enterprises, with the qualification that some State industrial enterprises are also part of it, although in a small proportion.

In the group of private enterprises, installed capacity has remained practically the same in the last few years. This reflects the withdrawal of private electric power enterprises from the activity of generation. The groups which have been responsible lately for increases in generating capacity are subsidiaries (Federal enterprises) and associates (Federal State's enterprises) of ELETROBRAS. Between 1963 and 1974, the generating capacity of ELETROBRAS subsidiaries grew at a yearly geometric rate of nearly 16.2 percent and that of its associates at a rate of 16.9 percent, whereas total generating capacity grew in the same period at a geometric rate of nearly 10 percent per year. It should also be noted that the generating capacity of these two groups taken together grew from 40 to 74 percent of the total installed capacity between 1963 and 1972. Out of ELETROBRAS' eight subsidiaries, four are responsible for carrying out and controlling regional planning of electric power. Among enterprises in which ELETROBRAS is minority shareholder, those owned by governments of federated states are the most important. ELETROBRAS owns only 0.2 percent of

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(2) Tavares, José and Dick, Vera N. 1975. Os investimentos em petroquímica: novos padrões de relacionamento entre o setor público e a iniciativa privada no processo de incorporação de tecnologia, FINEP, STPI Report.



the largest private enterprise in the sector (LIGHT), and 10 percent of CESP (owned by S. Paulo's government), one of the largest State enterprises in Brazil. Foreign capital is important only through LIGHT, a Canadian concern, which is practically restricted to the sphere of distribution.

Steelmaking: The Brazilian steel sector is divided into two sub-sectors, which are distinct because of their ownership, concentration, and kind of product. The subsector of flat steel products is constituted by the three large State enterprises, which produce common flat steel products, and by one State enterprise, ACESITA (Acos Especiais Itabira, i.e. Itabira Special Steel), the only producer of special flat steel products. In the subsector of common flat rolled steel, production was 3,253,000 ton/ingots in 1973: USIMINAS (Steelmills of Minas Gerais State) produced 41 percent of that total; CSN (National Steel Company), 40 percent; and COSIPA (Steel Company of Sao Paulo State), the remaining 19 percent. ACESITA's production was 56,000 ton/ingots in the same year. In the subsector of nonflat steel products, of the producers of common nonflat rolled steels, out of a total of 29 enterprises only three have State participation in their capital: CSN (10 percent of total production in 1973); COFAVI (Companhia Ferro e Aço de Vitória, i.e. Vitória Iron and Steel Company), with 3 percent of total production; and USIBA (Usina Siderúrgica da Bahia, Steelworks of Bahia State), with less than 1 percent. COSIM (Companhia Siderúrgica de Mogi das, Mogi Das Cruzes, Cruzes Steel Company), with 6 percent of total production is associated with CSN. The chief producer of common nonflat rolled steel is Belgo-Mineira, with 23 percent of total production. The Companhia Siderúrgica Nacional (CSN) is the only producer of rail tracks and parts for railroads, as well as of some heavy structural shapes. Out of the eight enterprises producing special nonflat rolled steel, two are State-owned: ACESITA (24 percent of the production of special nonflat rolled steel in 1973), and PIRATINI (1 percent). Mannesmann is the main producer, with 36 percent of total production; it also dominates the production of seamless tubes (90 percent of total production), COSIM being responsible for the remaining 10 percent. Foreign enterprises' participation in the steel sector has been taking the form of minority partnership, either through associations with State capital (as in USIMINAS), or with national private groups. The two totally foreign companies are Belgo-Mineira, created in 1921, and Mannesmann, whose foundation dates back to 1952.

In late 1973, a holding company of State enterprises (SIDERBRAS) was created for the restructuring of the sector and its more efficient coordination. SIDERBRAS has been associating with foreign and private national capital, mainly for export oriented production.

Oil and Petrochemicals: As a State monopoly, the characteristics of PETROBRAS define the branch and the enterprise at the same time. Since its creation in the mid 1950s, this State enterprise has shown active work in prospecting, production, refining, and transporting of oil, with priority given to investments in prospecting and refining. PETROBRAS has been able to cope with refining activities, but the gap between production and consumption has been continuously increasing. Consequently, PETROBRAS has begun to promote prospecting in other countries, creating a subsidiary (BRASPETRO), which has signed agreements with several countries, such as Colombia, Iraq, and others.

The expansion of petrochemicals within the enterprise gained speed in the early 1960s, when PETROBRAS set up its rubber plant (FABOR), followed by the setting up of the petrochemical ensemble on the northeast of Brazil.

Through the creation of a subsidiary "PETROQUISA," PETROBRAS began to work in a nonmonopolistic way, associating with private enterprises, foreign and national, through equal partnership in shareholding. However, PETROBRAS has kept control of the chief raw materials, in order to maintain its leadership in the association.

### Use of State Enterprise as an Instrument of Economic Policy

It is necessary to make a clearer description of the role of State enterprise, its purposes and means of action, and its relations with other agents of economic activity. Two reasons for the creation of State enterprise in Brazil are stressed: (i) The nonexistence or inefficiency of the traditional mechanisms of collection and transfer, among sectors of savings, which does not allow the raising of resources on the scale and with the fluidity necessary to carry out larger-sized industrial investments (such a collection of funds is still more problematical in economic spheres in which profitability is considered rewarding only in the long run, as in the case with the production of intermediate goods); and (ii) the domestic scarcity of certain intermediate goods or services necessary for the development of industrial production, specially that of finished goods; this scarcity being explained either by the reasons mentioned above, or by others, such as the lack of knowledge about the market or about the endowment of raw materials, etc.

It was basically to solve this deadlock that the State enterprise has been developing in Brazil. Although the second fact mentioned above is important, it is the first that determines the actual characteristics of the State enterprise in Brazil: the agglutination of savings that the private financial system has proved incapable of implementing, when those savings are geared to investment in the production of certain goods essential to the development of the industrial sector. In addition, the State enterprise "makes feasible" economic development not only as a factor in overcoming bottlenecks in the chain of industrial products, but also by absorbing part of the production costs of its industrial consumers by means of the subsidized prices of the inputs that it produces. By compressing its volume of profits or by making some consumers subsidize others in the purchase of these inputs, the State enterprise works as a "repasser," a "transferrer" of resources to the groups whose development should be encouraged.

One cannot restrict the reasons for the creation of State enterprises to the two mentioned above; the political issues, which evolve around State enterprises, should also be taken into account. The state enterprises were placed in opposition to the fast growth of multinational enterprises in the Brazilian economy. The State enterprise represented the only assurance that strategic natural resources would remain under national control. It is clear that this control does not mean merely the decision about who will benefit from the immediate profits originating from the exploitation of resources, but, above all, it implies greater decision power about the use of the resources and about their repercussions upon the economy as a whole.

The solution adopted to make the Brazilian pattern of growth feasible was not free from frictions. There are several spheres of permanent, though not always explicit, conflict within the State sector itself, within the sector of activity of a State enterprise which coexist with private enterprises, and outside the State enterprise's specific sphere of action, as reflexes of the competition for resources within the economy as a whole. Within the State bureaucracy the chief conflict lies in the search for greater autonomy on the

part of the State enterprise, in terms of price policy, retention of profits, allocation of resources, expansion plans, etc. The effort of control and centralization exerted by the State, with the aim of changing the State enterprise into a powerful and flexible instrument of sectorial and global economic policy and specially of capital formation, can run against the State enterprise's growing autonomy, particularly when the latter's interests coincide with regional interests or with those of industrial sectors linked to them. This can be seen through the State enterprise's plans for expansion.

The behaviour of the State enterprises presents some fundamental differences when contrasted with the behaviour of the monopolistic or oligopolistic enterprise traditionally portrayed in the texts. One of the fundamental differences, which affects internal conditions of profit accumulation and expansion plans when the latter are based upon self-financing, lies in the fact that State enterprises cannot manipulate their prices towards profit maximization. This does not occur because their directors consider only "the social objectives of the State enterprise." As soon as market conditions emerge, which would allow them either to manipulate their supply or to control the expansion of their capacity, or to search for cartel agreements to maximize their profits, the position previously attributed to those enterprises by the global economic policy must be revised. In simpler words, the search for greater profits on the part of State enterprises obviously conflicts with the objectives of "optimization" inside the industrial sectors that consume their products; therefore, when the above-mentioned market situation arises, it becomes necessary to reshape the State enterprises' plans of expansion, to alter their structure, and to change the previous schemes of public resources they count upon, in order to eliminate the threat of constriction of operational conditions for the consuming private sector, the threat represented by a bottleneck in the supply of essential inputs to the private sector.

In the same way, when the demand for goods produced by State enterprises contracts or the relative prices of their inputs rise rapidly, their profitability is immediately threatened, as their prices are controlled. The greater the weight of the product of a certain State enterprise in the structure of costs of the industrial sector, the more this occurs. Price control exerted upon the State enterprise, endangering its profitability, restricts not only its internal capacity for generating resources but also its capacity for collecting external resources, which makes it more dependent upon the public power, restricting in turn its autonomy. Therefore, after a certain level of economic activity has been reached, there seems to arise the need for a structure providing the means of control over, and organization and planning for, the sector of activities occupied by State enterprises, in order to allow it to react more promptly to the economy's needs. There is no longer any point in the mere existence of a group of independent enterprises, which, although efficient, are liable to behave according to their own microeconomic interests. As a consequence, the tendency towards centralization has been showing itself in three main groups of State enterprises, despite some differences among these groups: electric power; petroleum and petrochemistry; and production of flat steel products.

#### Patterns of Financing, Planning, and Expansion Programs

The pattern of finance within State enterprises is affected by the way they connect to industrial structure, and by their role in it. As suppliers of strategic inputs, State enterprises often subsidize private sectors via prices. Their margins depend, therefore, on the priority attributed to these

sectors. In addition to their operational resources, State enterprises count upon a certain amount of funds from the public budget. The more stable the source of funds (such as tied resources and compulsory loans), the greater the State enterprises' autonomy. It has been observed that a more regular flow of funds to State enterprise goes together with more integrated planning, both at the sector and the macrolevel. Demand for foreign resources is, to a certain extent, determined by factors considered above, and reinforced by technical constraints of internal production of technology. Even when local technology is available, a greater dependence on foreign resources will impose on a State enterprise closer connections with foreign suppliers of technology. In those sectors such as petrochemistry, which have recently been introduced in the country, following the international diffusion of innovations, supply of technology will, in itself, integrate the financial scheme. Foreign capital will then associate with public or private national capital, their shareholding coming often only through supply of technology.

Electric Power: The authorities of the Brazilian electric power sector expected to generate, through the tariff, part of the resources needed for its expansion, as well as that it be capable of utilizing the tariff as an instrument of reduction of the industrial costs. A tariff, in the same way as the price of any other product, should be sufficient to remunerate the investment needed for the production, transmission, and/or distribution of electric power, and to cover all the expenses of exploitation. The vast legislation concerning the subject has not prevented the tariff from being really utilized as an instrument of economic policy, when submitted to readjustments within more general standards of anti-inflationary policy, and as a source of resources aimed at financing the sector's expansion. However, because of the various aims and the different tariffs for each enterprise, its use made the differences among the several enterprises become more considerable than would be easily acceptable to the government bodies responsible for establishing the guidelines.

In enterprises generating electric power (CESP, FURNAS, etc.), the part of the tariff corresponding to fixed costs is much higher than that related to variable costs, on account of the size of the investments demanded. In enterprises concerned with distribution (LIGHT, CPKF, etc.), the opposite takes place. The difficulty of making general policies of price control compatible with the readjustments of electric power tariffs have affected more those enterprises concerned with generation than those concerned with distribution. Among the former, the larger the size of their work, the more difficult it has been to repay investments. For that reason, foreign and private enterprises have moved to distribution of electric power, with a clear definition of roles in the sector.

The generating enterprises have actually been serving the objectives of promoting development, supplying the industrial sector and the distributing firms with power in the quantity and quality required. Furthermore, the legislation itself establishes the priorities and, implicitly, the subsidies to different sectors. The tariff legislation establishes an inverse proportion between the tension in which power is received and its tariff; that is, those receiving power in high tension pay lower tariffs than those receiving it in low tension.

The industrial sector and the distributors of electric power have had their tariff partly subsidized by the consumers (household and commercial), which receive power in low tension, and also by the producing enterprise, due

to the tariff compression adopted in the years 1972 and 1973. During this period, readjustments could not be higher than those fixed by the bodies responsible for price control.

In some enterprises, tariff compression has been creating serious problems for the generation of resources. Nevertheless, even those obtaining the legal remuneration allowed are becoming more dependent upon resources from third parties. This is true for the producing enterprises, which have a vast program of investments. The enterprises operating in the sphere of distribution, whose expenditures in investments are relatively much smaller and have faster maturation periods, present a very different pattern.

As a consequence of the tariff policy adopted, the enterprises' operational resources have had a declining participation in the investment programs, which have been requiring growing amounts of resources. Besides, because of the centralization of sector, policy of ELETROBRAS, budget-tied resources were transferred to this holding, being allocated through it to all State enterprises now under its control. This fact has represented a considerable decline in their autonomy, at the same time as it has strengthened ELETROBRAS, providing it with a permanent source of funds.

For the sector as a whole, internal resources have allowed their participation in investment to increase from 42 to 73 percent between 1968/70 and 1972/76, ELETROBRAS being responsible for 40 percent of total financing. Tied resources from central government have increased slightly (from 16 to 17.8 percent, whereas operational resources have declined 18 to 15 percent in the same period (3). For resources coming from outside the sector, budget resources and funds from national agencies have become less important, with an overall participation of about 10 percent (3).

Foreign currency plus deficit (to be covered mainly by foreign resources) is expected to provide, between 1972 and 1976, 17 percent of total investment financing. Therefore, the sector's investment plans depend strongly on internal resources, with a pattern of financing quite different from other branches such as steelmaking and petrochemistry. However, foreign financing is generally linked to larger enterprises within the sector, which have the conditions for, and the need of, external resources. This is explained by their higher rate of investment, which reduces the possibilities of using their own resources, and sometimes even their remuneration, owing to tariffs.

Steelmaking: During the process of setting up and developing the steel sector in Brazil there have been endless discussions about the prices of steel products. The problems might be due to the sector's characteristics; in the case of Brazil, it is largely State-owned. The issue arises because this policy restricts the steel enterprises' possibilities of self-financing, to the extent that the prices of steel products are compressed in order to subsidize sectors such as equipment, housebuilding, motorcar production, and so on. As a consequence, the sector's autonomy for its expansion plans is jeopardized first by the lack of resources, and later, because it becomes dependent upon the approval of the government's planning bodies for raising money in national currency and for obtaining loans from the international agencies.

When the government's controlling and planning bodies establish a system of subsidies through the steel sector, in order to make competitive

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(3) Development Plans, ELETROBRAS.

those sectors for which the price of steel is significant, the State's responsibility for supplying the resources for the sector's expansion also grows. It is an apparent "vicious circle": the sector has its prices compressed in order to supply the other sectors with its products at competitive prices. As a consequence, the enterprises decapitalize themselves and have their expansion plans affected, which in turn leads to a shortage of their products. At this point, the following options present themselves: either to loosen the price controls or to provide the sector with government funds in order to cover the price insufficiency and to keep the expansion plans.

In the analysis of the formation and establishment of the prices of steel products, and specially of the flat products, it is not sufficient to decompose their cost and to consider that the steel companies resist both the prices of electric power and the maintenance of the subsidy represented by the extraction and use of national coal; nor is it sufficient to argue that, on account of the low cost of its labour and the abundance of iron ore in its territory, Brazil might become a large producer and exporter of steel products. There are other aspects related to the direct control of these products, which have affected considerably the generation of resources by the enterprises and their autonomous capacity for expanding their operations.

Until COSIPA and USIMINAS began to operate, CSN was the only producer of flat steel products. It established the prices for those products and, by means of delegation from the Federal Government, it imported whatever was in short supply in the sector; even so, there was repressed demand. The enterprise had expansion plans, held a correct view about the future worsening of the steel shortage, and adopted the practice of "quotas" for the supply of steel products. "Whoever had a steel quota was in an excellent situation." As USIMINAS began to operate in 1963 and COSIPA in 1966, both as integrated mills, the market of flat products became a divided and disputed one. The control over the prices of steel products would from then on be exerted in the ministerial sphere.

The control over the prices charged by the steelmills, exerted by the government body responsible for it, was becoming more and more effective. Decree No. 61.993, of 18 December 1967, made all price increases dependent upon previous approval by CONCEP (National Price Committee). The enterprises were facing a serious retraction of the market of flat steel products. Although part of the production was being exported, mainly for LAFTA's countries, export possibilities were limited, and sales abroad were not enough to absorb the stocks accumulated on account of the excess supply. As the crisis situation remained, the enterprises became more flexible in their relations with the consumers; they extended the terms for the payment of orders, and they began to give price discounts, up to the point that a price war was established. This only ended with an agreement among the enterprises, in which a price list was established, with the highest price levels reached so far. In the crisis years the enterprises' loss of profitability was quite considerable. In 1968 the economy was already showing signs of recovery, and the competition between the enterprises was to supply the consumers with the most profitable products, i.e., cold rolled and coated steel products.

It should be noted that the chief consumer of cold rolled steel is the motorcar industry, which, on account of its oligopolistic characteristics, was able to transfer the costs to the consumer. It was set up in the country during a period of steel shortages, which made it a sphere with heavy steel imports, and, therefore, a field for a possible import substitution process in the future.

The dispute for the several spheres of the market - from the most profitable ones that required more recent and expensive technology to the least profitable ones - represented a movement the enterprises saw as a "battle for quality," as the sectors which used common steel products, though not being very profitable, were the large consumers of the product. Thus, in steelmaking, diversification started to be used as a way to escape price controls, by reaching markets that could absorb better products at higher prices. Through this mechanism, steel enterprises tried to better their internal capacity of financing.

