TECHNOLOGY WITHIN NATIONALIZED ENTERPRISES:

A STUDY OF THE FACTORS INFLUENCING ITS ACQUISITION

AND DEVELOPMENT BY THE VENEZUELAN PETROLEUM INDUSTRY

by

JULIAN OBDULIO VILLALBA

M.S. Technology and Policy
Massachusetts Institute of Technology (1981)

M.A. The Fletcher School of Law and Diplomacy
Tufts University (1978)

Licenciado en Quimica
Universidad Central de Venezuela (1975)

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Signature of Author ______________________
Department of Chemical Engineering
February, 1982

Certified by ______________________
Raymond Baddour,
Chairman, Thesis Committee

Accepted by ______________________
Glenn Williams,
Chairman, Departmental Graduate Committee

ABSTRACT

TECHNOLOGY WITHIN NATIONALIZED ENTERPRISES: A STUDY OF THE FACTORS INFLUENCING ITS ACQUISITION AND DEVELOPMENT BY THE VENEZUELAN PETROLEUM INDUSTRY

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A study of the factors influencing the acquisition and development of technology by the Venezuelan petroleum industry was completed. These factors include historical, economical and political elements, in addition to the organizational factors which constitute the main focus of this study.

This study has a multidisciplinary orientation. Chemical engineering principles are used to classify and organize the information about technical assistance in a manner which allows a multivariate statistical analysis of the factors behind the choice of technology. Management principles provide the conceptual framework for designing the statistical tests and interpreting the results.

The results of this research have significant implications for the theory of technology choice. In a controlled experiment, we show that a host of personal characteristics, which are non-economical in nature, constitute major influences in the choice of sources for technical assistance. Most interesting, the corporate culture inherited from the ex-concessionaires appears as one of the most important of these factors. In other respects, this research contributes to the theory of transaction-cost economics by showing that that a whole set of cultural factors may account for the alleged superiority of the multi-divisional enterprise over other forms of organization.

From another perspective, this research contributes to the understanding of the technology transfer process at the firm level. Therefore, it provides an improved basis for the prescription of policy in this area. For instance, this thesis shows that technological dependence may have psychological roots which are traceable to the presence of foreign investors, along with their corporate cultures, in the host countries.

In regard to technology acquisition, this thesis establishes that certain personal characteristics of the selectors of sources of technical assistance, which are traceable to a process of "acculturation" undergone within the ex-concessionaires, have a major impact on the patterns of technical assistance received by this industry. Other elements of structure and strategy, all discussed within this study, do not appear to be as important.

In regard to technology development, this thesis analyzes the demand for indigenous technology by potential users, the capacity of the industry to conduct R & D, and the conditions which are most associated with apparent R & D success. This research establishes that the demand for indigenous technology by the potential users of such technology -- the operating ranks-- is minimal compared to the demand from researchers themselves. The capacity of the industry to carry out R & D activities seems adequate when compared with that of other oil companies. Finally, this study has found that professional background --several branches of engineering versus scientists-- is the characteristic of the project originator most related to R & D success.

This thesis concludes with a series of recommendations to the Venezuelan petroleum industry in the two areas studied, acquisition and development of technology. In regard to the acquisition of technology, it is recommended, 1) the implementation of several measures to counteract the negative effects of cultural biases at the corporate and divisional levels and, 2) the creation of a network of technological information including all the branches of the industry. In regard to the development of technology, it is recommended, 1) the modification of existing policies for the acquisition of research personnel, 2) the reduction of the proliferation of research projects, 3) the implementation of certain measures to improve the flow of information among researchers and, 4) the creation of knowledge-application incentives within existing management education programs.

INTERDEPARTAMENTAL COMMITTEE:

Raymond Baddour, Lammot Du Pont Professor of Chemical Engineering (Chairman).

Dorothy Leonard-Barton, Assistant Professor, Sloan School of Management.

Donald Lessard, Associate Professor, Sloan School of Management.

Richard Robinson, Professor, Sloan School of Management.

PREFACE

On January first, 1976, after more than sixty years of oil exploitation by foreign firms, Venezuela nationalized its petroleum industry. With this decision, this country completed a long process of acquiring control over its most valuable natural resource which had started as early as 1936, with the death of the dictator Juan Vicente Gomez. Despite intentions to the contrary, this control remains in part nominal because the newly nationalized industry has continued to rely on the ex-concessionaires for vital technological inputs. While all oil firms acquire technology from outside sources, the political and economic importance of the oil industry in Venezuela largely justifies an interest in diversifying the sources of such technology.

This thesis deals with technological aspects of the Venezuelan petroleum industry. In particular, it examines the factors which influence the acquisition of technological support and the development of technological capabilities by this newly nationalized industry. To this end, we have adopted a broad view and tried to cover not only those influences which are internal to the industry but, also, those which derive from its historical, political and economic context. However, the most distinguishing characteristic of this research is its emphasis in behavioral and organizational influences upon the patterns of technology acquisition and development.

Origin of this Study

This project was undertaken at the request of the Venezuelan Ministry of Mines and Hydrocarbons, whose legal mandate includes the supervision of the technological aspects of the petroleum industry. Five years after nationalization, the monetary magnitude and political content of the technical assistance received by the industry had demonstrated the need to conduct a comprehensive study of the factors that may constrain the diversification of the technological sources of the industry. Showing uncommon foresight, the ministry recognized that the fulfillment of its daily administrative duties curtailed its ability to conduct such an ambitious study.

Fortunately, the need of the Ministry of Mines coincided with this author's long-standing interest in the subject of technology transfer. From this original stage, the research project underwent a series of modifications which were required to accommodate the interests of the two parties involved. The project became more manageable when the original interest in reviewing the market for technical assistance was dropped, as it became clear that the supply of technical assistance from outside sources was not a limiting factor. A study of the internal supply of technology, i.e. R & D, was added. Its orientation was changed further when this author's preconceptions about the importance of negotiation were not supported by the reality of the industry's successful negotiating performance *vis a vis* its relative failure to take advantage of the favorable terms it had negotiated. The study became more "academic" when it was agreed that the project was going to be more than a diagnosis, however extensive, and that one of its main goals would be the development of a theoretical framework. In the end, however, the study retained its original practical orientation.

The institutional and financial support required for the completion of this project was assigned to INTEVEP, the research and development branch of the Venezuelan petroleum industry. The support of the other domestic oil companies was obtained during several stages of this project.

It is important to stress at this point that this research is not aimed at criticizing the Venezuelan petroleum industry, or its employees, but at understanding the way they behave regarding the acquisition and development of technology. It is hoped that this investigation will provide the industry's managers with useful insights for a more rational utilization of the technological inputs in their operations.

Acknowledgments

In a project of this nature it is impossible to acknowledge the help of all those who made it possible. Nevertheless I would like to start a long list by thanking the members of my doctoral committee, Professors Raymond Baddour (chairman), Dorothy Leonard-Barton, Donald Lessard, and Richard Robinson, for their overall support during my studies at M.I.T. and during the course of this research project. I truly believe that the extent of their comments, critiques and help went beyond the call of duty. To them I remain most grateful.

Similarly, I want to thank the members of INTEVEP's planning department whose help was crucial for the completion of this research. In particular, I want to mention my former classmate Kenneth Colli, for all his intellectual and logistic support, and Mirna Arispe and Antonio Rodriguez for their tireless efforts in solving a myriad of administrative and logistic problems. I would also like to acknowledge the support of Evanàn Romero and Carlos Corrie who allowed me to start this research project in the first place.

Individuals from all the affiliates of the industry graciously provided essential institutional and intellectual support for the the realization of this project. In particular, I want to thank Julio Cèsar Porras of LAGOVEN; Luis Mantellini, Pedro Aranguren, Coromoto de Kutziniski and Pedro Màrquez, of MARAVEN; Julian Flezcinski and Oswaldo Cortez, of MENEVEN; and Agustìn Lleras of PDVSA. I remain most grateful to all them.

The financial support of CONICIT throughout my entire stay as a graduate student is gratefully acknowledged.

I want to thank my fellow students from the International

Management Group of the Sloan School of Management, Lutz Alt, Doris Cheng, Yongwook Jun, Jan Katz, Bruce Kogut and David Sharp for their continuous encouragement and criticism throughout the course of this research.

The greatest thanks of all go to my wife, Clara. She not only supported me throughout my whole program of studies but, also, undertook the almost impossible task of typing this thesis while taking care of our small daughter, Sofia.

Needless to say, I remain responsible for all the viewpoints expressed in this study.

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CHAPTER I

THEORETICAL FRAMEWORK

A. INTRODUCTION

This thesis is concerned with the general problem of technology use by the Venezuelan petroleum industry. The crucial role played by this industry in the Venezuelan economy has led us to analyze the problem within a global perspective, covering historical, economical and political elements, in addition to the organizational factors which constitute the main focus of this study.

The results of this research have significant implications for the theory of technology choice. In a controlled experiment, we show that a host of personal characteristics, which are non-economical in nature, constitute major influences in the choice of sources for technical assistance. Most interesting, the corporate culture inherited from the ex-concessionaires appears as one of the most important of these factors. In other respects, this research contributes to the theory of transaction-cost economics by showing that that a whole set of cultural factors may account for the alleged superiority of the multi-divisional enterprise over other forms of organization.

From another perspective, this research contributes to the understanding of the technology transfer process at the firm level. Therefore, it provides an improved basis for the prescription of policy in this area. For instance, this thesis shows that technological dependence may have psychological roots which are traceable to the presence of foreign investors, along with their corporate cultures, in the host countries.

The two processes of technology acquisition and development are covered in this study. In regard to technology acquisition, we have interpreted the fact that this industry did not exploit the important contractual gains it obtained after 1979 during negotiations with the oil multinationals to mean that lack of bargaining capacity does not constitute a major obstacle to the transfer of technology. Accordingly, this study concentrates on the analysis of individual and organizational characteristics which may influence choices of technology and the transfer of technological information across the organizations under study. Negotiation issues, such as bargaining power asymmetries and contractual terminology, are not explored deeply since, as we mentioned before, they do not appear to be critical in this case.

This thesis establishes that certain personal characteristics of the selectors of sources of technical assistance, which are traceable to a process of "acculturation" undergone within the ex-concessionaires, have a major impact on the patterns of technical assistance received by this industry. Other elements of structure and strategy, all discussed within this study, do not appear to be as important.

In regard to technology development, this thesis analyzes the demand for indigenous technology by potential users, the capacity of the industry to conduct R & D, and the conditions which are most associated with apparent R & D success. This research establishes that the demand for indigenous technology by the potential users of such technology -- the operating ranks-- is minimal compared to the demand from researchers themselves. The capacity of the industry to carry out R & D activities seems adequate when compared with that of other oil companies. Finally, this study has found that professional background --several branches of engineering versus scientists-- is the characteristic of the project originator most related to R & D success.

This thesis concludes with a series of recommendations to the Venezuelan petroleum industry in the two areas studied, acquisition and development of technology. In regard to the acquisition of technology, it is recommended, 1) the implementation of several measures to counteract the negative effects of cultural biases at the corporate and divisional levels and, 2) the creation of a network of technological information including all the branches of the industry. In regard to the development of technology, it is recommended, 1) the modification of existing policies for the acquisition of research personnel, 2) the reduction of the proliferation of research projects, 3) the implementation of certain measures to improve the flow of information among researchers and, 4) the modification of existing management education programs.

1. Purpose of this Study

The purpose of this study is twofold:

1) to study the processes of acquisition and development of technology within the Venezuelan petroleum industry, and

2) to develop a set of strategic recommendations for the rational use of internal as well as external sources of technical assistance.

Hence, this thesis has both academic and practical objectives. In fulfilling the first set of objectives, it scrutinizes the effects of a series of elements, internal as well as external to the industry, upon the patterns of acquisition and development of technology by the Venezuelan petroleum industry. The exogenous factors are studied first. They include the historical, legal and economic elements that configure the the environment of the Venezuelan petroleum industry. The endogenous factors are studied last, and include, among others, corporate culture, organizational structure, internal availability of technical resources. We expect this study to yield general knowledge applicable to the design and development of technological policies within state-owned enterprises, as well as to the management of contractual relationships, primarily in the technological area, with this type of enterprises. In fulfillment of its practical objectives, this study uses the results from its theoretical and empirical analysis to develop a set of strategic recommendations for the Venezuelan petroleum industry.

2. Research Design

In this thesis we deal with the two processes of technology transfer and technology generation. Technology transfer is a complex process, constituted by several consecutive and interdependent steps. These steps are: 1) selection of technologies to be transferred, 2) selection of potential suppliers for these technologies, 3)negotiations of the terms of transfer, 4) use of the technologies, and 5) assimilation or learning of these technologies.

This multi-stage view of technology transfer has several practical consequences. In the first place, any serious attempt to build positive theory about this process has to consider its complexities. This means studying the various stages and their interdependencies or, in the case of partial analyses, justify the exclusion of stages from the analysis. In the second place, it must be recognized that failure in the whole process of technology transfer[1] may result from one general reason, e.g. lack of information, from specific reasons which are characteristic of each step, or as a result of negative interdependencies among the steps. Of course,

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1- Failure of the process of technology transfer, in this context, refers to the situation in which it is not completed in its entirety (i.e. all five steps), too slowly, or very partially. This is a very subjective definition which requires more precision prior to its application to any particular case.

market conditions and some characteristics of the receivers of technology can reduce the number of feasible strategies to a point in which the strategic and organizational solutions to any given step are trivial.

In this research we perform a partial analysis of the process of technology transfer which is fully consistent with the multi-stage view mentioned above. Although we deal here only with step two, the selection of potential suppliers of technology, we have taken steps to ensure that our analysis is not unduly affected by influences from other stages. To be sure, we have been aided in this aspect by the characteristics of the situation under study.

In regard to the first step, selection of technologies to be transferred, we have taken steps to eliminate from our study all those cases in which this decision is <u>not</u> trivial. This means that we have considered only those technologies which were in place, and for which technical assistance was required, during the period under study. In short, the choice of the technologies to be transferred is not a part of the phenomena under study.

In regard to the second step, the selection of potential suppliers for the technology to be transferred, legitimate questions may arise about the availability of sources for technical assistance. This is a significant observation since constraints on the supply of technology could mean that the study of the selection of sources of technical assistance is a trivial task as managers are exogenously "forced" to choose certain suppliers. Therefore, it is important, even at this early stage, to point out that the types of technologies being analyzed (see appendix V-A for details) are such that there is a relatively wide range of potential suppliers of technology.[2] Indeed, in the sample we analyze (table 14), 50 % of the transfers come from multinational oil firms, 22 % comes from independent foreign firms, and 27 % comes from Venezuelan firms (approximate, due to rounding error).

Another question about the second step is related to the one just discussed. In particular, we may want to know why the oil multinationals, whose main business is the production, refining and sale of oil and related products have any interest in becoming suppliers of technical services, e.g. suppliers of technology. Again, this is an important observation because it is conceivable that the terms of these technology transfers are just ancillary results of oil deals, thus being determined by factors external to the managers of the industry. Our answer to this query is twofold.

2- The terminology used within the Venezuelan petroleum industry refers to these transfers as "asistencia têcnica" (technical assistance), or "apoyo tècnico" (technical support), as different from "proyectos mayores" (major projects), a category which includes new investments involving the use of new proprietary technology.