The optimization of the product mix became a constant preoccupation of the three State steel enterprises in their dispute for the markets, and the conciliation of the several interests in the search for a "rational specialization" for each one of the enterprises was one of the important aspects to be found in the government's steel plans. Although the average revenues of COSIPA and USIMINAS grew faster than OSN's, the two newer enterprises also found themselves in an unfavourable financial situation, due to financial burdens connected with expansion and diversification of their products. With all these pressures, the necessity of coordinating the steel industry became an urgent task. The sector was asking for an injection of resources directly into the enterprises, at low costs, together with tax concessions, besides efficient tariff protection and rewarding prices; moreover, it claimed parallel stimuli for the sectors that consumed its products, in order to increase the demand for steel. Those claims reflect very well the difficulties State enterprises had to face at that time.

As the economy recovered, so did the steel sector. But the effective implementation of a centrally planned system only took place when the need for further expansion could no longer be postponed. The system was structured in 1973, and centred in SIDERBRAS, the holding company of State enterprises in steelmaking. This company was created with resources from the Federal Government's budget, but so far it cannot count upon resources other than the ones originating from its participation in its subsidiaries and associates. Nevertheless, in view of the expectations of a growing demand for rolled steel products, in a medium- and long-term range, and of the resulting need for investments on a large scale, the idea has been contemplated of creating specific funds for SIDERBRAS, similar to those existing in the electric power sector.

In contrast with this sector, the steel sector has not yet been able to adopt similar favourable schemes for the internal generation of resources because of the degree of concentration of its chief consuming markets. As the steel enterprises faced administered prices, their capacity for generating resources was restricted; and, more critically, the predictability of this restricted margin of resources was reduced, not only because the enterprises did not exert any control over their prices, but also because their performance was very sensitive to fluctuations in the economic activity as a whole. It was only when the need for expanding the domestic supply of rolled steel products became pressing that it was possible to increase the enterprises' own capacity to generate resources to render the needed expansion feasible. Even so, the contribution of public resources (in the shape of financing and capital inflows), which varies in inverse ratio to the contribution of the enterprises' own resources, was substantial. (See the case of OSN, before and after the 1964-67 crisis, and the case of the power sector.) The largest contribution, however, came from foreign financing operation.

Many mechanisms have been contemplated to assure sound resources to the steel sector, but so far with no success. These mechanisms range from the

establishment of a margin of profitability for the sector's enterprises to the creation of mechanisms of forced savings similar to the IUEE (United Tax on Electric Power) or the Compulsory Loan. (These two surtaxes are applied in the electric power sector.) SIDERBRAS can, today, count upon the budget resources allocated to it for the absorption of the enterprises that should become its subsidiaries and for affecting its participation in its associates (the mechanisms to be utilized in this process have not yet been defined), and upon the corresponding dividends in the future. As SIDERBRAS will only have those resources, no special funds being created to support it, it is difficult to foresee to what extent the sector will become independent from foreign resources.

The effective implementation of the financial program for the expansion of the three large State steel enterprises took place in a way somewhat different from the one proposed. The resources would come basically from the National Treasury and BNDE; the suggestion for the creation of a Compulsory Loan or any other form of fund of resources specifically for the sector was abandoned. The contribution of the capital market has been considered only for the expansion of the sector's private enterprises.

The estimate of the contribution of operational resources was based upon the recovery of the demand for steel, which actually took place. The apparent consumption of steel in Brazil grew from an average of 3,526,000 tons per annum in the period 1964/67 to an average of 5,648,500 tons per annum in the period 1968/71, and to 8,293,400 tons per annum in the period 1972/73. Nevertheless, while USIMINAS' domestic sales of flat rolled steel products grew by 215.1 percent and COSIPA's by 190 percent in the period 1968/71, CSN's domestic sales of flat rolled steel products (including coated ones) fluctuated around the average of 809,600 tons per year, a lower figure than the annual sales of those products by CSN in the crisis period (1964/67), when the average reached 817,600 tons per annum. The difference in the sales by CSN was precisely that the sales of coated flat products (more profitable ones) grew rapidly, not only in volume but also in their participation in total sales: in 1970 CSN's sales of coated flat rolled steel products reached 305,600 tons, in contrast with an average of 211,500 tons per annum in the period 1964/67.

A real average price rise of 25 percent, as from 1968, was expected, in order to allow the sector to generate internally sufficient resources, the recovery of the market already being taken for granted. However, between 1969 and 1973, the accumulated average rise in the basic price of rolled steel products was 70.6 percent, as against a variation of 140 percent in the general price index. It was only in 1974 that a substantial price rise would be granted to the State enterprises: 53.82 percent for noncoated rolled products and 50.75 percent for coated flat products.

In order that the State holding company can finally increase its financial capacity, and liberate public resources formerly directed to State enterprise, BNDE is becoming the main financial agent of private steel enterprises for resources in national currency.

To avoid delay in the implementation of expansion plans, the sector has had to rely on foreign resources, which are estimated as 47 percent of total expenditure up to 1980. The originality of the plan lies in the fact that the negotiations for collecting foreign resources would be led en bloc, thus breaking the traditional schemes of the three State enterprises and increasing their dependence vis-a-vis the sector's general coordination. The success of the new financial scheme proposed has allowed the present expansion



(1976) to follow the predicted schedules.

The ever-present question, when one studies the investment of public enterprises in Brazil - that of the real possibilities of replacing equipment imports by domestic production - is examined. The behaviour of State enterprises is often presented as contradictory. It is argued that State enterprises should be totally geared towards the development of an internal equipment industry instead of basing their expansion upon imported consultancy services and equipment units, because they are an instrument of economic policy. In the period under study, the growth of the sector producing durable consumer goods had priority. Besides the stimuli and exemptions applying to the industrial sector as a whole, its priority segment could also benefit from the tax-free importation of some inputs (chiefly steel); moreover, it counted upon an efficient structure for financing its sales, the direct credit to the consumer. Only the housing sector could rely upon similar mechanisms during the period. Therefore, the expansion of the State enterprise was oriented towards those sectors, and only secondarily to the equipment producing sector. Even in the last few years, when this sector has presented a faster growth in production, the State enterprises have increased equipment imports, with the justification of the quick need to expand capacity, thus allowing expansion of production and capacity in priority sectors.

In the electric power sector, the pattern of finance already presented would suggest a bigger autonomy in terms of imports of equipment, because of the smaller percentage of foreign funds in investment financing, as compared with other sectors. However, even this foreign financing has become important on account of the technical restrictions to domestic production of equipment, such as transmission systems and substations. The pattern of financing in steelmaking shows an increasing dependence on foreign resources, following the acceleration of economic growth and its impact on capacity requirements. A long-term plan would certainly rely on a different pattern of financing. Cyclical growth affecting demand, prices, and capacity requirements have had, up to now, disturbing effects on the sector's ability to obtain more stable financing.

#### Choice of Techniques

As proposed for the general framework, all aspects related to the choice of techniques (purchase of capital goods, engineering services, and selection of industrial processes) are to be taken as parameters, for studying technological behaviour of State enterprise. Therefore, information has been obtained from case studies to explicate similarities and differences, within sectors and enterprises, as to these determinants of technological behaviour. The purchase of capital goods refers to the purchase of the main (critical) equipment units and, in certain specific cases, to the package of an industrial unit (for instance, a blast furnace). In the choice of firms for engineering projects, the phases of feasibility, basic design, and executive project (detailing) of the undertakings will be identified whenever possible.

Purchase of Equipment: The purchase of equipment connected more directly with patterns of financing, technological "constraints" on the local capital goods industry, and sector investment plans is examined. The links between purchase of equipment and basic engineering will be in power production; the longer the distances to be covered, the higher should be the tension of the system, in order to reduce power losses. The higher the tension,

the larger the proportion of imported equipment. The use of imported equipment is overwhelming; except for transformers it is almost 100 percent in the systems with tension equal to or above 345 Kv.

Of the five largest enterprises, four State-owned enterprises (FURNAS, CESP, CEMIG, CHSF) are the main users of foreign funds for investment on the above equipment because they are forced to operate with higher tension, owing to the distance between their sources of power and their markets. One could have foreseen that the distances for power transmission would increase, on account of the location of the water resources in relation to the markets. In view of the substantial volume of resources already invested (and also what is planned to be invested) in the sector in the course of the whole period under study, the response to the demand on the part of the domestic sector producing equipment has been a slow one, either because of its apparent aversion to running risks or because of the restrictions the electric power enterprises have put upon domestically produced equipment. Moreover, these enterprises have had to complement resources available internally with foreign resources.

The connection between the origin of the financing and that of the equipment, which is generally applicable to the problem of consultancy as well, is stressed. Firstly, as was explained when discussing the policy adopted for the sector, the resources complementary to those generated internally should predominantly come from foreign sources, because other resources in national currency should be reserved for other priority fields. At any given moment, technical restrictions could impose strict limits, in the short and medium term, to the domestic supply of equipment, and resources in foreign currency would then be needed for the purchase of imported equipment. Hence, the connection between the origin of the equipment and of the financing becomes clear in the case of bilateral credits. In the case of resources financed by international development agencies, the connection occurs by means of the criteria such agencies establish for international licitations, not only in the purchase of equipment but also in the choice of the consultancy firms. There is also a close connection between consultancy firms and the origin of the equipment units. At the same time, the international agencies require obedience to certain managerial standards. The international agency's interference is not restricted to the specific areas for which financing has been granted, but reaches the whole project.

Therefore, to expect from electric power State enterprises a greater commitment to the domestic sector producing equipment or to the national consultancy firms would be to contradict the sector's policy itself. Firstly, it would imply the breakup of, or significant alterations in, the pattern of financing proposed for foreign resources. The strengthening of ties with domestic equipment producers, national consultancy firms, etc. becomes feasible to the extent that it is possible to replace these resources. Foreign financing can only be replaced by resources in national currency, and, in the last analysis, given the amount of foreign resources and their destination, by public resources. Such resources, however, should be outside the control of the central government, which has already made explicit its policy for the sector, and has set up an adequate structure to carry it out. This is an important aspect of the dichotomy between the State enterprise's autonomy and the growth of centralized control.

CESP is an adequate example of this situation. Being the largest enterprise in the sector, CESP enjoys great autonomy, in relation to ELETROBRAS that participates in only 10 percent of the enterprise's capital; it counts

upon substantial resources from the government of Sao Paulo to carry out its investments. Among the large State enterprises of electric power, CESP is the one that resorts less to foreign financing, although the participation of foreign resources in CESP's financing is a growing one. CESP's links with the domestic industry of electric power equipment and with national consultancy firms are closer than those of other State enterprises of electric power. Nevertheless, the fast growth in the demand of electric power in the region serviced by CESP implies an increasing volume of investments, which could lead CESP's pattern of financing to become more similar to the one adopted for the sector as a whole. Because of the need to limit the use of Sao Paulo State's resources in electric power, as considered a priority in other areas by the State's government, CESP will have to resort more and more to foreign sources of financing, thus weakening its links with domestic industry. If this is not done, the fulfillment of the needs of the electric power demand might be jeopardized because of the limitations of the alternative sources of public resources.

Secondly, a greater commitment of the State enterprises of electric power to the national equipment producers would be contradictory with the sector's objectives of maximizing efficiency, that is, of faster response to the country's growing needs of electric power. The technical and financial difficulties inherent in this kind of behaviour, which are capable of hampering the sector's desired performance, were solved with the definition of the policy for electric power, and specially of its financing scheme. The same applies to the problem of consultancy. It should be noted that the problem of efficiency arises both at the sector and at the enterprise level. CESP has been resorting more to foreign suppliers and consultancy firms also in the name of efficiency.

These conclusions - for the problem of complementation of resources and for the danger of jeopardizing the enterprises' investment chronograms and the quality of the service or product supplied - are applicable to state enterprises operating in other fields. As the dependence upon foreign consultancy and suppliers would imply, in the course of time, serious restrictions to the State enterprise's autonomy and to the possibilities of its expansion, it would seem that the tendency to adopt a "Statist" solution, in the shape of associations assuring the access to foreign technology would be irresistible. Such a tendency could only revert when there is a neat change in global economic policy, in which a different allocation of resources would modify the pattern of investment of State enterprise, which has been oriented towards the expansion of the so-called dynamic industrial segments.

Enterprises in the steelmaking sector have been traditional clients of foreign finance, owing to the absence of an adequate internal structure of financing. However, as centralized planning emerged, negotiations to grant new external funds took place, with the study of several alternatives of financing. Negotiations were carried out en bloc, under the coordination of CONSIDER and with the participation of representatives from the enterprises. One of the most interesting aspects of the financing scheme for present expansion in steelmaking capacity has been the process of international licitation for the choice of equipment units. The total estimated cost of the equipment, for the three expansion projects as a whole, corresponded to 42.2 percent of the total cost of the investments, reaching the value of US \$560 million.

The equipment was divided into two packages: one in which domestic producers had a good chance of winning the licitation and the other in which they might have a participation in an order placed in the IDB/World Bank

financing. It is expected that domestic equipment producers would have a larger participation in the new expansion than they have had in previous ones. Decree-Law No. 1.335 granted domestically produced equipment the same incentives granted by the CDI (Industrial Development Council) to equipment imported in a regime of priority; moreover, there were new types of resources: the funds of BNDE/FINAME (PIS/PASEP), which could be used for the purchase of equipment. These two reasons - the measures taken in Decree-Law 1.335 and the new types of resources - are mentioned as the main causes for the expected larger participation of domestic equipment producers in supplying the steel sector. Furthermore, one of the three enterprises expressed another kind of preoccupation: "we are willing to create our own market, heavy industry being one of the largest consumers of steel products." However, although the participation of national resources has remained the same, participation of IDB/World Bank has fallen from 24.5 to 8.5 percent of total available resources.

For both sectors, the source of foreign finance has changed, affecting the local capital goods industry. In fact, the withdrawal of IDB/World Bank, and its substitution for bilateral credits, has necessarily reduced the volume of purchases of domestically produced goods. In electric power, the greater autonomy of resources was partially neutralized by technical and/or time constraints imposed on the capital goods industry. Paradoxically, steelmaking, though more dependent on foreign finance, showed more concern for local producers, because of the interaction of their demand.

#### Contracting of Engineering Firms and Selecting of Industrial Processes:

In this section, the function of project engineering (or simply engineering) as an active agent in the process of industrialization is shown, and its strategic role as a link articulating the dynamic factors of the industrial system - units of production, the capital goods industry and research and development - is stressed. It is unnecessary to emphasize the importance of project engineering in the conception and implementation of investments, as it allows a higher productivity of capital and benefits the balance of payments of the industrialized countries; nor is it necessary to insist upon the analytical possibilities to be found in a study about project engineering, chiefly when it is considered as one of the most objective and direct forms of measuring a country's technological level, nor to take into account its role as an instrument of technological transfer. It thus becomes explicit that the firms of engineering projects occupy a strategic position in the transfer and creation of national technology, also promoting the diffusion and feedback of technical information within the industrial system.

Because the most important customers of project firms in Brazil are undoubtedly the State enterprises, an attempt will be made to detect the dynamics of this interrelationship. Thus, a brief analysis indicating the evolution of the services of consulting engineering in the country will be carried out in an effort to stress the differentiation in technology among the sectors considered: oil refining, steelmaking, and hydroelectric power.

The chief function of project engineering is to work as the articulating element between the knowledge available and concrete reality, thus bringing about safety to the investment and a reduction in its cost, as a result of the accumulated experience acquired by the enterprises that operate in the field. Such enterprises also supply their customers with a mass of stored information as a result of their relationship with the potential suppliers of goods and services necessary for an industrial investment.

State enterprises, since the setting up of their industrial units, have counted upon the services of foreign engineering firms, which were chosen not only on account of their technical competence but also because of the historic-contextual characteristics in which the various State enterprises emerged. The initial relationship of each State enterprise with the foreign source of financing for the investment, which induced the State enterprise to become the customer of a certain country supplier of technology should be noted; this is a connection that still remains in force today for some enterprises.

In the initial stages of setting up the first industrial projects, foreign engineering operated freely because of the timid limitations imposed by the State enterprises, which worked very near to a turnkey basis. Foreign project engineering was responsible for the feasibility study, the basic design, the executive project, the specifications of equipments, the choice of suppliers, etc. They worried little about local conditions in their operation, and as a result their techniques were more suitable to the human, economic, and physical conditions of their own countries.

Later, as a result of the experience in the development and setting up of investment project, and of the experience acquired by Brazilian technicians in the operation of the industrial units already existing in the country, the national enterprises of consulting engineering began to emerge. The development of such enterprises in the private sector seems to have depended either upon the technical qualification of their founders, their entrepreneurial outlook, and the connections and incentives they obtained from certain State enterprises (which took up the "risk" of delegating to national enterprises the responsibility for certain projects), or upon the association of those entrepreneurs with foreign firms of project engineering, with whom they became associated in projects whose global responsibility remained in the hands of the foreign enterprises.

The technological particularities, specific to each one of the industrial sectors chosen for analysis, require observation in detail, sector by sector. It is not by chance that the local firms of consulting engineering are technically more qualified in sectors where there is a prevalence of civil engineering, a more traditional technology, which allows for the reapplication in new projects, such as in the hydroelectric power generation sector. In the latter case, technical progress is slower than in the petrochemical sector, where the technological dynamism is more intense and the innovations of products often lead to an entirely new process technology that originates from an extended and costly research process. Therefore, in the present stage of project engineering, the most important local firms of consulting engineering are qualified to take up global responsibility in the setting up of new hydroelectric power stations. It might not be less important to ascertain that, in most State enterprises, the "phase of disbelief" in the qualification of local engineering has already been overcome, although in some State enterprises the "technological prejudice" still prevails, having as its result the contracting of foreign consulting engineering, with a loss for duly qualified national enterprises.

The situation presents itself in a totally different way in the sectors of steelmaking and petrochemicals, where the process know-how is vitally important, inducing a greater technological dynamism and a close connection and dependence vis-à-vis the foreign technological system. State enterprises operating in these sectors prefer foreign engineering, which has a solid reputation,

to take up the global responsibility for the undertaking. Local engineering firms are restricted to a symbolic participation, and there is no indication that State enterprises are sensitive to the idea of relying upon local engineering. Therefore, in the steelmaking and petrochemical sectors, on account of the above-mentioned factors, foreign engineering has been made responsible for the basic design, which allows it to control important parameters of the various undertakings. It is possible that the defense of its customer's interests is not the only thing foreign engineering has in mind. It is obvious that, if the function of engineering is left to the generally biased interests of foreign enterprises, these enterprises will tend to maximize their involvement in the definition of the chief parameters, to the detriment of the local economy.