First, the record (Vicker, 1978) shows that the multinational oil companies have become de_facto major worldwide suppliers of petroleum technology to oil producing countries. Essentially all OPEC members have entered agreements with these companies involving the supply of technology and, most important, the oil companies have been willing to sign the agreements. The reasons behind this evolution are difficult to establish. However, in a well-supported opinion, Levy (1982) contends that entry barriers have been reduced in all stages of the oil business, including downstream distribution. Thus the oil companies are being "forced" to rely on their most legitimate source of comparative advantage: technological know-how, in order to get their profits. This argument implies that they would be willing to supply technology even in the absence of oil dealings.[3]

Second, we provide evidence (see chapters IV and V for details) which indicates that the Venezuelan oil companies have diversified their sources of technology to include independent firms, even under the presence of contractual arrangements for the sale of oil and the transfer of technology with the majors. Thus, the provision of technology does

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3- Supporting this view is the fact that in the last issues of some trade publications, for example the "1982 Refining Handbook" of the magazine Hydrocarbon_Processing, most of the large oil companies (including Exxon, Gulf,Mobil and Shell) appear as licensors of refining processes, side by side with independent engineering firms.

appear to be an activity independent from oil purchasing.[4]

In regard to the third step of the technology transfer process, negotiation with potential suppliers, we provide evidence to show that the contractual terms obtained through negotiation are quite favorable (table 3), and that these terms have not been fully utilized (table 8). Moreover, the previous paragraph indicates that the existence of technical assistance contracts with the oil multinationals have not restrained Venezuelans from looking at alternate sources for technology. In short, negotiation does not seem to pose a major barrier for the transfer of technology to the Venezuelan petroleum industry.

In regard to the last two steps of the technology transfer process, the use and assimilation of technologies, we can safely exclude them from our study as we have confined our analysis to just one year, 1980. Therefore, learning/use effects, although expected with successive applications of these technologies, are not likely to influence our results. By the same token, our conclusions cannot be related to these two steps of the technology transfer process.

Summarizing, this study avoids unaccountable effects arising from the complex nature of the process of technology

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4- Moreover, independence seems further guaranteed by the fact that those individuals (in Venezuela) who deal in the sale of oil to the multinationals are quite separate from those who select the different sources of technology.

transfer, both because of the situation studied and the steps taken in the study. Thus, external validity is assured to the extent possible in this type of study.

The process of technology generation also is a complex process. However, our interest here is not to analyze the process as a whole but, rather, to diagnose the potential capabilities of the Venezuelan petroleum industry to undertake this activity. The reason for this orientation is, quite simply, that in our opinion there is not a sufficient R & D track record within this industry for us to undertake a process-oriented study. Nevertheless, we have made a partial start in this direction by performing a multivariate analysis of the relationship between certain organizational/individual variables and perceptions (by users) of R & D success.

Our empirical study of the step of selecting sources for technical assistance, together with further details of the research design, is included in chapter V. The study of technology generation, together with further details of the research design, is included in chapter VI.

3. Organization of this Study

As noted, this thesis seeks to study the bases for the pattern of choices of technology followed by the Venezuelan petroleum industry. To this end, we have adopted an expository scheme which is very common for the study of organizational processes (Mintzberg, 1977). Stated simply, we have classified the factors influencing the processes of acquisition and development of technology using two organizing dimensions. The first considers that factors, or influences, can be _exogenous_ or _endogenous_ to the industry. The second, on the other hand, captures the fact that some of these factors can be subject to _design_ or control, while others represent characteristics, or _contingencies_, of the situation. In our case, all external factors appear to be contingent, and labeled as environmental, while internal ones comprise both contingent and design factors.[5]

The environmental influences, or factors, studied here include historical influences, the legal framework, fiscal policy, and government infrastructure. The term "historical influences" is used to denote attitudes, structures, and administrative processes whose origin is traceable to the concessionary period. The other elements fit the category of historical influences but, in our opinion, have enough peculiarities to deserve separate attention. In all cases, these elements represent important influences within today's nationalized industry.

5-As we describe in detail later, these two dimensions not only reflect the obvious distinction between external and internal factors but, also, the well established tradition of research in organizational theory known as "contingency theory" (Lawrence and Lorsch, 1967; Woodward, 1965).

The "design" factors encompass those elements that can be manipulated by the industry's managers.[6] In general, these factors include strategy and structure at the corporate and divisional levels. The internal contingent factors, on the other hand, are summarized in this work under the single label of "corporate culture." In the context of this work, this term is used to encompass a whole series of attitudes and behaviors which unify (or separate) the different organizational units above and beyond the degree required by the structure and administrative processes.

Contents

The above discussion notwithstanding, we have chosen to analyze the historical influences at the beginning (this also helps the exposition in later chapters). The design factors are analyzed afterwards. The internal contingent factors are studied next as a part of a research design which is aimed at separating the effect of contingent factors (culture related) from those of the design factors. The particular characteristics of the research and development activity in itself have led us to study it in a separate chapter where the two types of factors, design and contin-

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6-Given the size and influence of the petroleum industry in Venezuela, it can conceivably manipulate some of the elements we categorized as environmental (governmental infrastructure, for example).

gent, are studied together. The content of the chapters is the following:

The first chapter has four sections. The first spells out the purpose and significance of the study and describes the organization of the research project. The next section presents a critical review of the literature on international technology transfer and state-owned enterprises. The third section assembles concepts from several areas of organization theory to produce the theoretical framework guiding our research.

The second chapter is devoted to the study of environmental factors. This chapter starts with a review of the historical record of the Venezuelan petroleum industry and the structural aspects of the concessionary period. These two sections explore the historical origins of several important aspects of today's industry such as inter-concessionary rivalry and the strong attitudes of governmental ranks toward the industry. Finally, the chapter ends with a description of the technological status of the industry, at the moment of nationalization, as related to the historical influences described earlier.

The third chapter, set in the nationalized period, attempts to establish the influence of corporate strategy and structure upon the technological function of the nationalized industry. This analysis shows, however, that the distinction between design and contingent influences is not very clear, as the government plays a significant role in strategy formulation at the corporate level. This chapter is organized as follows: first, it starts by describing how nationalization has changed the technological needs of the industry; second, it analyzes the effects of the early strategical orientation towards continuity upon the structure and technological preferences of the industry; third, it analyzes the effect that a gradual switch in strategy, from an emphasis on continuity to one on efficiency, has had upon the technology function of the industry.

The fourth chapter maintains the emphasis on design factors. This time, however, we are interested in strategies, and corresponding structures, which were specifically devised to guide and support the acquisition of technology (development of technology is covered in a separate chapter, the sixth). This chapter starts with a review of the technological needs of the industry as they are generated by the elements so far analyzed. Then, it reviews and analyzes the performance of the infrastructure in charge of technology acquisition. The last section shows the overall patterns of technical assistance which have resulted from the action of the elements described in these chapters. The showing of the patterns ends with a summary which sets the stage for the analysis of the next chapter.

The fifth chapter studies the selection of sources for technical assistance. In particular, we analyze a set of factors that lie behind the apparently incongruent patterns of technical assistance shown in the previous chapter. These factors belong both to the "contingent" and "design" categories defined earlier . An empirical test is used to separate the effects of the two types of factors. This is an important task since, as is elaborated within this chapter the strategic solution to handle each one of them (the effects) is different. The chapter comprises three sections. In the first section, we describe the substance of the tests and operationalize several hypotheses. In the second section, we describe the results. Finally, in the third section we discuss the implications of the results.

The sixth chapter is devoted to the study of R&D within the Venezuelan petroleum industry. The newness of this activity within the industry, as well as some of its intrinsic characteristics, have led us to employ a different method of analysis. In this case we are not only interested in analyzing the demand for indigenous technological support but, also, whether its supply is adequate in terms of quality and quantity; and this means examining the organizational structure of INTEVEP, the R&D subsidiary. This chapter starts with a short review of the process of the creation and the later expansion of this affiliate. The next section lays out the study of the structure of INTEVEP. The third examines the factors which determine the demand for the technical assistance provided by INTEVEP. The final section provides several conclusions and strategic recommendations.

The seventh chapter provides the conclusions of this thesis and makes recommendations for future research. Further, it fulfills the practical objectives enunciated earlier by providing a set of strategic recommendations for rationalizing the use of technology within the Venezuelan petroleum industry.

4. Significance of this Study

Among studies of international technology transfer, this thesis is original in its systematic analysis of behavioral and organizational elements. Although several studies with this orientation do exist (Fairchild, 1979; Hawrylyshyn, 1977; Morley & Smith, 1979; Wells, 1974), they tend to be idiosyncratic or to consist of case studies whose generality can be called into question.

The conventional view of technology transfer (United Nations, 1978), on the other hand, is primarily economic and assumes that the process of selection of technology is a neutral one amenable to technocratic solutions. While we believe that economic analysis is important, we do not share the view that the economic tools (project evaluation and so forth) are sufficient to describe the way managers evaluate technological alternatives and, therefore, adequate to support the prescription of governmental policy.

The significance of this research project is further enhanced by several factors. For one thing, the development of appropriate technological strategies for newly nationalized industries may have noticeable effects on their performance. The healthy functioning of these firms is a requisite for the maintenance of political and institutional stability not only in Venezuela, but elsewhere in the third world where similar industries have been nationalized. From a different position, it is becoming more and more important, for both multinational firms and their home countries, to obtain a view of the balance of rewards associated with post-nationalization relationships. This kind of research could lead to the inclusion of post-nationalization variables in the analysis of foreign investment projects.

From a theoretical perspective, this thesis makes several contributions. First, it enriches the theory of technological change because it challenges the well rooted assumption that technology choice is an objective process of selection of inputs. In this area, it provides first-hand evidence, obtained perhaps for the first time, within a highly-controlled, empirical investigation of the organizational factors behind non-economic choices of technology. Second, by virtue of its design, this research makes a contribution to the theory of transaction-cost economics. Specifically, the tests performed in this work explore a whole new set of factors which may account for the alleged superiority of multi-divisional over functional firms --an important hypothesis of that body of economic theory.

Finally, this thesis contributes to ongoing discussions on Third-World economic development by showing that technological dependence may have long-lasting effects traceable to the presence of foreign investors in less developed countries. Significant policy prescriptions can be drawn on this basis, but this task is beyond the scope of this thesis.

B. TECHNOLOGY IN STATE-OWNED ENTERPRISES: REVIEW OF CURRENT RESEARCH.

This research project is concerned with a range of questions about the acquisition and generation of technology within Petroleos de Venezuela, a large state-owned enterprise created through nationalization. Our goal is to produce knowledge useful for managers who are occupied with technological questions.

The orientation of this work is eclectic because, as with any real problem, the study of technological strategies in state-owned enterprises demands inputs from several disciplines. In principle, we should be able to draw material from several "mature" bodies of research such as those dealing with international technology transfer, state-owned enterprises or economic development. Further, within each, we should be able to find studies focusing on the generation and acquisition of technology. Given the relatively large number of enterprises with similar histories, we might have expected to find a substantial number of studies with a similar focus. As we show in the next paragraphs, the opposite is the case. There is virtually no literature dealing with technology within newly nationalized enterprises.

1. International Technology Transfer

In terms of the number of publications, international technology transfer surely ranks among the most popular subjects of the social sciences. Unfortunately, quantity does not lead to consistency, and the whole area remains without any established theory useful for governmental policy-making or private strategic planning.[7]

This situation is certainly not rare in areas of research with an international focus. Strong barriers of culture and language, differences in the academic preparation of researchers and geographical distance, to cite only three factors, impair the cross-fertilization of research efforts, limit the generality of the empirical results and, most importantly, reduce the chances of peer review. In the field of international technology transfer, however, we believe that there are more specific reasons for the lack of agreement among researchers.

First, the study of the process of international technology transfer has always been linked to the even broader fields of development and dependence. There, it has been analyzed as a problem of political economy and, consequently, has become a fertile ground for discussions of political nature. Perhaps for this same reason, researchers in the field became polarized into two tendencies --"radical" and

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7-A recent review of 240 papers on technology transfer matters is very appropriately entitled: "Chaotic Economics of Technological Change: A Systematization through Technology Choice", (Vitelly, 1982). For another set of state-of-the-art reviews, see a 1981 special issue of the Annals of the American Academy of Social Sciences which is devoted to International Technology Transfer.

an "orthodox"-- even before they had time to examine more practical aspects of this process.[8] From the point of view of governments, the polarization among researchers meant that any technological policy, no matter how small in scope, was to be regarded as a statement of one of the positions and, therefore, subject to attack or sabotage by the opposite side.

Second, as a result of its predominantly economic focus, research on international technology transfer has traditionally entertained only very broad questions of governmental policy (international codes of conduct, institution building, etc.) or the use of tools of economic analysis (project evaluation, for example) in the evaluation of technological alternatives.[9] Consistent with the tradition of the economic profession, many studies in this area suggest complete re-

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8-In our context, the term "radical" refers to the position which is almost exclusively concerned with the negative effects and high costs of foreign technologies. For a classic statements of this "radical" position see Stewart (1979) and Clark (1975). The "orthodox" position, on the other hand, stresses the social benefits of international technology transfer and tends to justify high costs and other rewards as necessary prices to pay for development and to maintain high quality transfer. For a classical statement of this position, see for example, Behrman (1974), and Behrman and Wallender (1977). Some writings (Naim, 1979; United Nations, 1979) make reference to a third, eclectic, position termed as "reformist."

9- The two classic works in project evaluation are the UNIDO (1972) report and Little and Mirrlees (1974). Two works devoted specifically to the evaluation of technology transfer agreements are Fernandes (1981), Janiszewski (1981), and UNIDO (1979).

liance on the government to foster technological development. One consequence is what Avalos (1981) has called "illusory planning." That is, planning for planning's sake. Perhaps for the same reason, many papers in this area tend to be tautological. For example, in a recent symposium on "Science and Technology in Development Planning," Hodara argued that[10] long-range planning must:

> "identify alternatives, reduce uncertainty, forecast the approximate duration of key processes, find functional equivalents, sponsor public experiments of new lifestyles, and identify and reconstruct the intellectual framework guiding the action of the hegemonic governments and multinational corporations." [11]

One may want to ask whether a country which is capable of performing all these functions can be considered underdeveloped.

Despite indications to the contrary, we do not want to deny the importance of studying technology transfer as a problem of political economy. We are aware of the possible strong effects that technology transfer can have upon the patterns of income distribution and employment of less developed countries (Cooper, 1974; Hellinger and Hellinger, 1975). We contend, however, that this body of research (hereinafter called "traditional") has overstated the role

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10- This discussion borrows from Villalba (1982-b) and Naim, Piñango and Villalba (1982).

11- Hodara (1981), op. cit.

of government in the technology transfer process as well as its capacity to influence the terms under which this transfer takes place. Because of this, we argue, it has diverted attention away from the study of many managerial questions which are equally important in the development process.