The participation of local engineering in the steelmaking and petrochemical sectors is generally concentrated on peripheral tasks, which have a repetitive nature from one project to another, such as building foundations and civil engineering, auxiliary systems (storage, cargo transportation, etc.), and systems of utilities (compressed air, steam, electric system, etc.). On the other hand, it can be ascertained that even the larger local enterprises of consulting engineering seem afraid to develop activities of basic process design, on account of the margins of risk. Until quite recently, there was no explicit policy of purchase of goods and services in the country on the part of State enterprises, and national enterprises of consulting engineering have accepted the technical and contractual limits imposed upon them by the foreign associate of the day. Consequently, national engineering in this sector of process engineering is running the risk of being reduced to a mere instrument of technological dependence on a permanent basis.

Another topic of interest, as a result of repercussions in the development of national consultancy services, is related to the interference of the foreign sources of financing in the technological decisions made by the State enterprises. The connection between the foreign source of financing and the origin of the equipment goods is a fact easy to be ascertained in the procedure of technological purchase by the State enterprises. Similar remarks could be made on the relationship between the source of financing and the nationality of the consulting engineering firm in an investment project; this relationship leads to a more complex chain reaction, exerting an influence upon the following stages of the project: the choice of the process, the purchase of equipment units, the task of supervision, building and assembling, and technical assistance. It is known that international sources of financing, such as the World Bank and the Inter-American Development Bank, although they do not totally finance the investment, impose upon the different items of the investment process their own requirements and criteria for the qualification and selection of suppliers of goods and services. However, there is no encouragement to qualify and develop local engineering, which could assure a more comprehensive importance than the one restricted to the financing of a specific project. It can thus be observed that the procedure of the international financing agencies has been reflecting upon the imposition of the participation of foreign consultancy firms for the inspection of the setting up of the investment, and upon the approval of the utilization of engineering with proved experience for the different stages of the project; that is, engineering that could have been supplied by a local project firm. Many State enterprises have their process of choice of consultancy firms influenced to a large extent by, and in many cases even linked to the "historical evolution" of, their sources of financing.

Transfers of Technology - The Role of the National Institute of Industrial Property (INPI): The remarks made above call attention to the need of a more active participation in, and control of, the importation of technology on the part of the State enterprise. Furthermore, it seems obvious that technological development cannot be reached without a coherent and coordinated set of specific national structures. One important component of this set of structures is the National Institute of Industrial Property (Instituto Nacional de Propiedad Industrial) whose function is to orient and regulate the contracting of services of consulting engineering abroad. Hence, the options intended for an industrial policy cannot ignore the articulations of the dynamic segment of the industrial system (capital goods industry, the sector that produces intermediate goods, consulting engineering, etc.); nor can such options ignore the establishment of a policy of importation of licenses and technical assistance for the production of equipment units and consulting engineering in the country. Moreover, if one considers the lack of sensitivity of the State enterprises for the repercussions that the importation of goods and services, the purchase of patents, etc. would have upon the country's balance of payments and upon the development of a national technology, the increasing importance of the role that the INPI has been playing in recent times can be understood.

It can be supposed that most State enterprises do not have yet criteria for the establishment of payments of royalties and contractual clauses; one can find cases of State enterprises where signed contracts with different clauses and forms of payment for the same services supplied by different foreign firms have been made. There are also cases where each department in the same State enterprise has had different sets of contractual clauses in contracts signed with one and the same foreign firm. It is natural that, in the case of this last example, the foreign enterprise tried to bargain, department by department within the State enterprises, in order to obtain contractual clauses identical to the ones established in the contract that seemed most favourable to it. On the other hand, although several State enterprises are mature enough to make adequate technical choices, the secondary importance, in signing of contracts with foreign enterprises of consultive engineering, allows the occurrence of certain liberalities in contractual clauses. The analyses and registers of such contracts before the INPI, whose approval is required also in the case of State enterprises, are usually considered an obstacle to the development of the undertaking in the time schedule established in the project. Most State enterprises do not realize that a systematic and planned contact with the INPI would not only bring about the establishment of contracts with more reasonable clauses and financial costs, but also induce a greater articulation of the industrial system.

Research and Development Within State Enterprises: If technology is considered in its wider meaning and not restricted to the way in which a certain technique or tool is used to reach a certain practical objective, the political character of technology, which changes it into an instrument of control that affects the socioeconomic structure and the distribution of power, wealth, and prestige in modern society, is evident.

In this context, technological R&D in a country's own territory acknowledgedly plays a fundamental role in the achievement of an autonomous economic development, because it is a vital part in any integrated system of science and technology, or because it constitutes an element that directly acts upon capital accumulation by means of the technological innovations it

generates. It can be observed that, to the extent that the costs of R&D have gone up and that large scale projects have begun to require not only a considerable time period for planning and maturation but also the assurance of a regular flow of resources for their implementation, the commitment of the State to the process of technological development has become increasingly important, even for the private sector in advanced capitalist economies. In the Brazilian case, this becomes particularly significant when the specificity that characterizes the action of its entrepreneur-State is considered, to the extent that the State takes up the risk involved in R&D activities and, parallel to that, has also been taking part in the process of capital accumulation as one of its main agents.

The performance of the research centres coupled with the productive structure (operational areas) of the State enterprises becomes particularly interesting as an object of knowledge. The empirical data cover oil and steel-making sectors. On the basis of the observations made in the research centres visited, it can be stated that the activities taking place in them are not predominantly geared to carrying out research and development. In most cases, the works relate to technical support and/or assistance which, in varying complexity, involve scarce creativity ("technical services").

The present study, which stresses as an explanatory factor the way the research area participates in the enterprise's general strategy, that is, the weight and the nature of its contribution towards the achievement of the targets of the enterprise, defines the predominant character of the work of these centres on the basis of the apprehension of the objectives that are considered a priority for entrepreneurial action. On the basis of this factor, it will be possible to understand why it has not concentrated on establishing innovative activities that could be translated into research and development for the gradual generation of technology within the country itself.

The research centre's capacity to meet the enterprise's technological demands, that is, the efficiency of its performance in relation to the entrepreneurial dynamics, varies in direct proportion to the degree of integration observed between the research area and the other units of the enterprise's productive system (basically, production and commercialization). This integration, resulting from direct and systematic contacts among the personnel in the areas referred to, shows itself as a basic condition to efficient performance, to the extent that the importance ascribed to the works carried out in the research centres depends directly upon the quality and promptness of the support that they supply to the operational areas. This support, in turn, corresponds to the solution of more complex technical problems, which are outside the routine of the quality control area or which are too sophisticated to be solved within the sphere of the productive units themselves. However, it is possible to find a lack of better scientific training on the part of the teams in research centres, which have been showing themselves to be productive and profitable to the enterprises. At the same time, it can be observed that the availability of highly qualified researchers, coexisting with a weak capacity or response to the enterprise's practical needs, affects in a negative way the efficiency of the research area and jeopardizes its "image" in the organization as a whole. The efficiency of these research centres, from the enterprise's viewpoint, does not appear in a causal relationship with the utilization both of the technological qualification of the research teams and of the amount of resources offered by the most "advanced" instrumentation. The centres seem to be able to stand, without losses that would endanger their performance, even the disequilibria observed between the potential of human resources and the availability



of material ones. This would lead one to conclude that the mere growth of technical qualification and/or of equipment units does not necessarily result in the generation of technological innovations.

By concentrating their activities in the supply of "technical services" to the enterprises, the research centres are logically prevented from justifying their limited technological contributions by the relative shortage of highly qualified technicians, or by the absence of modern and well-equipped installations. Both these factors can, in fact, act as strong conditioning factors under circumstances, but they cannot be made responsible for the activities carried out by the research areas of the State enterprises studied. The lack of articulation between the research activities and the operational areas endangers the purposes that justify the adoption of modern techniques for planning the centres' activities, as it withdraws all usefulness from the contents of that planning and thus prevents it from transcending the limits of a mere formal instrument. This planning is also hampered by the nature of the activities that still predominate in the research area, as the research centres have been working with autonomy for several years. In all the enterprises studied, there was a specific planning system for the research area. In some cases, this has meant great effort and devotion on the part of the technicians towards creating a system for programming their activities. However, no system of this kind, no matter how well structured, can work adequately while the research centre is considered first as a body supplying the enterprise with "technical services," and thus more complex technological activities, which require larger resources and longer maturation periods and therefore involve greater risks, are relegated to a secondary position. Thus, if the centre is dependent exclusively upon the interests of the production area and if its participation in the achievement of the enterprise's priority targets is not very significant, thus affecting little the productive system's working patterns, then this planning becomes incorporative; it is incapable of inducing and sustaining research and development activities.

In order to explain the research centres' "passive" attitude, their action "in the tow" of the enterprises' operational areas, the existence of a safe demand for their products (as a consequence of the market structure in which such enterprises operate or the benefits stemming from their strategical position in the functioning of the economy as a whole) is not excluded as a relevant factor. But the factor responsible for the approach given to technological questions is believed to be the easy resort to foreign sources of know-how. In principle, this resort is justified by the size of such State enterprises, which gives them not only conditions of access to, but also facilities for, international negotiations of purchase of technology, in particular. The facility for obtaining the financing of the purchase of huge amounts of capital goods abroad is based upon the same fact, and works as a conditioning factor of the entrepreneurial behaviour observed. An even stronger influence can be exerted through the creation of greater facilities for the utilization of a technology already available abroad, when the State enterprise has among its shareholders a foreign enterprise that is internationally recognized as an important generating source of know-how. A common trait that could be observed in all the enterprises studied was a strong disposition to avoid as much as possible any risk that might jeopardize the targets of the productive system; this, in a certain way, induces decisions to follow an option that very often privileges the internationally tested technology. Even this means a slower internal development of know-how.

This attachment to the safety of operations generally induces the non-diversification of the sources that provide the enterprise with technology,

when it is likely that to diversify would promote, in some cases, the acceleration of the process of transfer of know-how into the country, thus making its absorption easier for the Brazilian teams. A commitment is thus maintained to a certain supplier with the aim of assuring the continuous access to the "frontier" technological innovations generated there. The negative aspect of this behaviour for the promotion of a technology with an autonomous character originates not so much from this modernizing spirit as from the factor "safety" mentioned above. Diversification, in order to transfer know-how faster or to encourage the internal creation of technology, has the same problem: to assure that the benefits of the innovations are given to the enterprise, the risks being, for the greater part, the responsibility of the foreign supplier.

The research centre, working as a supplier of "technical services" to production, can occasionally make small innovations in the technology utilized by the industrial units and contribute to a reasonable rise in the enterprise's profitability. However, this rise is conditioned to the limit of the risk, set up by the enterprise, that it is willing to take, although this might endanger in a substantive way the role that might be ascribed to the research centres linked to the State's productive structure. These research centres would perform their role in a deformed way in view of the purposes admissible in an authentic body of research and development, as their activities would not contribute to a significant reduction in imported technology. One of the possible justifications for this assertion is the lack of articulation between the research works and project engineering departments. Project engineering, an indispensable "link" to any productive technoscientific system (which shows results), establishes a basic necessary condition for the transfer of the results obtained in research activities into the industrial area. Its absence or its disconnection from the research area, would hamper a better utilization and the importance of the works carried out by the research centres analyzed in this study, and, as a consequence, would damage the projected "image" of efficiency.

The conclusions of the present work stress the importance of factors distinct from those so far pointed out as conditioning the practice of research activities in the field of technology. The set of factors traditionally presented as restrictive of the successful practice of research and development are not excluded. However, above all, the kind of relationship established between this area and the others that make up the enterprises' productive system are stressed. Furthermore, what defines this relationship is the way in which the research centres are inserted into the enterprises' dynamics, thus conditioning the performance of their activities to the set of objectives that outline the general strategy of such enterprises.

As a final synthesis, the type of performance observed, which concentrates upon the supply of "technical services," would originate from the strategy adopted by the enterprise and from its easy access to, and negotiation with, foreign supplying sources of know-how. This resort to foreign know-how has as its aim: to assure for the enterprise possible modernizing innovations in the technology utilized, and also to minimize the risks that might jeopardize the production of its industrial units.

State enterprises have been playing a crucial role in the Brazilian economy, to the extent that they can direct and, in many cases, even lead the way for the country's technological development. The attitude of these enterprises towards the problems of technological development is of fundamental

importance, as well as their preference for local goods and services and their awareness of the role and the importance of technology for the country's economic and social development. However, Brazilian State enterprises are institutions that have a management of their own, and therefore make decisions according to their entrepreneurial rationality. This procedure implies that, in many cases, the options they select do not fit into government decisions, which are geared to the collective interest and are based upon a wider and longer term perspective. On the other hand, it can be seen that the technological decisions in State enterprises are made in a context that includes several conditioning factors outside the field of technology, such as the economic, financial, cultural, and politico-government aspects. Thus, it becomes fundamental to understand the influence of these contextual factors upon the "technical decisions" in order to incorporate them into the analysis of the decision-making process of the State enterprises, in an attempt to establish an effective articulation and integration between these enterprises and the government bodies concerned. This integration would induce the emergence of a technological perspective as one of the basic aims for the development of the State enterprises and of the country.



## CHAPTER 12

### TECHNOLOGICAL RESEARCH AT PETROBRAS

Dulce Maria Monteiro

#### The Research Centre - CENPES

The idea of institutionalizing technological research at PETROBRAS dates back to the creation of CENAP (Centro de Aperfeiçoamento e Pesquisa do Petróleo, i.e., Centre for the Improvement and Research of Petroleum) in 1955. This centre originated from the Sector of Supervision of Technical Improvement (Setor de Supervisao do Aperfeiçoamento Técnico) of the old CNP (National Petroleum Council), and had as its main purpose the training and perfecting of personnel for the oil industry. It also comprised a Sector of Analyses and Research (Setor de Análises e Pesquisas). Two years later CENAP was reorganized, and the six sectors were created to form the new structure, one of which was the Research Sector (Setor de Pesquisas), "which since then has begun to make the first steps in an attempt to encourage at PETROBRAS a state of mind favourable to scientific investigation, which might culminate in the setting up of a research centre."

A few years later, CENAP made a survey on a world scale, in order to establish a policy to be adopted for the setting up of a research centre. The survey covered 18 oil enterprises operating in the United States, Great Britain, France, and Italy. As a result of the survey, a report was drawn up (1960), which was the basis for intensified efforts aimed at the effective creation of a research centre, endowed with the human and financial resources needed for its development. PETROBRAS' annual report for 1963 states that the research centre (CENPES) would be created in the following year, but it was only in January 1966 that it was institutionally created as PETROBRAS's central research body.

In 1969 CENPES' activities were redefined as a result of the elaboration of a directive plan that established priority areas for research. The organizational structure, the basic lines of the new installations, and the main equipment units to be purchased were also defined. The directive plan was drawn up with the advice of ADL - Arthur D. Little, an international consultancy firm chosen by PETROBRAS to guide the conception and construction of the installations of CENPES. In 1969, the centre's activities began to comprise also research in the spheres of exploration and production, besides the research works already traditionally carried out in the fields of petrochemistry and chemistry. CENPES is currently made up of four technical divisions: Divisao Tecnológica de Refinação (Technological Division of Refining, DITER for short); Divisao de Química Geral e Analítica (Division of General and Analytical Chemistry, DIQUIM); Divisao de Petroquímica e Polímeros (Division of Petrochemistry and Polymers, DIPOL), and the Divisao de Exploração e Produção (Division of Exploration and Production, DEPRO).

The Chemistry Division (DIQUIM) works as a supporting unit not only for

CENPES' other research divisions but also for the enterprise's operative units. It is responsible for the coordination of PETROBRAS' ten laboratories and is one of CENPES' oldest divisions. PETROBRAS has had a unit of chemical research for about 20 years now, which has provided it with technical services (activities of technical assistance). Even today, within the structure of CENPES, about 30 percent of DIQUIM's activities are in this sphere: attempting to solve the more complex problems which the operative units, for lack of sophisticated instruments and equipment, cannot solve.

The activities in the fields of refining and petrochemistry were among the first to be developed at CENPES. According to PETROBRAS' annual reports, the first purchases of pilot units of catalytic cracking and catalytic reforming took place in 1960. Besides these two units, a pilot unit of distillation was projected in 1960 and a unit of continuous extraction was bought, with the purpose of developing studies of deasphalting with propane and of extracting lubricant oils with phenol and furfural. A research laboratory for testing catalyzers was also projected in the same period. The fields of refining and petrochemistry were separated in 1971, with the creation of the Division of Petrochemistry and Polymers (DIPOL). It is likely that the factors that led to the creation of this Division were the growing expansion of the petrochemical sector in the country's economy, and PETROBRAS' participation, through PETROQUISA, in the activities of the sector.

The DEPRO (Division of Exploration and Production) performs activities that had never before been carried out at CENPES, and only partly and on a small scale in PETROBRAS' own Department of Exploration and Production. Nevertheless, in the latter, such activities had never reached a high degree of complexity, which is the present purpose within this division of CENPES. Although it was created quite recently (1969), DEPRO is now responsible for research programs that have the utmost importance for the enterprise, such as the geochemical assessment of rocks and the development of special methods to increase the recovery of petroleum in the deposits, thus enlarging PETROBRAS' actual reserves. Another important activity at CENPES is carried out by DITER (Technological Division of Refining): studies about the processing of the schist oil of Irati, aimed at developing an economical scheme for refining this oil; in 1969 this was considered the most important program in this sphere.