The lack of managerial emphasis is particularly obvious in the area of technology acquisition. In dealing with this activity, the traditional approach contends, we believe correctly, that active government intervention can increase the bargaining power of technology buyers within the limits posed by the competitiveness of the market.[12] However, little or no reference is made to how organizational elements may affect the use and learning of the technology transferred. This is a significant omission because, as experience reveals (Naim, 1980; Bennet and Sharpe, 1980), the ultimate outcomes of these negotiations depend on the capacity of the prospective receivers of technology to realize their potential bargaining power.[13]

12- Government intervention refers, in this case, not only to the prohibition of monopolistic practices in the pricing and bundling of technology but, also, to the provision of information to the buyers.

13- Our opinion in this regard was strengthened further when one of our original assumptions, that negotiation was the most critical step in the acquisition of technology, was not supported by the evidence. This result seemed at odds with the emphasis that the traditional literature gives to negotiation. We have to recognize, however, that the managers we are studying here have had a level of experience in dealing with multinational corporations which may be lacking in other countries.

Another important problem of the traditional approach, also relevant to technology acquisition, is its assumption that the choice of technological alternatives is a rational evaluative process. However, the evidence presented in this work and elsewhere (Fairchild, 1979; Hawrylyshyn, 1977; Morley and Smith, 1979; Vaitsos, 1980; Wells, 1974) suggest that this selection process is strongly influenced by non-economic criteria.[14] These criteria may be the result of organizational incentives (Hawrylyshyn, 1977) and individual biases related to educational background (Wells, 1974).

Despite its weaknesses, the traditional literature on international technology transfer provides a rich organizing framework in many respects. For instance, it allows us to compare the performance of our research subject with that of equivalent firms, to organize many essential aspects of the transfer (contractual formats,etc.) and to analyze many economic aspects of technology transfer such as long term pricing and the effects of competition on bargaining power. Unfortunately, the usefulness of this framework is limited in

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14- Non-economic refers in this instance to any criterion not based on the cost of economic inputs (capital, labor, etc.). We admit, though, that the economic discipline offers at least two explanations to peculiar choices of technology. The first may be labeled as technological determinism, e.g. there are no more appropriate choices available (Eckaus, 1955; Kahn, 1974; Stewart and Streeten, 1971). The second assigns importance to distortion in factor prices, for example, subsidization of capital (Diaz-Alejandro, 1974).

studies with a managerial interest such as this one. Further, as is discussed elsewhere (Villalba, 1982), some of the research most relevant to technology transfer is found outside the realm of this subject, international political negotiations, for example.[15]

2. State-Owned Enterprises (SOEs)

The volume of research being conducted on SOEs has increased dramatically during the last few years as the activities of these enterprises have acquired worldwide scope. Accordingly, the sub-areas of research have proliferated to include among others: 1) control systems and performance evaluation, 2) SOEs as instruments of economic and social policy, 3) economic significance of SOEs, 4) structure of a SOEs and, 5) decision processes within SOEs. In this section we will review the literature within the last subdivision, decision processes within SOEs. The literature on control systems (1) and structure (4) is reviewed in some detail in chapter III as a part of our discussion of the structure of the newly nationalized oil industry. Literature on the economic significance of SOEs and their use as instruments of policy will not be reviewed here because it does not seem

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15-The potential usefulness of this field promises to improve dramatically, as a new line of rigorous research develops. We refer to several statistical analyses on the structure of technology agreements which have been published recently by Contractor (1981) and others.

directly relevant to this study.[16] In any event, this classification has only expository purposes, as there is considerable overlap among the sub-areas.

Much of the research on decision processes within SOEs has evolved out of governments' desire to understand the reasons for their generally substandard financial performance. Considerable discussion has surrounded the issue as to whether this poor performance has a legitimate basis (e.g., is a result of SOEs' social, political and regulatory obligations), or whether it is the result of more fundamental business or economic difficulties. As we will show in the next paragraphs, a variety of explanations have been advanced to explain how these organizations handle their multiple, non-economical, goals. In all cases, goal multiplicity seems to make a difference in the behavior of managers[17].

The "organizational process" approach (Allison, 1971; Cyert and March, 1963; Mazzolini, 1979) conceives the decisions and actions of organizations as the outputs of units functioning according to standard patterns of behavior. These

16-For references on these two topics see, for example, United Nations (1968 and 1974), op. cit.

17-This review is limited to works done within the context of SOE's or to those that, although not originally developed within such a context have been applied to the analysis of these enterprises. More general research in this area will be cited in the next section, I-C, as part of the developent of our conceptual framework.

"patterns" may vary from one organization to another and need not be rational in an economical or technical sense. The novelty of this approach is that any type of goal may be responsible for these patterns of behavior. Thus, the organizational process view accepts patterns of behavior that may be different from, or contradictory to, standard economic theory as long as they satisfy (or, as March and Simon, 1958, term it, "satisfice") managers' goals. Within this approach the development of goals is viewed as an inconsistent process and corresponds to a series of circumstances, one being the particular nature of the group making the decision. The pattern of conduct is one characterized as: 1) organizations use different goals at different times; 2) organizations set an acceptable outcome level and select the first alternative that reaches that level without trying necessarily to find the best solution; 3) organizations solve pressing problems rather than developing long-term strategies.

The "organizational process" approach has been strongly criticized as being unable to explain anything more than standard operating decisions. According to Ansoff and Stewart (1965), this view is useful as long as the firm keeps its organization intact and its competitive position constant. When the firm has to make non-repetitive or very significant decisions, this critical view holds that other decisions mechanisms enter the scene and the new elements such as the relative "power" of actors may become important. In recognition of these limitations of the organizational process framework, Allison (1971) and Mazzolini have supplemented it with an additional approach, referred as "transactional."

The "transactional" approach (Warwick, 1979 and 1980) holds that SOE's operate through numerous dealings, referred to as "transactions," within their organizations and between them and their relevant environments. This view bears strong similarities with other explanatory constructs developed outside the scope of SOE's such as "muddling through" (Lindblom, 1959), "governmental politics" (Allison's model III, 1971; Mazzolini, 1979) and "logical incrementalism" (Quinn, 1980). These views stress that the conduct of organizations is the outcome, in one way, or another, of a process of bargaining among the affected elements of the organization. Moreover, all the "transactional" approaches contend that it is because of this bargaining that policy (or strategy, depending on the context) adopts a piecemeal,[18] incremental, pattern.

The X-efficiency approach (Leibenstein, 1966, 1975) has been used as a general framework to explain the non-maximizing tendencies of firms. Gillis (1977) has used this

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18- There are, of course, substantive differences between these approaches we have collectively referred to as "transactional." Quinn (1980), for instance, stresses that his "logical incrementalism," as opposed to Lindblom's "muddling through," is a conscious strategic option which can be explicitly proposed by managers.

framework to analyze several mining SOEs in Asia and Latin America. In essence, the X-efficiency approach holds that the inefficiency of firms depends not only on the misallocation of resources (mi oeconomics' allocative inefficiency) but, also, on the other elements not recognized by traditional economic theory, effort for example. The main focus of this approach is to enrich the economic analysis of firms and not to guide managers in the operation of organizations.

A fourth line of research on SOEs' decision processes may be labeled as the" new institutional economics," or NIE. It comprises a loosely defined group of works which are directly concerned, among other things, with the effect of multiple goals upon managerial behavior. Here we can find studies on the management of SOEs under the simultaneous influence of economical and political goals (Zif, 1981), and motivations and incentives within SOEs (Adar and Aharoni, 1980; Bergson, 1978; Fama, 1980; Gillis, Jenkins and Lessard, 1981). Other authors (Williamson, 1975), although not directly concerned with SOEs, address the relevant question of which is the most appropriate form of organization (the term governance is used) to handle economic transactions under conditions of great uncertainty.

A common objective of NIE is to generate a risk-return profile for SOEs' managers which results from hypothesized influences of environmental factors and/or ·ganizational structure and then, on the basis of such profile, explain or predict the behavior of SOEs' managers for decisions of interest (financial decisions, for example). This, admittedly diffuse approach gives a lot of attention to issues such as risk sharing among organization members, monetary and non-monetary incentives within the hierarchy, distortion of information across hierarchical ranks, etc. In most cases, NIE reaches its conclusions without making explicit assumptions regardi individual preferences.[19] In other words, differences in behavior which are caused by individual or psychological differences cannot be explained within this framework.

In our opinion, the different views presented here are complementary. With the exception of X-efficiency, which is a very abstract construct, each one of these approaches excels in explaining a particular type of decisions. The "organizational process" framework appears well suited for operative/routine decisions. The "transactional" approach seems better fitted for explaining "strategic" decisions such as divestment, diversification, etc. These decisions, by virtue of their significance and other characteristics, seem to generate the sort of power games --bargaining-- described by the transactional approach. The last body of research des-

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19- Implicitly, however, most NIE researchers assume "rational" economic behavior: patterns of conduct are explained in the form of responses of managers to certain characteristics of the organizational structure. One noticeable exception in this regard is Williamson's (1975) assumption of "opportunistic" behavior.

cribed here, "the new institutional economics," is parallel to the other two, providing a different framework to address similar questions.

There are, however, two features present in all the approaches reviewed here that restrain us from attempting their outright application to our case. The first, and most fundamental is that they often are concerned only with the mechanics of arriving at decisions. In practice, the content of the goals, incentives, and so forth, is as important as the way they are used in determining the courses of action an organization (or a part of it) takes. Oddly enough, this aspect is not made explicit in the works we have reviewed here.[20] Thus, we have to extend these models of decision to to include goals' content before we apply them to our case (and, perhaps, to any specific situation).

The second feature is related to the first but applies only to the particular type of situation examined in this work. We refer to the fact that all these conceptual constructs were developed to explain the behavior of SOEs which were originally created by the government. Our case, however, is that of a nationalized enterprise. In the case of a recently nationalized enterprise, particularly in our case where nationalization was shaped so as to preserve the

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20- Gillis, Jenkins and Lessard (1981) point out this characteristic of their framework, but do not elaborate on the implication developed here.

administrative practices of the industry, many characteristics of the organization are just residuals from the period of private ownership. These inherited attributes include not only overt aspects of its administration, but also key elements of corporate culture. Further, these inherited characteristics may be expected to change continuously until the enterprise settles down in its role of SOE. In any event, the analysis of nationalized enterprises clearly requires some changes to be made upon the received literature on SOEs.

3. Summary

We were able to find only five works with a simultaneous focus on international technology transfer and SOEs. Of these, two studies (Berliner, 1976 and Williams, 1976) were conducted within socialist countries and are, hence, of limited applicability to capitalist countries. Another, Stinchcombe (1974), is a sociological study of three industrial bureaucracies in Latin America which focuses on the innovative problem-solving required to keep production lines running. The fourth, Mytelka (1979) is a general study which includes a microeconomic comparison of technology choice between SOEs and private firms in Latin America.[21] The last, Bhatt (1981) is an institutional

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21- We believe that Mytelka's study, otherwise excellent, makes the mistake of correlating technological preferences (foreign vs domestic) with the degree of foreign ownership in joint ventures. In the case of the Venezuelan firms included in her sample, the percentage of foreign ownership was negotiated together with other (continues on the next page) analysis of the process of establishing a factory with indigenous technology. Most of these studies point clearly to the importance of institutional/organizational factors in the selection of technology.

Our review of the literature on our two subjects of interest, international technology transfer and state-owned enterprises, reveals a strong need for the development of specific theories on the determinants of actual patterns of decision. This need is the result of both a lack of related research and the inadequacy of existing models. Three excellent starts in this direction are the recent institutional-oriented works of Bhatt (1980), Kelly (1982) and Vermeulen and Sethi (1982).

In the area of international technology transfer it is clear that the need for more theory-building research is the result of the failure of existing approaches to address managerially-relevant questions. In the subject of SOEs, our review indicates a need for the elaboration of some aspects neglected by the existing literature. In particular, the determinants of the <u>content</u> of goals and decisions are in need of further examination.

21- (continues from the previous page) terms of the technology transferred as part of the compensation package. Thus, the decision about the technology to be transferred was not made by the joint venture, but by the domestic partners before the constitution of the joint venture.

Normative statements regarding the application of theory have not been included within our review of the SOEs' literature as, we observed, these theories have not been used in the actual management of these enterprises. In fact, this would have been almost impossible given the general character of the existing literature, as reviewed here. So far, it appears that SOEs have been managed in a theoretical vacuum, guided mainly by vague partisan and ideological principles (and, the use of normative statements without any positive theory behind might have been a partial cause for their widespread dismal performance). However, we believe that as the direct involvement of governments in manufacturing continues to escalate, the need for, and the use of, positive theories of SOEs' behavior will increase. We hope the the elements discussed in the next section, although limited to the particular subject of technology, can help in this direction.

C. A MANAGERIAL FOCUS

So far, our review of the literature on international technology transfer has shown a need for a managerial focus to the issue. That is, an emphasis on providing specific instruments of strategy and structure which can be used by actual managers, not government policy makers, to enhance the technological capabilities of firms in less developed countries. As we show in this section and later chapters (specially the sixth), there is a considerable, although still developing, body of knowledge about the way firms adopt new technologies, about the way they innovate and, to a lesser extent, about the ways they incorporate technological considerations into their strategies or create special infrastructures for technology generation and efficient utilization. This theory, however, was built exclusively within developed countries.

On the other hand, our review of the literature on SOEs has shown that there are several available explanations about the way SOEs arrive at decisions in general. We concluded that the two main approaches, "organizational processes" and "transactional," are complementary. Keeping with the terminology used in the last section, we may say that: a) routine --operating-- decisions are made according to the process mechanism, that is, following standard procedures devised according to not-so-rational criteria; b) non-routine --strategic-- decisions are made according to a bargaining mechanism, that is, as a result of dealing among several actors with varying degree of power.[22]

In order to fulfill the call for a managerial focus to technology transfer it is clear that we need a more precise framework which, consistent with our descriptions of decision processes, would be able to produce specific recommendations about structure and strategy. As we show next, the "information processing" (sub-section C-1) view of organizations offers this possibility. Further, to account for the actual content of the decisions we must add to our framework an explanation for the way differences in individual background, corporate culture, hierarchical position, etc. (what we call "differentiation"[23]), affect the preferences of decision

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22-Two points should be made at this stage. First, the typology of decisions, operating and strategic, corresponds to Simon's (1965) division between programmed and non-programmed business decisions. Second, the "organizational process" (OP) view referred here <u>also</u> recognizes bargaining as an important process within organizations. In our interpretation of this approach (Cyert and March, 1963: 117-118), however, this conception is different from the "transactional" (T) or bargaining mechanism on at least two counts. First, the OP view speaks of bargaining in the generation of goals, while decisions are arrived at by the sub-units which are faced with the need to make decision, hence the term "local rationality" (Allison, 1971). In the T view, on the other hand, bargaining occurs during the making of the decisions. Second, who makes decisions is, according to OP, a matter of circumstances (whomever is pressed to make it), while the T view argues that this will be determined by the power of the different participants (Allison, 1971: 144-45; Warwick, 1979: 18-25).

23-The original definition of "differentiation" ("differences in cognitive and emotional orientation between managers of different functional departments," Lawrence and Lorsch, 1967: 11) encompasses (continues on the next page)

makers. The "clans" view of organizations (to be described in sub-section C.2) provides such explanation. The two views, "information processing" and "clans" can be accommodated within the more general, and well established, "contingent" theory of organizations.