At the same time, efforts were being made to obtain a site for the research centre. Several task forces were formed to study the problem and propose solutions. However, the enterprise made no final decision for many years, although some negotiations were carried out, such as the possibility of purchasing a site in the city of Rio de Janeiro. It was in 1968 that an agreement was signed with the Federal University of Rio de Janeiro (UFRO), establishing that a site in Fundao Island, where UFRO is located, would be assigned for PETROBRAS to install CENPES. Therefore, although CENPES as an institution has formally existed since January 1966, it has only recently been provided with adequate requirements, both in terms of installations and equipment, and in financial and human resources. The transfer of CENPES' headquarters to Fundao Island took place in November 1973.

#### The Activities of Technological Research at PETROBRAS

Technological research at PETROBRAS was from its inception linked to the training of personnel. It was born as an activity that was carried out simultaneously with teaching and probably only when the latter did not fully occupy the time of the "lecturers-researchers." The main activities in the

sector of research dealt with the execution of technical services, such as the evaluation of national and foreign oils, aimed at the orienting of processing schemes, selecting oil to be processed in the enterprise's refineries, and identifying national types of petroleum. Among other "technical services" carried out at the time at PETROBRAS were: assessment of the schist oil obtained in the retort plants of the Superintendency of the Industrialization of Schist (SIX for short, X standing for "Xisto"); analyses of schist gases; assessment of asphalts; control of the life of catalyzers utilized in the units of catalytic cracking and reforming in the existing refineries; and studies about the performance of catalyzers. These activities continue to be carried out, when necessary and on account of their greater sophistication, by CENPES. Simpler routine activities are carried out in the laboratories of the refineries themselves.

Besides these technical services, PETROBRAS has carried out, and still carries out, research to optimize processes of production, such as that of catalytic cracking and catalytic reforming. It has also been developing research aimed at adjusting processes and products already existing in other countries to local market conditions and raw materials. This was the case for the operation of the lubricants unit at Mataripe Refinery, which was to process Brazilian oil with high paraffinic content, different from the oil usually utilized in that unit. It was also the case for the research developed to extract a larger amount of LPG, liquified petroleum gas, and a smaller amount of gasoline from crude oil in 1965, as at that time Brazilian market conditions were different from market conditions in the United States where the technology involved had originally been created.

PETROBRAS' oldest research works were mainly geared to the search for the minimum indispensable knowledge about either the quality or the characteristics of the inputs utilized in several productive processes, such knowledge being necessary for a better internal control in the purchase of these goods. PETROBRAS could thereby assure in the dialogue with its potential suppliers that it would be able to choose among the products available in the market those most adequate to its situation (for example, technically and/or financially) at any given moment. In this way, PETROBRAS has acquired a significant know-how about catalyzers, which has allowed it to reach greater efficiency in choosing the suppliers of these products.

Besides research on inputs, the initial research activities at PETROBRAS were closely linked to the solution of problems arising in the operation of refineries, and to a large extent they represented attempts at optimizing processes of production for adjusting imported technologies to the needs of the national market of oil derivatives.

The activities listed above refer chiefly to routine situations, with the prevalence of either applied or development research of little complexity, as was to be expected in the initial phase of technological research at PETROBRAS.

Since 1970 data have been available on the research activities carried out at the CENPES. The data were supplied by the centre, which sent the present author the material requested on all the research work carried out, including that still in progress, in the research centre in the last five years. The 34 research works, for which information was made available, are classified according to their nature - exploratory, applied, and development research: exploratory research, 6 projects (17.6 percent); applied research, 17 projects (50 percent); and development research, 11 projects (32.4 percent). This

indicates a predominance of the activity of applied research at the CENPES. The average duration of each kind of research work is practically the same - 2 years - which suggests that the predominance of applied research is not due to the time factor. The similarity of the average durations may suggest that CENPES is only interested in carrying out activities of a relatively short time span, as the more complex a research work and also the more it aims at being industrially applicable, the longer it will last. The optimization of a process of production is a much simpler activity to be carried out and requires much shorter time than the creative replacement of a process being utilized, which would often imply the construction of a pilot unit adequate to the new process which could be used to test it. It is also necessary to build a prototype unit before proceeding on an industrial scale. The kind of replacement mentioned above is clearly an activity which would require longer time periods (longer than 2 years).

Most of the projects developed at CENPES were requested by the operational units (70 percent); then the research centre itself, the enterprise's sector of planning only requesting one research work. This situation suggests a close relationship between the research works carried out by CENPES and PETROBRAS' practical problems. The form whereby research works are chosen also suggests this link. A general survey of the problems arising is first carried out in the respective operational areas: DIPOL at PETROQUISA, DEPRO at the Department of Exploration and Production, and DITER at the DEPIN (Departamento de Producao Industrial-Department of Industrial Production). The next step is to send a set of projects to these areas, and the areas classify them as more or less attractive for themselves. Finally, the research centre assesses the feasibility of the projects thus classified and proposes to PETROBRAS' Board of Directors a schedule (chronograph) for developing and concluding the research works to be carried out, which has to be approved by the Board of Directors. The most important criterion in the choice of the projects to be developed is their attractiveness for the operational area, as the other criterion (feasibility) is not selective, but restrictive.

If the importance applied research has for PETROBRAS and also the pre-dominant initiative of the research works (i.e., the operational area) are considered, it can be inferred that, although the dominant preoccupation is to solve problems in the industrial area, the industrial application of the results of research works often does not materialize, i.e., the preoccupation is still disconnected from the industrial stage which is characteristic of development.

The data on the research works that CENPES has developed in association with other sectors of the enterprise itself or with other institutions outside PETROBRAS also show that there are now few links between the enterprise's research area and the operational area, as only five out of the 34 research works were carried out in association with PETROBRAS' industrial sectors. Activities of development (even when of a low degree of complexity) must now require some sort of association with these sectors. The table below shows those research works (out of the 34 dealt with in this section) that were carried out by CENPES in association with other bodies, either inside or outside PETROBRAS. The links are weakest in private industry and universities. The commonest links are established with research institutions outside PETROBRAS. The data show that, with the possible exception of DEPRO, there does not seem to be a tendency on the part of CENPES to establish significant links with institutions outside its own organization.



	Research Institutions	PETROBRAS' Industrial Sectors	Universities	Other Government Institutions	Industry	Total
DIPOL	5					5
DEPRO	5	3	1	3		12
DIQUIM	1	1		1	1	4
DITER	-	1(Schist)				1
Total	11	5	1	5	1	22

Finally, by analyzing the answers given in the item referring to the obtention of profits in the transfer of the results of research works to the operational sphere, it is concluded that out of the research works completed and in progress only one, developed by DEPRO, which deals with the development of equipment units in order to attain higher efficiency and lower costs or to avoid importation, and which has been in progress since 1971, has given a profit of over US \$45,000 per month. This situation suggests that CENPES' directive of transferring its research works directly to the operational area is not being carried out in a systematic way; moreover, it suggests that one of the possible causes for that is the fact that the enterprise has not yet been worried about reducing its costs through the development of these research works.

PETROBRAS first developed routine activities and research works of little complexity, which would provide it with know-how about its several productive processes, in an attempt to create better conditions for bargaining with its suppliers. In the following stage, the enterprise devoted its efforts to carrying out some adjustments (sometimes, complex ones) that were necessary to supply the market of petroleum derivatives or to adapt productive processes to local raw materials. This phase might have evolved much sooner towards the development of more ambitious projects of replacement of technology, in cooperation with the industrial area, but was however postponed by PETROBRAS until quite recently. (It should be noted that a task force was recently constituted at PETROBRAS to study the possibility of replacing imported technology by technology developed at the enterprise.)

The following is the situation now at CENPES: (i) Although being preoccupied with serving first the operational area, CENPES still keeps itself quite disconnected from it. (ii) Probably on account of the situation above, its research projects have mostly been applied research ones, with neither planning nor materialization of the industrial stage, which is characteristic of development and more closely linked by necessity to the activities of the operational area. (iii) The kind of request for research to CENPES or the kind of demand it was initially asked to supply was linked to the solution of operational problems, to the adjustment of productive processes either to our market conditions or to the raw material in the area of refining. Since 1969, this request has arisen emphatically for programs connected with the area of exploration and production of petroleum. (iv) The idea of creating a research centre is an old one at PETROBRAS; the intention of creating it dates back to 1963, but its effective creation only took place in 1966. (It was not even mentioned in that year's annual report; the Centre was only granted minimum working conditions with its transfer to Fundao Island

in 1973.) All this shows that, although the idea was an old one at the enterprise, it was never a dominant one.

### Interpretation of the Data

Several lines of inquiry arise when analyzing the data collected and interpreting the role of technological research in PETROBRAS' development. Whenever possible, a coherent line of interpretation is followed although this interpretation is neither exhaustive nor definitive.

The form in which the enterprise was created - in a very agitated atmosphere of political struggles and heated debates about who would be responsible for the exploration, drilling, and refining of petroleum in Brazil - seems to have influenced PETROBRAS in the exploration for oil in the national territory in order to satisfy the demands of the victorious nationalist current. The data on the enterprise's investments show an insistence upon the activities of refining and exploration above all others, the former being utilized as the means of collecting resources for the aleatory activity of exploratory research. (It is important to recall that research activity is not usually financed by foreign capital, as is refining.)

The fact that PETROBRAS - both to be created and to develop outside the spheres of action protected by the State monopoly - had to face actual barriers represented by foreign and national private interests seems to have contributed towards making the enterprise not interested in actively searching for new solutions to its problems, but cautious in the adoption of new lines of action. PETROBRAS thus concentrated upon satisfactorily performing its basic functions: fully supplying the national market of petroleum derivatives and exploring for petroleum in Brazilian territory. This persistent defensive attitude varied according to parameters external to the enterprise, such as: the international situation for foreign capital; greater or lesser problems in the petroleum supply for Brazil and the rest of the world; Brazil's problems with the balance of payments; and the kind of development policy adopted by the country's government.

Nevertheless, while there were no serious problems in any of these areas, PETROBRAS was allowed to follow its own policy of exploration financed by the activity of refining; the latter in turn responding to the growth in the internal market of petroleum derivatives. There has been a constant search for self-sufficiency for 20 years in the sectors of refining and exploration. Therefore, the enterprise's development policy does not express an aggressive attitude, in which it would be taking initiatives all the time, but rather a passive position, of fulfilling the needs imposed by the country's development. It is a responsive attitude, not a provocative one. PETROBRAS has not been jeopardizing the country's development, but it has not shaped it either.

Lastly, it is suggested that "nationalism" which surrounds PETROBRAS has reduced the influence of external variables upon it; these variables only affect it when they become critical for the country's development: the "contratos de risco" (literally "risk contracts"), recently adopted (1),

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(1) The adoption of these contracts was publicly announced by President Geisel in an important statement in early October 1975. The contracts will allow foreign companies to carry out activities of exploration and prospection, which had not been the practice adopted by PETROBRAS up to then. The payment for the services supplied by the foreign companies will be greater or smaller, according to whether they find oil or not (thus the idea of "risk").

and PETROBRAS' creation itself, can be seen as consequences of Brazil's difficulties in solving the critical problems of its balance of payments, in the early 1950s and the mid 1970s. On the other hand, nationalism has helped provide PETROBRAS with an attitude of little enthusiasm for the adoption of new lines of action, holding itself in the defensive, making it worry about not adopting attitudes that might reinforce the atmosphere of disputes amidst which it was created.

By reflecting on how technological research places itself in this context and by analyzing the data, it is suggested that: (i) technology was another factor, undoubtedly important, which helped the enterprise to fulfill its priority objectives - to fully supply the domestic market with petroleum and its derivatives; and (ii) the "nationalism," which surrounded the search for and future possession of oil, was linked only to this aspect. Other elements such as technology, for instance, were left out, and were thus more vulnerable, not only to the influence of the variables already mentioned (the balance of payments, the problems in the supply of oil in Brazil and abroad, the country's kind of development policy) but also to the influence of other variables such as the uncertain nature of any research activity, and the tendency of big enterprises not to take great risks but to try rather to assure their mere survival and the continuity of the organization.

The question of foreign exchange may have worked against the domestic development of technological research, as the spheres of crude oil production and refining were the ones in which the enterprise could save the largest amounts of resources in foreign currency, thus leading to a tendency to concentrate upon these areas. Perhaps the haste in reducing the purchase of derivatives worked as a factor that put PETROBRAS under pressure to assure as rapidly as possible the construction of refineries, which would undoubtedly be done through importing technology, and not domestically creating or developing technologies. The problems that arose in the market of oil producers on an international scale seem to have affected the development of activities of technological research in that it determined a new field of action: to work also and in an intense way in the sphere of exploration.

The kind of economic development and the policy adopted vis-à-vis foreign capital may have influenced the development of the activities of technological research in the following ways: directly; i.e., the government establishing and demanding the development of those activities in the enterprise; or indirectly; i.e., by the measures adopted in other areas or sectors of the economy by the government, and which reflect upon the development of research activities inside the enterprise.

It is difficult to draw conclusions about these questions, but if one observes the evolution of government policy concerning the country's global development, foreign capital, and science and technology, some conclusions can be inferred. It can be seen that, in the Goulart period, there was no possibility of resorting in a significant way to the help of foreign capital and technique on account of internal economic and/or political reasons. At least, as made explicit in speeches by government leaders, this was not considered the best alternative. On the contrary, there was an open encouragement of the country's independence in wide terms.

Although there is no explicit, concrete reference in the enterprise's plans for the period about how to carry out development, without resorting much to foreign capital and technology, several measures taken by PETROBRAS at the time show that indirectly the atmosphere was favourable to the activity

of technological research at the enterprise.

PETROBRAS began its activities in this field by technical services, such as quality control, analyses of oils and gases, which in the course of time became more complex. The next step was to carry out technological adjustment to operational conditions in Brazil, to solve more sophisticated operational problems, etc., all of which made the enterprise able to enter the phase of replacement of technology. In order to do so, it became necessary not only to create a research centre, but also to set up an engineering department. As was mentioned above, in 1963 the plan was established to set up both the CENPES (Centro de Pesquisas) and the engineering department in the following year, but neither was created in the subsequent years. It is possible that some measures taken by the new government which took power in 1964, as well as the fear of the enterprise's technicians in taking initiative of action in a period of changes in the government spheres, led to the postponement of the creation of these two new sectors in the enterprise until a more favourable period. Nevertheless, after a period of adjustment to the new situation in force in the country, CENPES was created in 1966. The foundation of CENPES seems to be closely linked to the initiative of some of the enterprise's technicians who, ever since the creation of PETROBRAS, worried about encouraging the idea that this activity was important for the enterprise. It is relevant to stress that at the time CENPES was founded one of the directors was Leopoldo Miguez, who considered it important that PETROBRAS developed research on its own account, as well as that it should elaborate its own projects.

The creation of CENPES was not considered important at the time (it was not even mentioned in PETROBRAS' annual report for that year) and the engineering department was not created, which suggests that the foundation of CENPES fulfilled the demands of a small portion of PETROBRAS' technicians, as well as that there were no significant external factors that could put pressure upon the enterprise to follow this course of action. The government was concerned about the balance of payments, which, as was seen above, can work in the opposite direction of the interests of technological research. On the other hand, government plans had not yet explicitly shown any preoccupation with the area of science and technology. It is only in the Costa e Silva period that this preoccupation begins to be felt. The Programa Estratégico de Desenvolvimento (Strategic Development Program), established for the 3-year period 1968-1970, was the first Federal Government program that explicitly considered science and technology as an instrument of economic development. It established the reorganization of the National Research Council (Conselho Nacional de Pesquisas, CNPq for short) and the creation of financial mechanisms aimed at providing a complementary support to the functions of the Sistema de Ciencia e Tecnologia (Science and Technology System). It thus established the creation of the Fundo Nacional de Desenvolvimento Científico e Tecnológico (National Fund for Scientific and Technological Development). In President Medici's term of office this government effort materialized in the Primeiro Plano Básico de Desenvolvimento Científico e Tecnológico (First Basic Plan of Scientific and Technological Development, 1st. PBDCT for short), which would orient government action in the field and would work as an indicator for the private sector. Finally, the present government drew up the 2nd. PBDCT.

If the actions of these two agents (the Federal Government and PETROBRAS) are compared, it will be seen that there is a coincidence between the beginning of the Federal Government's concerns about the area of science

and technology in 1968 and PETROBRAS' renewed preoccupation with the same area, which materialized in the elaboration by the enterprise of the first Global Plan of Investments in Research (Primeiro Plano Global de Investimentos em Pesquisa), the reorganization of CENPES' activities, and even in the purchase of a site and the beginning of the construction of the headquarters for the research centre in Fundao Island. Nevertheless, as could be seen from the analysis of the data shown above, the nature of the research works carried out at CENPES is in the most applied research, in which the pre-occupation with the industrial stage is not as strong as in development. Moreover, they are activities developed in a relatively short time span, which does not characterize ambitious projects of creative replacement of technology, but rather simpler adjustments of imported technologies to local conditions of the market and of raw materials. Furthermore, the engineering department has not been created so far, which reinforces PETROBRAS' lack of involvement in great development projects aimed at replacing imported technology by domestically produced technology.

In order to understand this situation, it is important to consider briefly the uncertain nature of research activity, the behaviour and the motivation of the technicians who direct large enterprises, and the differences in mentality between the enterprise's groups of research, operation, and management (direction). PETROBRAS is a large organization, in which the property of capital is disconnected from the enterprise's management. The motivation of the administrators is not, therefore, based upon obtaining the greatest profits, taking big risks, but is rather linked to individually assuring and improving their position inside the enterprise, which is perhaps attained not with the greatest possible profit, but merely with reasonable profits. In this sense, the big risks represented by situations of great uncertainty, such as the development of technological research (chiefly as regards innovations), should be avoided. It is a quite different situation from that of a private entrepreneur, who, on account of directly benefiting from the profits, would accept big risks, such as "betting" on the development of a new product, the success of which could not be guaranteed.

PETROBRAS had to face an area of uncertainty in the performance of its activities of exploratory research, which requires large investments and is aleatory within certain limits; that is, geologists can indicate areas in which petroleum might occur, but nothing can assure that drilling in these areas will bring favourable results, whether commercially exploitable petroleum will be found or not. This situation of uncertainty has been continuously faced by the enterprise ever since its creation, with the further disadvantage that some research previously carried out has shown that there was no chance of discovering "bonanza fields." This undoubtedly heightened the degree of uncertainty involved in the activity of exploratory research. Also, Brazilian oil is not to be found in conditions as accessible as those in other countries.