Before facing the dangers of framework building, it is appropriate to posit our research problem in terms amenable to the framework being developed. Some of the elements of our research subject are:[24]

1- PDVSA (the Venezuelan oil holding) is an heterogeneous organization. Four different styles of operation coexisting under corporate guidance. Further differences may exist as a result of job specialization and personal background. Therefore, we may expect substantial "differentiation" to exist among different parts of the organization (see note 23).

2-This organization accepts technological inputs from outside as well as from inside.

3-There are two basic types of technological decisions. First, about the acquisition of technical assistance and, second, about the acquisition of complex types of expertise (large projects and R&D). The first type of

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23- (continues from previous page) both individual and contextual elements. We have extended the scope and content of this original definition to account for differences between divisions, not just functional departments. Accordingly, this expansion of scope to include larger segments of the organizations led us to include some division-wide integration elements to account for differences among such divisions. We use the term "corporate culture" to denote these integrating elements. This term is close to Sheriff's (1958) and Pascale-Athos' (1981) ."superordinate goals," or to Ouchi's (1981) concept of clan.

24-A detailed description of the structure of the Venezuelan petroleum industry is presented in chapter III. The historical roots of such structure are discussed in chapter II.

decision is akin to what we called operative decisions while the second is akin to strategic decisions.

4-Barriers to the communication of technical knowledge have been observed. Barriers for the communication of other messages, such as alternative sources for technical assistance, are noticeable also.

5-As we see it, our research question is about how to enhance communication among different parts of the organization in order to fully take advantage of the resources available both inside and outside the organization. These communication problems are to be resolved for two types of information: first, information useful in the selection of technological sources and, second, technical information itself.

In the next two sub-sections, we describe the information processing and clans frameworks. The first provides a basis for making specific recommendations for strategical and structural change. The second provides an explanation for the way individual characteristics of managers affect the content of their decisions.

1. The Information Processing View

The "information processing" (IP) view conceives organizations as systems created for the processing of information (Galbraith, 1973; Tushman and Nadler, 1977). An organization's effectiveness is a function of how well its IP capacity matches the IP requirements for its assigned tasks and for its environment. In other words, highly complex tasks, such as R&D require much more IP capacity than simpler routine tasks, such as technical assistance. Similarly, organizations facing complex, changing, environments necessitate more IP than those within stable environments. In all cases, uncertainty[25] is at the heart of the problem and, of course, the more uncertain the task or the environment, the higher the required IP capacity.

The interest of this framework is that it proposes specific solutions, in the form of new mechanisms of coordination and control or new structures, to match the informational needs of the environment and/or tasks. Thus, as the size of the operations increases, the environment becomes more volatile, and the tasks become more complex, it is possible to keep modifying the structure to accommodate to such changes. Specifically, the IP view holds that as IP requirements increase there are two basic options: 1) decrease the informational requirements for decision making (e.g. change the nature of the decisions to be made) 2) increase the organization's capacity to process information.

In specific terms, IP views rules, programs, hierarchical referral and goal setting as the basic means used by organizations to handle the information requirements of their tasks. For instance, the existence of rules reduces somewhat the need for further communication to solve some problems. As uncertainty (whether task or environment related) and the frequency of exceptions increases, the hierarchy becomes

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25-Uncertainty, within this context, is defined as the difference between the amount of information required to perform a given task and the amount of information possesed by the organization (Galbraith, 1973: 5).

overloaded. To this effect, IP proposes two basic remedies: 1) reduce the amount of information required to perform the tasks and 2) increase the capacity to process information.

The amount of information required for making decisions can be reduced, in turn, in two ways (Galbraith, 1973: chp. 3): 1-a) by creating slack resources and, 1-b) redefining the tasks performed by the units. The creation of "slack" resources, a term used to denote a lowering in performance levels, may come as a result of increasing personnel, increasing delivery times, over-designing equipment, etc. Redefining the tasks, in this context, means organizing in terms of products/outputs instead of functions, thus, each unit is self-contained. By reducing the sharing of resources there is no need for information to coordinate activities among the organization's units (there is no need for coordination), and each one is able to react to changes.

An organization's IP capacity can be increased in three basic ways: (Galbraith, 1973: chp. 4 and 5; 1977: chp. 10) 2-a) investing in centralized decision systems, 2-b) creating lateral relationships among the units and, 2-c) creating a matrix form of organization. Centralized decision systems comprise, basically, the use of computer-based systems for the organization and use of information. Besides the hardware element, there are several other relevant variables of interest for the design of the appropriate information system (Galbraith, 1977; Huber, 1982). The creation of lateral relationships increases IP capacity by cutting across lines of authority. These include, among others, direct contact between two people sharing a problem, liaison (i.e. contact) roles, task forces or teams, integrating roles and management linking roles. The first three types are appropriate for unique consequential problems, while the last two types of lateral relationships are appropriate for the resolution of continuous problems (the management linking type brings real authority to the lateral relationship).

The last way to increase IP capacity is the creation of a matrix organization. This term denotes the ultimate lateral relationship: a structure organized across functional and product/output dimensions. Thus, each member has two bosses. As is to be expected, an organization structured this way is very difficult to manage, because it is difficult to balance the functional and product/output/project orientations of individuals. Still, it has proven to be effective in particular environments with high uncertainty (R&D and international banking, for example).

We must consider several factors during the selection of the adequate strategy to match IP needs. First, all the solutions proposed here are costly (to a varying extent), so an "excessive" IP capacity may have a detrimental effect. For instance, increasing slack in the form of more machinery will absorb capital otherwise useful elsewhere. Second, if no action is taken to match the information requirements of the tasks and the environment, the amount of slack will grow, with the accompanying decrease in performance. Third, the different options can be combined when necessary. Fourth, the type of information to be processed seems to make a difference. For instance, centralized information systems are better for quantitative or otherwise codifiable information while lateral relationships are good for subjective types of knowledge.

2. The "Clan" View[26]

Our interest in this analytical framework is to relate organizational structure to the content of particular goals and decisions. The "clan" view focuses on the existence of informal relationships and shared values among organizations' members and suggests that the influence of this informal structure upon decision making becomes more important as the uncertainty surrounding the decision increases. The interest of this framework, which is consistent with IP, lies in the fact that it "predicts" those situations under which the informal structure is most relevant to decision making.[27]

26-The term "clan" is borrowed from Ouchi (1979, 1980). This concept, however, appears elsewhere in the literature under less appealing names (Athos and Pascale, 1981).

27-This view has other implications on the attitudes toward risk of organizational members. For the moment, these are not discussed here but are available in Villalba (1982-b).

The "clan" framework starts on grounds similar to IP: frequency of decisions (transactions, depending on the case) and uncertainty do make a difference in terms of the appropriateness of the structure. This view assumes that control within organizations, and hierarchies in particular, is implemented through formal channels, behavior control and output control. The first "mode" of control is akin to individual surveillance and requires some knowledge of the means-ends relationships, that is the transformation process. In other words, there has to exist some knowledge of the kind of behavior which is appropriate to fulfill the objectives of the organization. For example, individuals may be told that smoking is prohibited because the "theory of the office" indicates that smoking somehow affects the office's capacity to fulfill its objectives. Output control, on the other hand, requires the existence of a yardstick such as production volume, costs, etc. This is typical of organizations producing measurable outputs. Both "modes" of control complement each other but, while output measurement can be used to compare performance among several sub-units, behavior control is a subtle and subjective activity which tends to be confined to small segments of the organization.

In all cases, information is at the heart of the control problem. When the information required to implement one "mode" of control is costly or impossible to obtain, the other "mode" may still be available. There are, however, cases where neither of the two overt "modes" of control can be implemented. In such situations informal control enters the picture. This "mode" of control is present in all organizations as a result of a natural socialization, acculturation or acquaintance process (Schein and Van Maanen, 1977; Wanous, 1980), and becomes particularly relevant whenever overt forms of control are unfeasible. In its essence, informal control is the result of achieving substantial congruency among individuals. As organization members come to share several common goals, monitoring performance becomes largely unnecessary because very few members, if any, will attempt departures from the code of conduct representing those common goals.