The research process does not develop itself according to previously established stages. It changes its course as new ways emerge in the development of the process. This can, at any time, change a good risk into a very bad one, or an almost worthless idea into one with great potential for success. Research work may begin with few problems, but the final solution may become more and more complicated and difficult to reach; or, conversely, it may begin with many difficult problems to be solved, but in the end the solution may be quite easy to attain.

The result of all this uncertainty is that it becomes difficult for the enterprise to make decisions regarding investments in this sphere. How

can one accurately assess whether it is worthwhile to invest in certain research projects if it is not possible to foresee a priori the probability of success to be expected from the projects? The enterprise's directors want assessments, justifications, in order to make decisions, but how can one supply them? The process of invention is by its own nature opposed to this. One of the ways of not becoming too involved in this situation of uncertainty is to devote oneself to research activities connected to improvements and adjustments, rather than to great projects of development of new processes and/or products which would involve larger investments and would place the enterprise in a position of uncertainty. This situation is further worsened when there is a physical and a cultural distance between the personnel linked with technological research and both the personnel responsible for the operational area and the personnel in charge of the decision-making nucleus in the enterprise. The values sought by the research group are often different from those shared not only by the technicians working in the operational area but also by directors and advisors directly linked to the enterprise's centre of decisions. The group of directors and advisors is usually deeply influenced by values connected with the notions of modernization, efficiency, and profitability. Researchers, on the other hand, on account of their academic nature, are taught to praise the search for knowledge and, whenever possible, to contribute towards its growth. Furthermore, it is on the basis of this criterion that their performance is evaluated by the technoscientific community, which transcends the enterprise and to which they belong. Moreover, the researcher has learned to consider a negative result as good as a positive one; the result, and its contribution to knowledge, is what interests him. The bureaucrats and the technicians linked to the operational area judge the researcher's contribution rather in terms of its profits, the speed with which it was made, and its usefulness; many times they think a negative result is a failure, and even more importantly, that money was thrown away that might have been utilized more efficiently in another activity.

Two kinds of behaviour may arise in response to this situation. Either the research group tries to adjust itself to the directing group's mentality, or it remains faithful to the old values of the search for knowledge, which prevail in the wider technoscientific community, and tries to transform the research centre into an extension of academic life. This latter position might bring about, as a consequence, the isolation of the research group within the enterprise, as well as an increasingly difficult line of communication between the groups of research, operational areas, and decision-making centres. The former behaviour, that of adaptation to the operational and administrative mentality, would have the advantage of making it possible to bring the research group nearer to the other areas of the enterprise. It would, however, lead to the serious risk of making the group lose its identity as a research group, thus drastically restricting its creative contribution and changing it into a more sophisticated and more resourceful extension of the laboratories of the operational units.

The position of the head of the research group is a most delicate one. He is responsible for the group, and has to establish a bridge between the two cultural outlooks; for instance, those under his command demand creative pieces of research work, whereas those above him require "down-to earth" works. It is also his task to put pressure upon, to "catechize" the enterprises' directors, to "preach" in favour of the importance of the activity of technological research inside the enterprise; to obtain more financial resources for his group, and to promote the research group before the other sectors of the organization and other institutions outside the enterprise.

PETROBRAS' research centre (CENPES) has been concerned about overcoming the communication barrier. This preoccupation is expressed not only in the significant number of projects originating in the operational area that CENPES has developed, but also in the criterion adopted for the choice of research programs; the prevalent factor for the selection is the attractiveness of the project for the operational area, together with the feasibility of assessment of each project made by CENPES' technicians. Nevertheless, the small participation of technicians from the operational area in CENPES' research work seems to indicate that, despite the efforts made, this communication, although very necessary, has not yet established itself in a stable manner among the subgroups considered in this work.

### Summary

The role of technological research was conditioned by: (i) The nature of PETROBRAS' internal policy, which did not value technological research as much as other activities, but concentrated upon the activities of refining and exploration in a persistent and sometimes far from creative manner. (ii) The role the enterprise played in the country's global economic policy. In this sense, the State oil enterprise had to attain, at any rate, the targets established by the government. The simplest and safest way of fulfilling this purpose was to import technology, rather than to develop it domestically. In this context, technological research is made responsible for performing the role of adjusting imported technology, and not of replacing it. (iii) The balance of payments. As was shown, the situation of the balance of payments did not encourage the activities of technological research. On the contrary, balance of payments may have been a barrier to its development. (iv) The uncertain nature of technological research, chiefly in the case of large-sized projects linked to the development of new processes and/or products, or to the creative replacement of existing processes and/or products. (v) The type of motivation prevailing in large organizations, which does not encourage administrators to take great risks. One should also consider that the enterprise was already involved in a highly uncertain activity: exploratory research in the sedimentary basins and on the continental shelf. (vi) The lack of a uniform and continuous pressure on the part of the Federal Government to encourage the practice of the activities of technological research. The government's role has been a varied one: now it encourages such activities in the country, such as with the elaboration of the PBDCT (Basic Plan of Scientific and Technological Development); now it demands that PETROBRAS fulfill in a short time the targets it establishes, which prevents the development of these activities. (vii) The difference in mentality existing in the several groups inside the enterprise, which makes communication among them weak (research group, operational groups, directing groups).





## CHAPTER 13

### STATE ENTERPRISES AS INSTRUMENTS OF TECHNOLOGICAL POLICY IN VENEZUELA

Ignacio Avalos and Rafael Rengifo

State enterprises represent one of the most important instruments of technological policy, given the limited experience of some Latin American countries and the far wider one of advanced nations. In the case of the latter, it is difficult to imagine the development of key sectors implying advanced technology without the existence of a given policy on the part of these enterprises.

In Venezuela, the situation has been completely different, as State management has had very different interests and goals. It has been characterized mostly by a trend towards importation owing to a total lack of interest in generating, adapting, and improving productive technologies, and a lack of interest in optimizing the conditions in which foreign technology is acquired.

This chapter deals with the State enterprises in terms of their current and future significance as tools for technological development. It is considered that, according to the Fifth National Plan, these firms will have a decisive role in national economic development and will be almost as important for the creation of a national technological capacity.

#### The Role of the State in the Venezuelan Economy

Since the discovery of oil, the development of the economy has depended fundamentally on the State, and public expenditure has represented more than a quarter of the national income until 1973. More than half of the fiscal revenue has come from the oil wealth and nearly 40 percent of fixed investment has been of public origin. However, despite this, the direct participation of the State in production has been small.

In the economic sphere, the State has acted as a dispenser of credits, exonerations, subsidies, etc. for private capital. It has also provided an adequate physical infrastructure for private capital to act (irrigation systems, roads, etc.). Its entrepreneurial activity has been limited and it has responded to the idea of "public service" in some way. The State has entered productive activities in sectors not attractive for private capital, either because of the risks involved or because of low profits. Often, it has subsidized private investors by means of low prices; the State steelworks and petrochemical industry are very clear examples of this. From 1974 on, however, there has been a change in the economic role of the Venezuelan State, as a result of the so-called New Development Model adopted. The key elements in this model are the basic industries geared towards exports. The justification for the adoption of this new model is found in various factors (1). Firstly,

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(1) Paredes, Edgar and Serna, J.M. 1976. Capital Goods Purchasing Policies in the Petrochemical and Steel Sectors. Mimeo, June. This study forms part of the STPI project.

there is the new pattern of the international division of labour that has begun to give rise, for various reasons, to a displacement of certain industries that had always been localized in advanced countries, towards the underdeveloped ones. This is happening, for instance, in certain of the so-called "heavy industries." Secondly, there are already visible signs that the process of import substitution is becoming exhausted. National industry is unable to compete with foreign industry, and therefore cannot contribute in a significant way to the fulfillment of the new strategy. Finally, conditions exist for the setting up and development of these basic firms: natural resources, physical location, and a good financial situation, as a result of the recent rise in oil prices, etc.

The Fifth National Plan expresses the direction of the New Development Model and the decisive importance of the State enterprises. The figures cited in the Plan show this very clearly. The participation of the State in gross fixed investment for 1976-1980 will be raised to 53 percent, that is, almost 20 percent more than in the previous 5 years. A large part of this investment will be made in the industrial sector, such that, if in the previous 5 years the State contributed 33 percent to the fixed capital formation in that sector, between 1976-1980, the percentage will rise to almost 50 percent. Nearly 60 percent of public investment will be dedicated to the basic industries, which are expected to produce the majority of nontraditional exports. These exports should increase by 30 percent a year, in contrast with the reduced growth of the traditional exports: oil and iron.

The Fifth National Plan states that, in principle, the development of the basic industries is the responsibility of State enterprises. However, it goes on to establish fairly wide exceptions. Thus, in the case of the steel industry, the Plan states that private capital will not participate in the basic process industry except "...when technical or economic reasons justify it." (2) It also indicates that, in processes other than basic, unrestricted private participation is allowed. As regards the petrochemical industry, joint ventures for basic products are forbidden except when necessary, but permitted firstly for byproducts, provided that the State holds 51 percent of the investment, and secondly, for complementary products without majority participation of the State.

Finally, the New Development Model presupposes modifications in the rationality that guides the behaviour of the State enterprises. They can no longer operate ambivalently, that is with private enterprise criteria as firms, but with public criteria as State entities. By becoming the defining elements of the new strategy, the State enterprises clearly have to be concerned above all with profits, and it is only in these terms that they may be evaluated (3).

#### The Technological Behaviour of the Basic Enterprises

The most striking fact, as was pointed out earlier, is that these firms have little or no concern for the technological aspects of development. This was true when they had a limited role, almost exclusively as supporters for private capital, and remains true although their objectives have changed and their role is more important. They have behaved as if technology was a fixed

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(2) Fifth National Plan, Official Gazette, No. 1.860 (Special issue), 11-5-76, p. 38.

(3) Rengifo, Rafael, 1976. The Technological Behaviour of State Firms, CONICIT, draft.

and external fact whose characteristics and conditions of acquisition are imposed by the foreign supplier, and so their behaviour has been clearly dominated by a perspective that only takes into account the immediate situation. The pre-eminence of economic considerations or, more correctly, of the objectives of production, has pushed aside all other concerns. The stimulation of domestic technological potential has been sacrificed for the security that established goals will be fulfilled on time. The risks inherent in the participation of Venezuelan research workers or engineers in the design and installation of industrial plants, contrasted with the confidence inspired by the technological packages brought from abroad, have become the main brake on the development of a local technological capacity. Thus the guiding thread in the negotiations of the purchase of technology lies in the weighing of these risks, not only for the user, but also for the supplier. The latter weighs them in the same way as the former; he fears local participation for two reasons: firstly, he wishes to protect his efficiency image, and secondly, exporting packages means better profits plus the power gained over the buyer.

This approach, which is short termed and concerned primarily with the economics of the situation, has justified the "technological passivity" of the basic enterprises. The contracting of turnkey plants in which the technology is acquired quickly and safely closes the door on the possibility of local learning. The first negative effect is that it prevents the assimilation of technology through experience by national managers, research workers, engineers, and technicians. In other words, it blocks off a source of technological external economies, which are of undoubted importance to the industrial process of the country (4).

It is true that the disaggregation of the technological package, which is decisive in a strategy based on "learning by doing," produces benefits which almost certainly will not be capitalized by the plant owner who imports the technology in the first place, but will be external to his project. In the case of a private firm, it can easily be understood that the incentives offered by disaggregation might be minimal, since they may even benefit competitors. However, the situation should be different in the case of State firms, where the external economies generated in this way should be seen in the long term from a social point of view (5).

The criterion of social effects has not and does not rule the behaviour of the State enterprises. The development of a technological capacity has always been seen as a goal that implies sacrificing the achievement of the fundamental objectives of the firms. When the aim was that the State should dispense a good, cheap, and prompt "service," anything that might conspire against the quality, price, and convenience of the "service" in question was pushed aside. In the present situation, within the New Development Model, the goals are quantitatively and qualitatively different. In view of the imminent end of the process of substitution, the basic firms represent the key to capital accumulation in an economy that has to structure itself and grow by means of exports and, on the other hand, should fulfil its role efficiently in the new international division of labour. Given these goals, it seems there is not much room for a learning process which might cause delays and errors. In either

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(4) Paredes, E. and Serna, J.M. Op. cit., p. 27.

(5) Cooper, Charles and Maxwell, Phillip. 1975. Machinery Suppliers and the Transfer of Technology to Latin America. Prepared by the University of Sussex for the OAS (mimeo), p. 4.

case, it stands clear that technological assimilation is minimal, barely covering the requirements for the use and maintenance of equipment.

By taking this line, our basic enterprises reinforce a situation originating in the "technological passivity" already mentioned and in the interest of domination on the part of the more advanced countries. It is worth mentioning, although it has been said so often, that these interests are preserved through this "passivity."

### The Petrochemical Industry

The Venezuelan petrochemical industry began in 1953. The period from that date until 1966 has been described as the first stage in its evolution. In retrospect it can be seen that this stage lacked clear objectives and precise strategic guidelines, and so naturally it was a period of errors: in location, in the estimations of pre-investment costs, in the time provisions, etc. At the same time, it was a period of intense and varied learning. Regarding technology, there was a more or less habitual trend towards the disaggregation of packages, and the rules governing bids permitted the diversification of supply sources. Thus, in the construction of the Morón Complex, the foremost achievement of this period, there was a relatively large participation by national engineers. The Venezuelan Institute of Petrochemicals (IV) contracted abroad the supply of the process and basic engineering, while national personnel carried out the rest of the work required for the installation and operation of the plant, with or without foreign advice, but always with a marked participation of Venezuelan personnel (6).

The lack of information prevents a satisfactory analysis of these beginnings of the IVP. However, one can suggest, albeit tentatively, that the technological policy followed had much to do with the role played by the State enterprises at that time. The petrochemical industry had a role of limited economic importance, which allowed it to "get away with learning by doing." The risks mentioned earlier do not seem to have counted for much, and consequently the dilemma between "the economic" and "the technological" did not arise.

The second stage covered the period 1966-1970, when the Morón Complex was enlarged and El Tablazo was constructed. There was a substantial change in technological policy as a result of the greater importance given to the petrochemical industry in the country's economy. This change implied leaving aside "learning by doing" and permanently resorting to the acquisition of packages.

The same thing happens in the third and present phase, which is characterized by the importance of joint ventures. The importance of the petrochemical industry is now even greater; it stands at the centre of the capital formation process of an economy which has virtually exhausted the possibilities of "growth inwards."

In recent years, national participation in the design and installation of petrochemical plants has been clearly reduced. There has been a policy that recognizes the necessity for Venezuelan personnel to have the greatest possible involvement in industrial projects, but this policy has been stated in very general terms and there has been a lack of mechanisms for putting it into practice. In these circumstances, national engineering has been restricted

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(6) Villanueva, Mariadela. 1976. The Technological Behaviour of Joint Ventures in the Petrochemical Industry. CONICIT, June. This study forms part of the STPI Project.

almost exclusively to technological developments in the periphery (7). Furthermore, when Venezuelan firms have been able to carry out more complex tasks, they have had to associate with international firms (8).

Thus, the main feature of the technological behaviour of the petrochemical firms these days is turnkey contracting, which leaves nearly all the responsibility for the formulation, installation, and often the operation of industrial plants in the hands of the contractor. This policy of "doing things the easy way" has not only frozen the possibilities for forming a local technological capacity, but has also frequently given rise to technical problems of different sorts and has produced considerable economic losses. In other words, it has not managed to avoid the negative effects which are precisely those on which the argument for buying in packages to guarantee safe and rapid installation of industrial plants is based. The olefines plant at El Tablazo is a very clear example of this. The construction of the plant, initiated in 1968 and finished 9 years later, was entrusted to the firm M.A. Kellog. At the beginning of 1977, after only one year in operation, various technical faults led to a decision made by the President of Venezuela to paralyze operations for at least 6 months. General Valentín Montaña Madriz, General Director of IVP, blamed Kellog for the faults that were present in the design and the installation of the plant, and revealed that these errors were producing large economic losses: 30 million for the necessary repairs, 12 million for the stoppage of production in January, and an unspecified amount derived from having operated at no more than 7 percent of the plant's capacity, and from the damage caused to other plants who used the plant's production (9).

The Director of IVP also revealed details of the negotiations between the IVP and Kellog: (a) The contract with Kellog had no clearly fixed duration and did not establish fixed costs; (b) the plant ended up costing 150 million bolivars but the contract specified that the contractor gave guarantees for only U.S. \$50,000 (less than Bs. 250,000); (c) the plant was only to function for 72 hours consecutively in order to prove it was in perfect condition; and (d) according to the contract, Kellog was responsible for the construction and inspection of the plant.

Soon after initiating operations, the defects were identified by Venezuelan personnel. Kellog's reaction, according to General Montaña Madriz was to say that these faults were due to the "inefficiency" and "lack of discipline" of the Venezuelans, since there had been problems in the supply of some services, especially electricity. IVP solved this problem and contracted

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(7) It is worth indicating that, in the plants with little rotating equipment, national engineering has had a larger participation. Examples of this are the sulphuric acid plants (although this is a chemical process) in which 70 percent of the installations were made by Venezuelan firms. In addition, the design was provided by a national firm. It is estimated that for nonrotating parts local firms could have an even greater participation. However, there are doubts about short-term local capacity for the needs of the Petrochemical Plan. Paredes E. and Serna, J.M. Op. cit., p. 58.

(8) For instance in the case of Formicone and Ley, and Van Dam which have associated respectively with a Japanese and a Belgian/German consortium. Paredes, E. and Serna, J.M. Op. cit., p. 58.

(9) Statement to the press, El Nacional, 19-2-77.

Foster and Associates, a consultancy firm, for 6 months (renewable) in order to make the plant work and train Venezuelan engineers. Foster and Associates ratified the opinion held by the Venezuelans regarding the design (10) and installation errors. Immediately, IVP contracted Continental Technical Services to carry out a technical inspection and the firm Arthur Andersen to carry out an administrative inspection. The latter, in its first report, found a discrepancy of 17 million bolivars. Finally, the Director of IVP stated that the possibility that Venezuela might sue Kellogg was remote.

As previously pointed out, the case of this plant clearly shows the problems inherent in the "technological passivity" of the basic firms. Given that, in this case, State participation was not just majority but absolute, the situation is less justified than in firms where private and even foreign capital participated. One might think that in these latter there is more pretext for "passivity." The joint ventures were set up from 1966 with the justification that the private sector could contribute decisively: (a) in the international commercialization of local products; (b) in the supply of technology; (c) in the development of the management capacity required by this complex industry; and (d) in the financing of some projects in order to lessen the IVP's burden (11). On the basis of the same reasoning, the National Petrochemical Plan (1976-1981) establishes that 30 percent of its finance should come from the private sector by means of agreements signed with the State (Table 1).

At the beginning, the joint venture agreements were governed by rules established by the IVP. Regarding the treatment of foreign capital, these rules were very similar to Decision 24 of the Andean Pact. Once Decision 24 was incorporated into national legislation by the National Congress, it became the regulatory instrument, replacing the IVP rules. In both cases, the aim was to preserve the control of the industry for the country, something which has only been achieved at a formal level. In practice, the foreign shareholder has power far beyond his holding of shares. This power is based on the fact that he is the technology supplier to a large degree, runs the management and administration, and supplies part of the financing. It is hardly necessary to point out that this limits the range of choice of possible technology suppliers and encourages turnkey negotiations, since these are contributions that only with difficulty can be considered separately.

Thus, financial participation by foreign private capital has favoured decisively this orientation in the acquisition of technology. In most cases, this participation has implied ties regarding the acquisition of engineering services, the purchase of equipment, inputs, etc., as can be seen in the vast

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(10) The Director of IVP indicated, for example, that the economic losses caused by the suspension of work at the plant were large "because the products should have a 99.85 percent degree of purity in the case of ethylene and a 95 percent degree of purity in the case of propylene. If they do not they cannot be recycled because the design of the plant did not anticipate storage of the product, which should be refrigerated at 100°C below zero. This installation now would cost around 80 million bolivars. When the plant starts operations again it will need 8 to 10 days to reach the required levels of purity and everything produced before must be thrown away", *El Nacional* 19-2-77.

(11) For a more detailed account of these reasons, see Mariadela Villanueva, *Op. cit.*, p. 17.

Table 1: The Financing of the National Petrochemical Plan (1976-80)

Nuclei	Estimated Investment	Finance	
		State	Private
El Tablazo	3520	2300	1220
Paraguaná	2400	1920	480
Pto. La Cruz	2560	1450	110
Caripito	960	960	-
Total	9440	6630	2810

Source: CONIP

majority of the joint venture contracts. The analysis of these contracts reveals the existence of a chain linking the foreign shareholder with a financial entity and with a technology supplier, and clearly shows that the joint action of these elements implies an enormous influence on the part of the foreign shareholder in decisions regarding which technology to buy, from whom, and in what conditions (12).

In relation to this, a counter example is pertinent: Estizulia, a joint venture that formed part of the El Tablazo complex. This firm had to partially substitute the anticipated foreign finance with a loan from the National Industrial Credit Fund, which meant a saving of 48 percent of the original investment estimation. Since foreign participation was limited, there were opportunities for disaggregating the technology. Although the operation was relatively simple, in this case it achieved a diversification of suppliers, increased the presence of national engineering, and reduced the investment cost in five of the seven payment items.

In the rest of the joint ventures the technological policy of the State sector has facilitated the dominance of foreign capital in the technical agreements. Firstly, the foreign suppliers have managed to get contracts signed which include restrictive clauses of different sorts: prohibiting exportation, restrictions on the diffusion of the knowledge acquired by means of the contract, limitations on the volume of production, etc. One or several of these clauses appear in the contracts signed by all the joint ventures, despite the fact that they are forbidden by the IVP rules regarding the participation of foreign capital (13). This leads one to suppose that the same may have happened with Decision 24 (14), although detailed information in this respect is lacking. Secondly, the data on the joint ventures set up until 1976 show that 25 percent of foreign participation is not by means of a financial contribution, but through the capitalization of technology according to the value of the technology established by the shareholder/supplier. Again, this is contrary to the IVP rules and Decision 24 (15). Thirdly, there is

(12). For a detailed examination of these contracts, see Mariadela Villanueva, *Op. cit.*, pp. 47 ff. For an analysis of the relations between financial entities and "technology factories", see Chapter V of this report.

(13) Villanueva, Mariadela. *Op. cit.*, pp. 38 ff.

overpricing. Although this was not widely detected it is well known as a habitual practice, especially in the case of turnkey contracts.

These practices obviously do not occur only in joint ventures, although the latter provides a very favourable medium. They also occur in cases where the State is the sole shareholder, despite the fact that one might think that in these cases there are more and better possibilities for resisting them. The problem is that, in both cases, technological behaviour is subordinated to immediate economic goals. As a function of these goals, the technical complexity of the petrochemical industry, the concentration of the world supply of engineering services and capital goods, the speed of technological change in the sector, and the interest in control on the part of the countries that supply the technology, are all passively accepted, apparently with the conviction that little or nothing can be done.

### The Steel Industry

The difference between the petrochemical industry and the steel industry suggests that the latter may provide better conditions for the application of a policy aimed at the creation of a local technological potential. In effect, looking at some of the characteristics of the steel industry and comparing them with the petrochemical industry, it is found that in the former: (a) the market of technological services and capital goods is less concentrated, although it is still oligopolic; (b) the technological complexity is lesser; (c) the rate of technological change is slower; (d) a larger proportion of knowledge has become publicly available; (e) the gestation of projects takes less time; and (f) the losses caused by delays are fewer and less serious (14). These characteristics, which generally speaking are considered characteristics of the technological supply, combine with other elements related to the functioning of both sectors in Venezuela. If the two are compared, it can be seen that, in the steel industry, management and administration have been better and foreign private capital has been less involved.

Despite all this, the technological behaviour of the firms of both sectors has been fairly similar. The position of the steel industry in the global development strategy, the size of the investments anticipated in the Fourth Steel Plan, the technological weakness of the country, and the "passivity", which was mentioned previously, have all combined with the technology salesman's interests and together determine the similarity. Just as in the petrochemical industry, the immediate production goals have prevailed over technological development goals in such a way that the anticipated local participation in the construction of the plants that form the backbone of the Fourth Steel Plan is minimal. Local capacity is limited to providing the metal structures and the civil engineering for the cement structures and electricity conductors. Yet even more limited is the incorporation of national capital goods (15). The pattern followed for the development of the various steel plants has been the acquisition of packages, although there have been some positive occurrences of undeniable importance. A recent study (16) shows

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(14) For a comparative analysis of these sectors, see Edgar Paredes and J.M. Serna, *Op. cit.*, pp. 30 ff.

(15) Paredes, E. and Serna, J.M. *Op. cit.*, pp. 52 ff.

(16) Azócar, Luis Matos. 1977. Technology Transfer and Capital Goods Policy. Paper presented at the seminar on technology negotiation in the purchase of capital goods, sponsored by CONICIT and CORPOZULIA, June, mimeo, p. 22.



that, even when turnkey contracts have been signed, steps have been taken which suggest the possibility of a far greater national participation. SIDOR has been using information better and SIDOR personnel has been participating in the formulation of the technological requirements for each plant and in studying the existing technological alternatives, which strengthen the bargaining position of the firm. At the same time, the firm's financial capacity has been used to some extent, thus countering, in some cases, the technology suppliers' policy of "ties," which comes into play when they are the direct or indirect sources of investment resources.

### Conclusions

A new international division of labour is currently taking shape, although, to be objective, it must be considered to be due less to the efforts of the underdeveloped countries than to the economic strategy of the advanced ones. Furthermore, it must be acknowledged that the new division of labour will consequently maintain the inequality of the relations between both.

Therefore, despite the fact that industries, which previously only existed in developed areas, are now transferring to underdeveloped ones, and that there are qualitatively different productive functions, unthinkable to the classics, this global distribution of tasks follows a logic produced by the developed world, which cannot, logically, be turned against the developed world.

Thus, situations of domination persist in the new international economic reality. The technological superiority of the developed countries is a factor of prime importance in the conformation of these situations. It can be concluded initially that the access to the knowledge necessary for taking on complex economic activities is not without obstacles for underdeveloped countries. In the middle are the interests of the developed nations in safeguarding their supplies of certain products, the monopolic property of knowledge, and the owners' interests in releasing it in small doses, holding onto as much as possible and using it as a power mechanism. There is, on the other hand, the technological weakness of the underdeveloped countries, reinforced by the absence of precise goals regarding the formation of a local technological potential and particularly by the absence of political will to change a type of behaviour that at best can only bring short-term benefits.

Throughout this chapter, it has been maintained that the function assigned to the State enterprises within the national economy has largely determined their technological behaviour. The latter has always been subordinated to economic policy as a result of the dilemma between "production goals" and "technological goals." This dilemma is sustained by the firm opinion that the acquisition of technology in packages assures the adequate achievement of the established production goals, by passing all the responsibility to the foreign supplier. Conversely, the dilemma originates with the idea that to the extent that one allows local technical participation in the various phases of an industrial project, quality and efficiency are endangered to the same extent, and consequently also the economic growth of the firm.

Four comments can be made regarding the above statement. Firstly, even when it is disguised as "economic urgency," this attitude openly and passively accepts that in the international division of labour it is the task of some to produce knowledge and of other (us) to make use of it. This acceptance leads to the corroboration of the domination exercised by advanced nations by means of technology. The second comment is supported by what we have said previously in this chapter: turnkey contracts have entailed problems

that cannot be ignored or minimized - delays, flaws, excessive costs, etc. - not even from the point of view of immediate economic goals. The path followed by the basic firms is instructive in this respect and shows that purchasing in packages also implies risks, which are probably directly related to the absence of the buyer in the formulation and implementation of the project. This appears to demonstrate then that local learning is also necessary for immediate growth. Thirdly, it is not true that the choice between "economic" and "technological" goals can be dealt with without looking further than the short term. To be valid, the dilemma would have to take into account the external diseconomies produced by the importation of packages in terms of the future global development of the country. The fourth and final comment follows on from the previous ones and indicates that the dilemma is really a false one. In effect, the authors consider that a dilemma between economic and technological policy can only be maintained if one believes that the latter's goal is the immediate and total replacement of foreign technology, but this is not the case if the technological goal is understood as the progressive incorporation of national capacity, in accordance with the development of local abilities and contained in a long-term strategy. It does not distinguish between "the economic" and "the technological," since present technological decisions have future economic repercussions. There is no dilemma then. The question is not that if we want economic growth we should side-step local technological growth, and vice versa. Both goals should be dealt with within a general long-term policy. The authors believe that the correctness and efficacy of this approach has been fully demonstrated by the experience of various countries. China, for example, did not sacrifice its economic growth for technological development. Inasmuch as it has achieved the former, it has done so largely thanks to the growing participation of its scientists, engineers, technicians, and workers in the conception, construction, operation, and consolidation of all sorts of industries, including of course the basic industries. Something similar can be said about India, although to a lesser degree. Finally, Japan also clearly demonstrates that compatible productive and technological goals are not only possible but necessary.

In accordance with the above, basic enterprises in Venezuela have to take on policies for technological learning and estimate the risks involved, not in the way these have been estimated to date, but in the light of the following factors: (a) the technological potential of the country; (b) the direct costs associated with turnkey contracts; (c) the external technological diseconomies produced by turnkey contracts; (d) the industrial significance of the industrial project under study; and (e) the long-term development of the country. The simultaneous appreciation of these elements should give rise to a strategy whose application centres on opening technological packages. The only necessary condition for this is simply the will to do it.

## CHAPTER 14

### TECHNOLOGICAL BEHAVIOUR IN THE MEXICAN STATE ENTERPRISE

#### THE CASE OF PEMEX

Alejandro Nadal E.

#### Introduction

In order to examine the technological policy of a State enterprise, it is necessary to specify the part played by the State in the regulation and promotion of the development process and as an agent intervening directly in the production of goods and services. In Mexico, the State controls companies that dispose of about half the total capital of the 500 largest firms. Some of the largest are Petróleos Mexicanos, Altos Hornos de Mexico, Comisión Federal de Electricidad, or Guanos y Fertilizantes. In all, the Mexican State controls about 400 companies, either through ownership or through participation. Another indication of the importance of the State sector is the fact that it is responsible for 40 percent of the gross fixed investment. Similarly, the strategic position of certain companies, such as Petróleos Mexicanos and the Comisión Federal de Electricidad, which allows them to promote accumulation in the private sector of the economy, is an important factor.

Petróleos Mexicanos (PEMEX) is the most important of Mexico's public companies. Being the only offerer of petroleum derivatives, the country's main source of energy, it is in a strategic position, since most sectors of production are obliged to depend on it in order to satisfy their energy requirements. It is precisely this strategic position that has given the Mexican State the capacity to implement globally and consciously a policy of economic growth based on its own productive capacity.

Since the main aim of this study is to analyze the technological policy of PEMEX, an analysis of the nature and characteristics of the global development strategy followed by PEMEX up to the present is given first, which includes PEMEX's production participation in the gross internal product, the evolution and composition of the offer and demand of petroleum derivatives, the employment and the derived demand generated by PEMEX, and its financial situation. The second half is devoted to its technological policy and covers the use of unincorporated technology, the selection of engineering companies, the acquisition of capital goods, and the creation of the Mexican Petroleum Institute. This section also examines the connection between these activities of the enterprise and certain instruments of policy, particularly the National Register of Technology Transference, the Public Sector Imports Committee, and the Mexican Petrochemical Commission.

In synthesis, the study reveals that the part played by PEMEX has implied the existence of various contradictions, which have meant that the company has depended almost entirely on foreign technological sources, for both unincorporated technology and technology incorporated in capital goods. Thus, the need to

satisfy a very dynamic demand for energy at low prices and with absolute reliability (almost as a public service) has obliged PEMEX to follow a strategy of maximization in production. In this sense, the company has operated a real subsidy to the rest of the economy, and in the process has met with a series of financial restrictions which have accentuated its dependence on foreign sources of credit. The creation of the Mexican Petroleum Institute (IMP) did not occur within this framework despite PEMEX's technological dependence, but rather because of the intensity of this factor. The IMP thus has become a PEMEX agent whose initial function is to obtain better contract conditions with technology suppliers and engineering. Because it offers a series of technical services to PEMEX, it acquires the capacity to convert itself into a real engineering company, and today it represents a very important technological achievement.

Over the last two years, the prices of petroleum derivatives have increased, and the financial strategy of the company has been reconsidered. The increase in income has been converted into new investments in exploration, extraction, and refining, which represent a substantial increase in PEMEX's ability to satisfy the requirements of national demand and carry out exportation. The implication of these facts will be examined later. The company has two fundamental options: it can correct its financial situation and decrease its technological dependence on foreign countries; or it can continue to subsidize other sectors of the economy and become one of the fundamental pillars of a model of development whose internal contradictions induce us to question its medium-term viability.

#### The Function of Petr6leos Mexicanos in the National Economy

Petr6leos Mexicanos' function in the economic growth of the country has been of vital importance. It has provided fuel to industry, transport, commerce, the domestic sector, and agriculture; it has provided raw products to the secondary petrochemical industry; it has generated employment and has provided a demand for inputs, products, and capital goods that it requires for its own development; and it has contributed in maintaining an internal price stability, which lasted until 1973 (15 years). In synthesis, it is correct to affirm that the internal policy in the development of Petr6leos Mexicanos has been intimately linked with the policy of industrialization, economic growth, and economic stability pursued by the Mexican State. This policy of PEMEX has been possible because of the strategic condition of being controlled by the State and of being the only offerer of petroleum derivatives.

The mechanisms used by PEMEX to promote the industrial and economic development of the country have been basically the following: to expand production according to the requirements of national demand and to maintain a low price policy for petroleum derivatives, which affects the low cost of the circulating capital of companies producing either industrial goods or productive services, in such a way as to be a strong stimulus for obtaining high rentability quotas and for promoting the process of capital accumulation.

The instrumentation of the mechanisms has implied the need for considerable investment in exploration, refining, and basic petrochemistry, and for following certain guidelines for price policy, the selection of financing sources, the acquisition of products and capital goods, technology selection, distribution of investments, and general administration of the company. These guidelines have not remained homogeneous throughout the company's development, though one can find a common direction in the basic part which Petr6leos

Mexicanos plays and has played in the growth of the country. On the other hand, this part played by PEMEX has conditioned the technological development of the company. Therefore, it is necessary to examine in more detail each of the aspects mentioned in general terms, so that the global strategy of development of Petróleos Mexicanos may be clarified.

#### The Growth of Petróleos Mexicanos and Its Participation in the Gross Internal Product

From 1960 to 1972, the GIP grew at an average annual rate of 7 percent, while the energy sector grew at 9.3 percent. Among energy products, the production of petroleum and coal (not including petrochemical production) has grown at an annual average of 7.6 percent, and the electrical industry at 13.6 percent. When it is considered that, in recent years, the basic petrochemical industry has grown proportionately more than the petroleum industry, (for example, a growth of 22 percent in 1972, while that of petroleum and coke was 6.2 percent and that of electricity 10.6 percent), it can be concluded that the petroleum sector is more dynamic than the electricity sector and that its growth is much more dynamic than that of the GIP.

#### Offer and Demand of Hydrocarbons

The offer of petroleum derivatives has basically been conditioned by the availability of natural resources and the characteristics of the demand, which has reflected the nature of the economic development of the country. The basic criterion, which has governed the production of petroleum derivatives, has been to satisfy the needs of the various sectors of the economy; that is, other criteria, such as that of obtaining adequate profit rates to use them in the internal development of the enterprise or in order to fortify the State's productive sector, have had to be considered secondary. The objective of satisfying national needs is, basically, the aim to subsidize the industrial and economic development of the country. (This subsidy has mainly been maintained via prices.) In this way, the objectives of stimulating the development and expansion of productive forces and of the social relations of production corresponding to Mexico's socioeconomic system have been met.

To justify the criterion of maintaining low prices in energy products on the basis that energy is characterized as a public service, or that an adequate offer should be maintained (even though this has not been achieved) at the cost of the company's rentability, is unacceptable. Behind this type of view, which is mainly ideological, lies the desire to shift towards private enterprise the economic surplus generated by PEMEX.

Hydrocarbons have represented and continue to represent a predominant proportion of final energy consumption, both in absolute and in relative terms (88.6 percent of total consumption). The historical tendency (from 1960 to 1972) is towards a relative decrease in fuel consumption and a relative increase in electricity, coal, and coke consumption. However, the increase in consumption of coal and coke has limited perspectives owing to the reduced deposits in the country. Electricity consumption will show a relative increase, but petroleum derivatives will continue to provide the fundamental supply of energy, since by 1982 hydrocarbons are calculated to represent 84.8 percent of total consumption, against 11.6 percent for electricity.

For 1972, the distribution or assignation of energy according to sectors in consumer structure was, in order of importance, as follows: 45.9 percent to industry; 39.3 percent to transport; 11 percent to the domestic

sector; 2 percent to agriculture; and 1.8 percent to others. The final destination of hydrocarbons in 1960 was: transport sector absorbed 55 percent of the total; industry, 20 percent; the domestic-commercial sector, 15 percent; and other sectors, 10 percent. From 1960 to 1972 the national total offer of hydrocarbons grew by 5.8 percent annually, whereas demand grew by 6.8 percent. As a result this deficit in demand had to be satisfied through imports. PEMEX covered 93.6 percent of internal demand with nationally produced petroleum derivatives, and imports amounted to 6.4 percent.

The main reason why, over this period, the rate of growth of the national offer was less than the demand lies basically in the fact that the internal capacity of the company was inadequate to increase and diversify Petr6leos Mexicanos' production in accordance with the national demand for hydrocarbons. Besides, when it is considered that the growth of national offer depends on the increase of available primary products (crude oil, gas, and absorption liquids) and in refining capacity, it is concluded that these sectors do not grow in an adequate proportion to satisfy national requirements. The correct explanation, which is accepted by the Director General of PEMEX, is that the company's lag, whereby it is unable to meet demand, arises from a growth rate hindered by financial conditions which are determined by price levels. The latter remained frozen for 15 years, despite the constant rise in costs and salaries (1), and this created a situation in which Petr6leos Mexicanos' financial resources slowly but inevitably dwindled in relative terms, when compared with the requirements that the company had to face. By 1973 this situation was complicated by the fact that the increasing dependence on imports (and the multiplication of petroleum derivatives' prices on international markets) led inevitably to a situation whereby "the secondary benefits obtained in terms of the economic growth of the country, on the basis of the financial sacrifice made by PEMEX which maintained the price of its products over a long period, began to be counterbalanced, and even exceeded, by the burden represented by the cost of these imports; by the increasing debt built up by the company in order to sustain minimal investment programs and thus maintain the rhythm of our development; and by the restrictions imposed on us by the scarcity of certain products on the world market (2)."

With PEMEX operating in these conditions, one inevitable result was that current expenses were financed more and more via credits, and that the company's capacity of investment declined. Indeed, it can be observed that investment in exploration deteriorated and was overtaken by that of refining and petrochemistry. In 1966, the wells perforated were 153, against only 143 in 1972; and the lowest level was reached in 1973, when 103 wells were perforated for exploratory purposes. Hence, there was the inevitable need, if greater instability was to be avoided, of reorienting PEMEX policy in relation to investments, increasing prices, selecting finance sources, purchasing products, equipment and technological development, etc. Over the last two years PEMEX modified its policy by increasing the sale price of its products. In fact, two increases have occurred in petroleum derivatives. One was promoted and

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(1) It is necessary to point out that production costs grew 13 percent annually until 1973, while income only grew 10 percent, as a result of the increased volume of sales, and not of increased prices. The behaviour of prices of petroleum derivatives has remained below the general index of prices, and petrochemical products even registered a constant fall.

(2) Jaime, Antonio Dovalf, General Director of PEMEX, Informe, March 18, 1974, pp. 4 and 5.

effected directly by PEMEX; the other occurred as a result of a tax on these derivatives aimed at increasing the resources of the Federal Government.

As a result of this policy of change, the total production of crude oils (condensed oils and absorption liquids) increased from 177,272,744 barrels per year in 1971 to 184 million barrels in 1974. This corresponds to a 25 percent increase as against 1973. In 1974, refining increased 11.8 percent as against 1973, and basic chemistry increased 13 percent as against the same year. This permitted the local demand to be met more fully with national products, which resulted in a saving of foreign currency, since imports, including the value of petrochemicals, were reduced by about five million pesos. Besides, as from September 1974, once refining capacity had been saturated with national production, excess volumes of crude oil were directed towards the export market. It is calculated that, when the three refineries now being built begin production, there will be volumes of distilled products in excess of the national consumption, which will have to be exported at better price conditions.

#### The Pattern of PEMEX's Demand for Products and Services

Petróleos Mexicanos is the largest industry in the State sector (in 1972 it represented 18 percent of public investment) and thus it shows a considerable demand for products, equipment, and technology, which constitute a quarter of its total spending. The primary products and equipment that it requires most (72 percent of the total spent in primary products and equipment) are chemical substances and primary products (which absorb 50 percent of the total value); tubing, tools and special perforation and production parts; internal combustion machinery parts; medicines and surgical products; valves; and containers and construction materials. Of the combination of these materials, those most imported are the following: perforation equipment parts; parts for turbine, steam motors, and compressors; and equipment as yet not produced in the country.

The Imports Committee for the Public Sector was created in 1959 in order to maintain a control on imports to relieve the growing pressure on this sector's balance of payments and to promote national manufacturers (3). In fact, PEMEX is the State Company with the largest proportion of public sector imports and this Committee has been unable to reduce PEMEX's growing importations. The relative and absolute decrease registered in 1975 was due to the fact that crude oil ceased to be imported and to the reduction of imports of certain petroleum derivatives. However, the importation of equipment parts and accessories for the

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(3) In this context we should recall declarations recently published to the effect that "the only serious attempt to favour national production of equipment and parts for PEMEX was cut short ten years ago by the company itself; the 50,000 plans for as many parts and machines which were already being manufactured here disappeared along with the Department of National Manufacturers. In the previous administration of PEMEX, this office was replaced by a private company. During the years of activity of the Department of National Manufacturers the company's imports of parts and equipment fell, in the metal-mechanical area alone, from 1200 million pesos per year to 600 or 700. At that time, anything from special bolts to catalytic reactors or cyclonic separators was made in Mexico. And also Latin America's largest heat changer. At present there is a list of parts which have open importation permission." (Excelsior, April 7th, 1974, information provided by the Head of the Department of National Manufacturers).

petroleum industry did not diminish. In general, PEMEX's main suppliers are connected with foreign investment.

### PEMEX's Financial Structure

PEMEX plays a key role in the country's economic growth because of the kind of generation, appropriation, and use of the excess value it produces.

The character of the appropriation of the excess value generated in PEMEX is what essentially conditions its use and destination. In a public enterprise the excess value does not necessarily have to take the form of profits. In fact, PEMEX has above all used the low prices of its petroleum derivatives as the basic means of transferring the excess value generated in the company and has used it to promote the economic growth of the country. This has brought PEMEX to a financial situation that prevents it from following a policy of internal accumulation in the face of the need to expand the petroleum industry to satisfy the needs of the different sectors of the economy. Thus PEMEX's expansion, which implies greater integration and diversification of the production process, supposes a considerable demand for various products and equipment, and also for new methods and technology necessary for the development of all PEMEX's activities. When the rise of the prices of products, equipment, and technology observed over the last few years is considered, it is clear that the investment has had to be increased considerably. However, since the financing of this investment could not be obtained via an increase in sale prices, outside sources had to be tapped. The evolution of the index of petroleum and basic petrochemical production prices has, in fact, remained relatively stable during the period from 1960 to 1972. This transmission, via prices, of the excess value generated in PEMEX, has been justified by the argument that the company fulfills a "public service" (which also supposes continuity, reliability, and low cost, which in turn imply serious restrictions to the selection of embodied and disembodied technology, since they reduce the company's risk tendency almost to nil).

Three matters of importance for the objectives of this study are outlined: the behaviour of investment over the last years, the growth of financing from outside the company, and the destination of investments.

There has been a growth of investment over the last 9 years of about 31 percent (annual average), the main increase being in the years 1966, 1967, 1973, and 1974. In 1968, investment increased very little compared with the previous year, and as from 1969 it decreased compared with the preceding years, only to regain a growth tendency in 1972. From 1965 to 1974, the sum of total investment was directed, in order of importance, towards works, perforation, and replacing and purchasing equipment (50.6, 32.98, and 16.4 percent, respectively). PEMEX's global investment began to decrease since 1967, and the elimination of PEMEX's passive capital began to reach really high levels (reaching 30 percent of the company's costs in 1971). On the other hand, the company's deficit began to grow rapidly, increasing from 2771 to 8924 million pesos from 1967 to 1971. The investment in works also fell from 2752 million pesos in 1967 to 1888 million in 1971 (precisely the year after which PEMEX's external financing showed greatest increases). Thus the refining capacity was reduced and the company was prevented from putting into motion all the projects required in order to satisfy the demands of the secondary petrochemical industry. Hydrocarbon imports and input imports for the secondary petrochemical industry made the country's balance of payments even worse.



When the evolution of income and expenses is analyzed, it can be seen that the situation had been getting more and more critical, until it was halted in 1974, when income shortened the gap between expenses. It must be assumed that if, beginning in the first year for which figures are available (1969), expenses grew faster than income, PEMEX would have been obliged to increase financing external to the company, basically to cover the growing costs of operation and of capital depreciation, since its investment fell between 1968 and 1971. The increase in external financing after 1972 was caused basically by the need to increase investment in order to improve conditions of offer. In 1972, 1973 and 1974, investment increased considerably. In 1972, investment in capital-increasing purchases rose very considerably, and to a lesser extent investment in works; whereas since 1973 investment has increased evenly in works, capital-increasing purchases, and perforation.

It is clear that, since 1972, it has been necessary to redirect PEMEX's productive and financial policy towards greater productive investment and towards the increase of petroleum derivatives prices. The increase in investment has been directed basically towards the production of crude oil and its derivatives, and petrochemical products, which at the same time implies greater expenditure in perforation, exploitation, refining, and the purchase of technology.

This policy of increasing the investment required to expand the company, to satisfy internal demand, and to reduce imports necessarily has implied increased indebtedness, though this problem has been absorbed with the exportation of crude oil beginning in September 1974. (In 1974 income rose 73.1 percent over the previous year, while expenses rose 19.52 percent.) It was precisely as a result of this that only 4179 million pesos of credits were obtained in 1974, against 10583 million in 1973, representing 11.4 percent expenses in 1974 and 34.4 percent in 1973.

It is clear that PEMEX depends basically on foreign credits for financing: 89.49 percent in 1974. The reorientation of the company's financial policy is thus inscribed within the framework of a considerable increase in the country's external debt.

When the credit sources on which PEMEX depends, whether they be banking institutions or suppliers and contractors, are examined in more detail, it can be observed that of the credits that are considered internal, NAFINSA is the main supplier, representing 7.31 percent of total credits. Funds obtained through emissions (internal credit) represent only 3.2 percent of total credits obtained by PEMEX in 1974. The banking institutions that lend to PEMEX are varied, the main ones being the Bank of America and the French American Banking Corporation. Of the total credits from abroad, revolving credits represent 53 percent, credit institutions absorb 43 percent, and suppliers and contractors 4 percent. This structure of the foreign credit open to PEMEX has followed the clear policy of financing selection laid out in the last few years; this policy has restricted credits from suppliers and this has permitted greater negotiating capacity in terms of the purchase of technology. It must be pointed out that many of these credits have been tied. The Eximbank credits, of course, imply the acquisition of goods produced by U.S. firms.

Finally, if PEMEX's productive sectors - exploration, refining, petrochemistry, and transport - are considered, when greater importance started to be attached to investment in petrochemistry, the latter absorbed 56.5 percent of the total investment in 1965, and by 1967 it represented 65 percent. All the basic petrochemistry plants constructed in 1973 represented on completion an investment of over 7900 million pesos. Refinery works were completed in 1974

at a cost of 74.2 million pesos, while in the petrochemical branch 12 works were completed at a cost of 1343.3 million pesos (4). These figures give an idea of the importance granted to the investment in petrochemistry in answer to the increasing demand from secondary petrochemical products.

### PEMEX's Technological Policy

In general, it can be affirmed that the technological behaviour followed by PEMEX has necessarily been subjected to its global strategy of promoting and stimulating the country's economic growth: the policy of purchases presumably tends to promote industries established on the national territory; the low-prices policy tends towards indebtedness and its result is that dependence on external credit increases technological dependence (for which reason it has been considered necessary to establish a policy of price adjustment, a more selective policy of finance selection, and the creation of the Mexican Petroleum Institute); the investment policy must of course establish priorities in the demand for products, equipment and technology, if the aim is to diversify and integrate the enterprise to satisfy increasing local demand.

The conjunction of a number of factors has caused PEMEX to depend basically on foreign technology. Principal among these factors are the following: the high level of financial dependence on foreign sources and the low institutional ability to generate, adapt, and transform scientific and technological knowledge. Apart from the fact that it has proved too costly for PEMEX in purely economic terms, this situation has, in turn, been a vehicle for consolidating the nation's financial and technological dependence on foreign countries. As already noted, although PEMEX has a low product-worker relation, due to the employment of more than 78 thousand workers, a big push was given in 1972 to the acquisition and replacement of equipment and technology, thereby provoking a considerable impact on the balance of payments because of their high cost. This has in part been absorbed by exporting crude oil and some derivatives, beginning in September 1974, and by the part played by the Mexican Petroleum Institute, which has developed its own technology in some of its fields of activity, as also by the changes generated in the licensing of the technology with the creation of the National Register of Technology Transference at the end of 1972.

To conclude, the predominant tendency so far has been that PEMEX's technology selection has been fulfilled in accordance with the technological universe presented by foreign firms. Most of the technology purchased by PEMEX is to be used in the refining and petrochemical processes, although some also was acquired to carry out exploration (particularly on very deep perforation or perforation on the continental shelf). Project engineering, which basically includes technical services, design projects, and construction, has also been purchased abroad, often in the form of "package" plants that involve a series of problems. Although the fitting and construction plans are generally well presented, the operation manuals are imprecise and lack fully explained instructions. As a result, when operational problems arise, additional consultation services are required, with the corresponding drain on foreign currency.

The central hypotheses of this study hold true for the company's practice of purchasing disembodied technology. The contradictions inherent

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(4) Report of the Director General of PEMEX, March 18, 1974.

in the role assigned to PEMEX in the Mexican economy (satisfaction of a growing demand for hydrocarbons; low-price maintenance in order to transfer the excess value generated within the company to the sectors of the economy; financial restrictions and growing outside indebtedness; the need to use "reliable and proven" technologies, and therefore a strong technological link with foreign sources) are reflected in its role as license-giver. The analysis of more than 40 contracts of license, technical services, and technical assistance showed that PEMEX has frequently acquired these services without concrete guidelines and without making an effort to learn the practices of contracting with outside technological sources (5). The analysis revealed that many contracts made before the Technology Transference Registration Law were of indefinite duration. An even more serious defect was the fact that frequently the contract was not clear as to its object: patents were negotiated without even defining precisely which ones were the object of the contract; the guarantee against patent invasion was of course forgotten as a result of this; and in most contracts the "know-how" definitions were inadequate or very general. Neither did PEMEX have precise guidelines for the most adequate mode of paying for the technology it received. In certain contracts, the licensing party used tricks in order to dilute its responsibilities: in one contract of license for technical knowledge and the provision of consultancy services, for example, the licensing party offered the technical knowledge "gratuitously" and only obtained a compensation for the consultancy services. If the technical knowledge proves defective, the licensing party can argue that it is not financially responsible, since its compensation stems from the consultancy services provided and not from the technical knowledge provided. In many contracts, payment is stipulated without a direct relation to the transferred technology. Besides, in some cases supplementary royalties are claimed for plant expansions, and this is inadmissible in international practice.

Not only were guarantees against patent invasion frequently lacking in these contracts, but guarantees of the correct development of the process itself were not included in most of them. This does not necessarily reflect negotiating incapacity on the part of the receiver, since in many cases a guarantee is hard to specify (for example, if the process produces a main product and various coproducts, or if the plant is multiproductive). However, it is possible to be more specific about the guarantees, rather than simply to make general mention of them (6).

One important aspect to be looked at in depth is the relation between PEMEX, the Petrochemical Commission (which functions in the National Patrimony Office), and the acquisition of technology for this branch of the industry. In principle, the basic petrochemical industry is reserved for the public sector (PEMEX or its affiliated companies), while national or foreign private enterprise (up to maximum of 40 percent) may intervene in the secondary petrochemical industry. It is up to the Petrochemical Commission (in which PEMEX participates through the Mexican Petroleum Institute) to define which products pertain to basic petrochemistry, and it is also up to the Commission to grant

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(5) The analysis was carried out by Dr. V.R.S. Arní, ONUDI consultant in 1974. The conclusions presented in this paper are taken from an interview with Dr. Arní and an analysis of his recommendations to Direction of Technology Transference.

(6) The guarantees may cover the volume of production, volume of inputs or primary products required, quality or purity of the product, critical consumption of primary products, critical occupation of equipment and installations, duration of catalyzing agents, wear of equipment, contamination levels of refuse, etc.

the corresponding permissions so that private investment may participate in the secondary petrochemical activities. By means of this mechanism, PEMEX could have begun some years ago a policy of centralized contracting in order to sublicense to various private investors. The advantages of this process are evident: a reduction in the amount of currency required to pay foreign suppliers; faster diffusion of acquired technology and promotion of a more competitive productive structure; and finally, a more intense standardization for machinery and equipment, inputs, and primary products (7). This possibility has been totally ignored and in 1971 there were 130 companies in the secondary petrochemical industry, most of them operating under technology contracts with foreign sources.

#### Buying Machinery and Equipment

There is a selective policy of financing for the purchase of machinery and equipment, which has rebounded favourably in technology negotiation and in PEMEX purchases. In 1967 and 1968, external credit from suppliers and contractors was, respectively, 1299 and 1095 million pesos; by 1974 credits from foreign suppliers and contractors amounted only to 154 million pesos. This indicates an improvement in interest rates, payment lapses, and periods of grace, in PEMEX's favour, and also more favourable negotiating conditions for the purchase of technology, when it is considered that suppliers generally concede credits tied to the purchase of materials, equipment, and technology. Although PEMEX tends supposedly to favour national suppliers in its purchases of machinery and equipment, imports have remained high. In 1973, the imports of PEMEX reached a figure of 1785 million pesos: equivalent to 25 percent of the total investment for the same year. This fact, of course, reveals the weakness in capital goods production for the process industry in Mexico. For certain types of projects (for example, ammoniac plants) the national component of the required equipment is particularly low. An idea of the requirements in imported capital goods is obtained from the following data: in 1971, PEMEX imported 40 percent of the processing columns, 55 percent of the pressure vessels, 70 percent of the heat interchangers, 40 percent of the pumps, and 70 percent of the compressors which it bought (8). Some of PEMEX's main national suppliers have pointed out, however, that they would be able to cover a greater demand from this company if payments were not delayed, because these companies have fairly high working capital requirements. The stranglehold on PEMEX's finances may thus have unfavourable repercussions on the capital goods industry.

#### Selection of Engineering Companies

After the oil expropriation occurred, PEMEX suffered a boycott organized by the big firms which, at that time, virtually monopolized the technology of the refining process. An embargo was also placed on Mexican purchases of various products and parts. This front, however, was not monolithic and a short time later some foreign firms decided to collaborate with PEMEX. (It is possible that the Second World War was the catalyzing agent, which made them decide to "collaborate" with a country that shortly before had nationalized the entire

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(7) It would, of course, be necessary to avoid the establishment of plants that operate at inefficient scales.

(8) Castillo, Arturo del. 1971. Equipment demand For Petróleos Mexicanos plants. Memory for the I Congress of the National Association of Engineering Firms, Mexico, p. 132.

oil industry.) It should be mentioned that in these first years PEMEX made very little use of the local engineering companies, apparently because of fears "that in the sociopolitical conditions of Mexico (at the time), politicians would impose unreliable candidates on them (9). The need for PEMEX to fulfill its mission satisfactorily seems to have played an important part: the required security kept the company safe from contracting with firms or individuals whose only merit lay in their relations and "contacts." Later, when the national companies had reached a considerable level of maturity, PEMEX was able to contract them for a variety of services. These have fundamentally included detail engineering services, supervision and inspection, the purchasing of equipment, preparation of tender documents, etc. In certain cases, national companies have been used to render services in basic engineering. The rendering of services, which we might call "secondary" (detail engineering, etc.), has been used to test and prepare local firms, and in certain cases these same firms have been able to render basic engineering services some years later.

It is revealed that, in the process of decision-making for the purchase of disembodied technology (licenses on patents and know-how, technical assistance, and consultation services), in the purchase of machinery and equipment, and in contracting with engineering firms, PEMEX has not followed very precise guidelines; it is difficult to find signs of a uniform technological behaviour pattern. The only thread linking all the company's decisions is the fact that behind them all there is a strategy of maximization of production aimed at fulfilling PEMEX's global function. However, it cannot be affirmed definitely that the company's performance in this area has been defective. There are many cases in which the participation of Mexican technicians has been sought in tasks of basic engineering entrusted to foreign companies; also, in several cases, the conditions stipulated in license contracts have been bettered (10). On the other hand, the policy of contracting national engineering firms for many projects has been decisive in promoting national engineering services; finally, the creation of the Mexican Petroleum Institute also says much for the company's technological effort. However, behind the strong dependence on foreign technological sources, there are contradictions which have been imposed on the company, in addition to its faulty and heavy administrative structure. The productive functions of the company constitute units, which, in the words of the executive interviewed, work "as different companies" in practice. This partly explains the lack of unified guidelines in the technological decisions of the company. In the future a deeper analysis of this point will be made.

#### Research and Development in the Oil Sector

The Mexican Petroleum Institute (IMP) was founded in 1965 as an autonomous entity with its own legal person and patrimony, in order to render to PEMEX the technological services it required in order to optimize its activity, expand and diversify its production, and reduce its technological dependence. The IMP was created at a stage when investment in exploration was decreasing and the company's indebtedness was beginning to increase. It began to function

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(9) Kamenetzky, Mario. 1975. Scale Engineering and Technology. Engineering and Industry of Processes in Argentina and Mexico. Buenos Aires, preliminary report, p. 269.

(10) It should be pointed out that, unlike other State companies and decentralized organizations, PEMEX has decided to collaborate closely with the Technology Transference Register in the negotiation of its contracts on licenses and technological services.

as a service unit for PEMEX. Its assignments have been varied, but have not tended towards basic investigation. On the contrary, its activity has been directed to solve PEMEX's problems, to such an extent that its main financial source has been constituted by the payment received from this company. Of its 1973 budget (183 million pesos) 97 percent was in payment of PEMEX orders, and the remaining 3 percent were orders from the private sector (11).

The functions of the IMP are: to carry out scientific and technological research in order to be of service to PEMEX for exploration, exploitation, refining, and petrochemical technology; to carry out basic process investigations in order to elaborate the chemical products required by the oil industry; to provide technical servicing of exploration, perforation, refining, and petrochemical works; to carry out project engineering; to prepare personnel, at various levels, both for PEMEX and for the Institute itself; and to carry out economic studies and industrial planning. The IMP's function is not limited to serving PEMEX absolutely; it also has the capacity (it is a decentralized organization) to license patents developed by other companies (nationally or internationally).

The IMP's basic achievements concern the development of production processes, refining, and petrochemistry, and approximately 130 patents have appeared in connection with these precise processes, of which 66 have been duly registered by the General Direction of Industrial Property. The IMP has participated in the development of refining and petrochemistry plant production. In 1974, for example, it completed the engineering for 11 refining and petrochemistry plants for Petróleos Mexicanos. The most outstanding is the ethane and liquefiable recuperation oreogenic plant of PEMEX in Tabasco, the engineering of which, both basic and detail, was developed by the IMP. It has begun the project engineering of 21 other plants, the total investment of which will exceed 6000 million pesos. In 1974, for the first time, it has exported technology to a highly developed country, the United States: two PEMEX plants which are to be set up in that country. This makes a total of four plants licensed, three abroad and one in Mexico. Together with the IMP, PEMEX has contracted seven new hydro-sulphur processing plants, to be installed in La Cangrejera and its new refineries (which brings the total of this type of plant to fourteen). The IMP has developed technologies for a plant which has already begun to operate, and for the production of four chemical specialties for private enterprise. It has continued research and technological development of additives and chemical products to subsidize imported products (among others, that incorporated in the new lead-petrol), and has worked to lay the design foundation for constructing hydro-sulphur processing catalyzers. The greatest efforts in basic process research have been directed towards studying the manufacturing, evaluation, and operation processes of catalyzers of hydro-sulphur processing, reforming, and also of those which tend to eliminate contaminating elements in the exhaust gasses of internal combustion engines. Three technological transference agreements have been signed with Ecuador and Venezuela, and the Institute has participated in international engineering bids in Peru and Venezuela. The technologies developed by the Institute have been promoted at a national level, with the result that three agreements have been signed with national companies. The IMP's activities have permitted considerable savings to be made for PEMEX, such as,

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(11) Information given by the Director General of the IMP in the questionnaire submitted by the STPI team.

for example, technical assistance in the elaboration of deemulsionating, deparafinizing agents, perforation fluids, etc., which obtained for PEMEX an accumulated saving of 26.8 million pesos and for the IMP a monetary entry in royalties of 2.1 million. The IMP has obtained royalties for technical assistance granted to industries, outside the field of petroleum, in the elaboration of rubber extension oils, demouling agents for concrete and tensoactive frames. Finally, the IMP has performed a very important function capacitating personnel for perforation activities, plant operation and maintenance, administration, etc. From 1967 to 1974, 686 specialization courses for qualified personnel were organized (approximately 10 percent of which were conducted by foreign experts), and 3423 courses were taken by over 55 thousand workers (12).

It should be stressed that, in fulfilling the activities entrusted to it, the IMP continues to depend to a considerable extent on external consultation mechanisms by means of technology contracts with highly developed countries. Thus, for example, the IMP has signed two contracts with Universal Oil Products for joint development of process technologies, and to give reliability for the commercial use of IMP developed technology. It also has an agreement with The Lummus Co. for joint development of process technology under adequate commercial conditions. The Universal Oil Products agreements establish that the royalties obtained at home and abroad for the licensing of jointly developed technology will be distributed between the two parties in the following manner: the party acting directly as license-giver will obtain 60 percent of royalties and the other party will obtain 40 percent. Unfortunately, the IMP will be the exclusive license-giver in Mexico, while Lummus or Universal Oil Products will be the exclusive license-givers in the rest of the world. In the future, the activity of the IMP, and the content and implications of these and other agreements, will be examined more closely. The IMP has used very distinguished foreign firms in order that some of its processes obtain the "reliability" demanded by PEMEX.

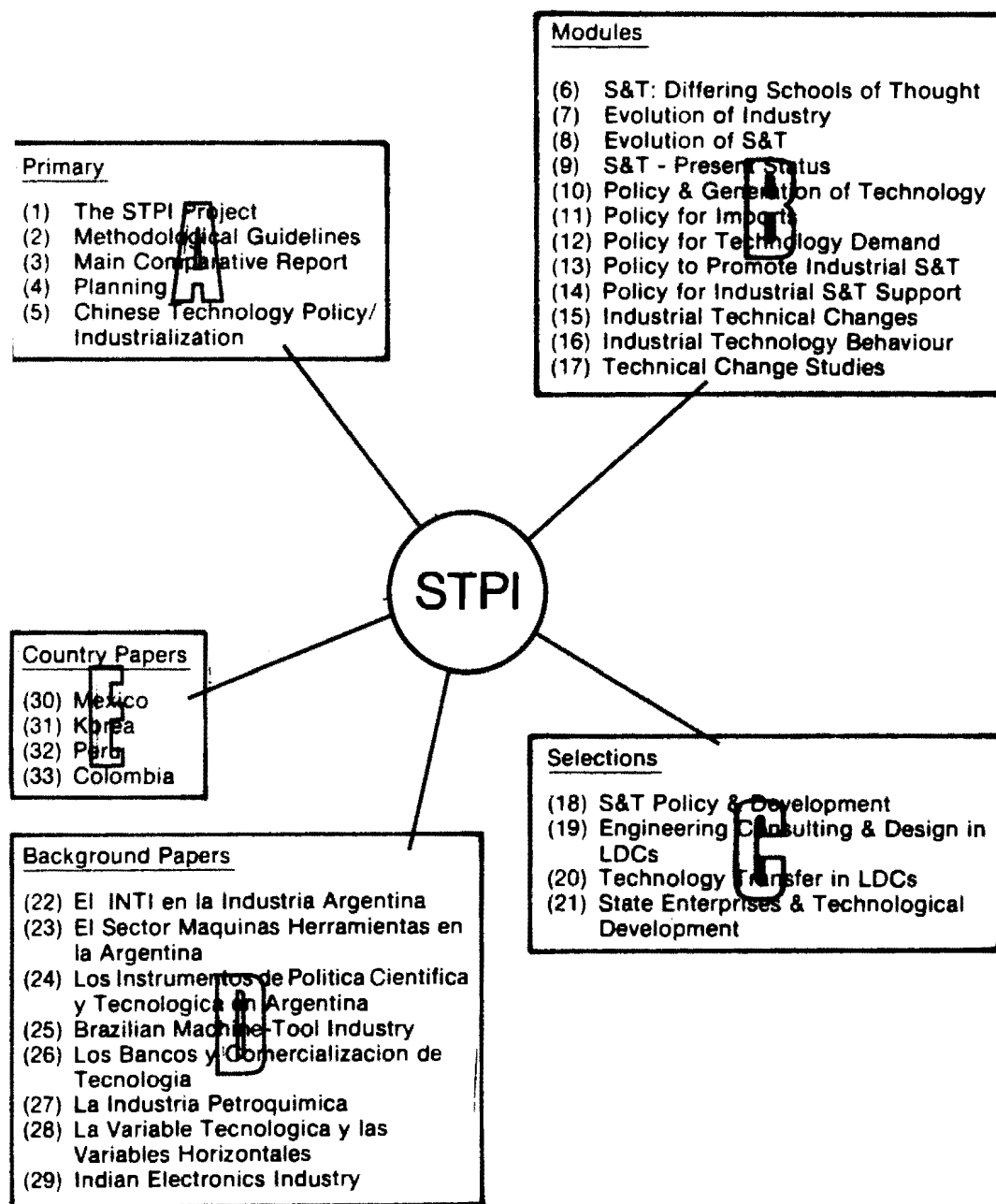
### Conclusions

In spite of IMP's effort, its extremely high standard of service, and its articulation to PEMEX, technological dependence is still one of the main characteristics of this State enterprise. Two factors can justify this apparent contradiction: Firstly, the pattern of financing imposed on PEMEX by the priority given to its subsidizing role to the industrial sector has weakened its own ability to provide internal funds for its expansion. Depending heavily on foreign finance, more often connected with bilateral and suppliers credits, PEMEX has less than the desired capacity to negotiate technology inputs. Secondly, a more favourable pattern of financing, together with some strong action by institutions to diminish imports of capital goods, would help it to achieve its goals only if articulated with policies giving incentives to the capital goods sector. This would demand, from the government, planning on a long-term basis, with the permanent dilemma of slowing down present development.

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(12) PEMEX, Memory of Activities for 1975; Kamenetzky, Y. Mario. Op. cit., p. 272.

## Key to STPI Publications





**A GUIDE TO THE  
SCIENCE AND TECHNOLOGY POLICY INSTRUMENTS  
(STPI) PUBLICATIONS**

**A. Primary Publications**

- (1) The Science and Technology Policy Instruments (STPI) Project (IDRC-050e) (out of print)
- (2) Science and Technology Policy Implementation in Less-Developed Countries: Methodological Guidelines for the STPI Project (IDRC-067e) (out of print)
- (3) Science and Technology for Development: Main Comparative Report of the STPI Project (IDRC-109e). (Also available in French (IDRC-109f) and Spanish (IDRC-109s).)
- (4) Science and Technology for Development: Planning in STPI Countries (IDRC-133e)
- (5) Science and Technology for Development: Technology Policy and Industrialization in the People's Republic of China (IDRC-130e)

**B. Modules**

These constitute the third part of (3) above and provide supporting material for the findings described and the assertions made in (3).

- (6) STPI Module 1: A Review of Schools of Thought on Science, Technology, Development, and Technical Change (IDRC-TS18e)
- (7) STPI Module 2: The Evolution of Industry in STPI Countries (IDRC-TS19e)
- (8) STPI Module 3: The Evolution of Science and Technology in STPI Countries (IDRC-TS20e)
- (9) STPI Module 4: The Present Situation of Science and Technology in the STPI Countries (IDRC-TS22e)
- (10) STPI Module 5: Policy Instruments to Build up an Infrastructure for the Generation of Technology (IDRC-TS26e)
- (11) STPI Module 6: Policy Instruments for the Regulation of Technology Imports (IDRC-TS33e)
- (12) STPI Module 7: Policy Instruments to Define the Pattern of Demand for Technology (IDRC-TS27e)
- (13) STPI Module 8: Policy Instruments to Promote the Performance of S and T Activities in Industrial Enterprises (IDRC-TS28e)
- (14) STPI Module 9: Policy Instruments for the Support of Industrial Science and Technology Activities (IDRC-TS29e)
- (15) STPI Module 10: Technical Changes in Industrial Branches (IDRC-TS31e)
- (16) STPI Module 11: Technology Behaviour of Industrial Enterprises (IDRC-TS32e)
- (17) STPI Module 12: Case Studies on Technical Change (IDRC-TS34e)

**C. Selections**

These are a selection of the numerous reports prepared for the STPI Project chosen as a representative sample of the various topics covered by the STPI Project in the course of the main research effort on policy design and implementation.

Science and Technology for Development: A Selection of Background Papers for the Main Comparative Report.

- (18) Part A: Science and Technology Policy and Development (IDRC-MR21)
- (19) Part B: Consulting and Design Engineering Capabilities in Developing Countries (IDRC-MR22)
- (20) Part C: Technology Transfer in Developing Countries (IDRC-MR23)
- (21) Part D: State Enterprises and Technological Development (IDRC-MR24)

**D. Background Papers**

- (22) El INTI y el Desarrollo Tecnológico en la Industria Argentina (In press)
- (23) El Sector Maquinas Herramientas en la Argentina (In press)
- (24) Los Instrumentos de Política Científica y Tecnológica en Argentina (In press)
- (25) The Brazilian Machine-Tool Industry: Patterns of Technological Transfer and the Role of the Government (In press)
- (26) Rol de los Bancos en la Comercialización de Tecnología (In press)
- (27) Comportamiento Tecnológico de las Empresas Mixtas en la Industria Petroquímica (In press)
- (28) Interrelación Entre la Variable Tecnológica y las Variables Horizontales: Comercio Exterior, Financiamiento e Inversión (In press)
- (29) A Planned Approach for the Growth of the Electronics Industry — A Case Study for India (In press)

**E. Country Reports**

- (30) Instruments of Science and Technology Policy in Mexico (In press)
- (31) Technology and Industrial Development in Korea (In press)
- (32) Los Instrumentos de Política Científica y Tecnológica en el Perú: Síntesis Final (In press)
- (33) STPI Country Report for Colombia (In press)