One consequence of implicit control is the creation of sub-units, groups or "clans," where the degree of goal congruency is relatively high. These "clans," while embedded in the hierarchical structure of the organization, are very influential in determining the behavior of organization in circumstances characterized by uncertainty and low frequency, e.g. where formal control fails. For the purposes of this argument, "clans" or sub-units may refer to small segments of the organization or larger ones such as departments or divisions.

Several social mechanisms to increase goal congruency have been recognized. Two obvious ones are education (formal) and co-partisanism (socialization within a political party).

In addition, Van Maanen (1976) finds job socialization coupled with long term employment to be an effective way to "process" people together. Ouchi (1979, 1981), on the other hand, considers that the "ritual and ceremony" associated with staffing policies ensures that sub-units are constituted by similar kinds of people. The prevalence of one type of mechanism over the other will depend on the amount of time available for socialization.

In highly mobile organizations (such as some government-owned enterprises in which some managerial levels are re-placed after each political cycle) there is insufficient time for socialization in order to acquire a common set of beliefs. Thus, the only way to achieve convergence of goals is by screening newcomers very carefully so that they will share a substantial part of their beliefs with those of their organization. When this happens, we can identify a "clan's" goals by examining its hiring practices. In a gross example, if a clan hires mostly economists we can expect it to behave as if it were an economist, or at least behave as such when transactions become very complex or uncertain. During the course of ordinary activities, though, clan members will act as other organization members. Still, the nature of the goals used during the course of ordinary activities will depend on the clan structure, independently of whether we assume a "process" or "transactional" view of decision making.

Consider the case of research as an activity. The measurement of output, that is of the attributes that define a successful research project, is extremely difficult, if not impossible. The ultimate outcome of a successful project, publications, a new product or process, a patent, etc., takes a long time to materialize. Moreover, the quality of many research projects may not even be measurable. On the other hand, behavior control is also difficult since we do not know the behaviors that make a researcher successful. Of course, hard work and other attributes help but we do not know the exact combination, despite the important efforts of Roberts and Fusfeld (1980). Hence, we may expect that as both modes of explicit control, output and behavior, break down, "clan" type of organization (with its implicit mechanism of control) will be important in research activities. Indeed, we find that inter-personal communication patterns are strongly related to research performance , and that such performance decays as the intensity of intra-group communication is reduced by tenure (Katz, 1980).

The existence of clans, or sub-units sharing a set of cultural values, has several strategic and structural consequences. For one thing, the patterns of organizational communication are strongly influenced by the "informal" organization we have just described. Within the groups, communication is relatively more intense, whether or not this corresponds to similar positions in the hierarchy. Among groups, on the other hand, the transmission of messages will occur through relatively few individuals that serve as communication liaisons or bridges. In consequence, the capacity of the organization to process information will depend on that of a small number of its members, so information overload is a real possibility. Further, messages may be distorted when moving from one group to another to suit the preferences of the groups and their bridging individuals (Huber, 1982; Tushman and Katz, 1980).

From another perspective, an important consequence of the view that organizations are constituted by "clans" with the characteristics described above is that one can explain substantial portions of the behavior of its members by examining the goals of the subunits rather than those of the organization as a whole. Furthermore, knowing the "common set of beliefs" that stabilizes "clans" could allow us to predict patterns of behavior toward risk and complexity. Consequently, we cannot expect to be able to manage processes occurring through clan-type behavior unless we are able to manipulate that set of common goals and beliefs that characterizes these groups. Attempts to elaborate explicit norms and procedures suitable for the occasion are likely to be of limited use when the conditions of ambiguity that led to clan formation are still present.

3. The Evidence

The framework described here is supported by a very large amount of evidence. We have to recognize, however, that the evidence is fragmentary because the framework as a whole has not been tested.

Regarding the importance of structure upon performance, the literature is filled with reports indicating that in environments characterized by high rates of change in markets and technology, successful firms are decentralized and show intense lateral communication. Burns and Stalker (1961) gave the name "organic" to this type of firm (in contrast with the term "mechanistic" to indicate structures with very defined roles and communication patterns following the line of command).

In addition to rate of change, diversity of operations gained by multinational involvement (Stopford and Wells, 1972) or just size (Armour and Teece, 1978) is associated, in the case of successful firms, with a particular type of structure, the multidivisional form. Other studies have concentrated upon "measuring" uncertainty (Duncan, 1971; Van de Ven and Delbecq, 1975). Lawrence and Lorsch (1967) concluded that high performers in uncertain environments had relatively complex structures characterized, among other things, by the presence of integration mechanisms and structures (akin to the lateral relationships we mentioned earlier).

In the particular area of technology, decentralization, complexity and informality have been linked with early and successful adopters of process innovations (Cohn and Turyn, 1980). Accordingly, the characteristics of the work being done, from the simple technical service to the more complex development and to the even more complex research, have been found to affect the communication patterns of organizational units (Tushman, 1979) and, in general, the way in which technology is transferred. Very significantly, these two last studies, as well as others (Allen, 1977; Rogers and Kincaid, 1981), point to the existence of a strong relation between the informal organization and innovative output or rate of adoption of technologies. It appears that this informal organization acts as a bypass to possible communication barriers posed by the formal structure.

The term "gatekeeper" has been used to denote individuals that maintain high levels of communication with both the inside <u>and</u> the outside of organizations. For universal tasks, such as basic research, the role of these individuals does not seem that important because members of research teams can easily have access to technical knowledge which, in the case of research, is well codified. For development, a locally defined task, these individuals appear very important in offsetting the barriers towards communication posed by the formal structure. For technical services, though, the formal organization appears sufficient to handle the communication requirements of this activity. (Allen, Tushman and Lee, 1979).

Finally, the strength of the informal organization has been related to high performance. In R&D, this strength has been related to intensity of oral communication by Allen (1977) and collaborators. In a more general sense, Deal and Kennedy (1982) have used the term "strong culture," Athos and Pascale (1981) the term "superordinate goals," and Ouchi (1981) the term "clan," to denote organizations that show strong bonds which go beyond those established by their formal structure. In all three studies, the strength and pervasiveness of these bonds have been associated with high performance.

4. Summary.

Throughout this chapter we have developed a conceptual framework to guide this research project and, eventually, provide recommendations for strategy and structural change. To this end, we have borrowed concepts from the existing literature on SOEs, which are discussed in section I-B, as well as from general writings on organizational theory, the "clan's" and the information processing (IP) frameworks. The IP view allows us to produce specific recommendations of strategical and structural change from the results of our research. The "clan's" view provides an explanation for the way subcultures are created within organizations and for the way these subcultures influence managerial decisions.

Our framework can be summarized as follows:

- There are two types of decision which differ in their requirements of information: operative and strategic. Decisions about technical assistance can be categorized as operative, those about large projects and R & D as strategic. Each type of decision is made according to a different mechanism.

- Operative decisions are made according to the goals of the organization's sub-unit that makes the decision. Some of these goals do not necessarily follow those of the organization at large, e.g. follow a "local rationality," and may be responsible for systematic biases in such decisions. For example, decisions about technical assistance (an operative decision) may reflect goals of the particular sub-unit (a division, for example) that makes the decision.

- Strategic decisions are made according to a different mechanism of bargaining among the organization's sub-units. Thus, the final decision not only reflects the local goals of the sub-unit (or top manager) who ends up making it but, also, its (his/hers) power relative to the others. Thus, decisions about a large complex, R&D project (a strategic decision) reflect not only the goals of the sub-unit but also the distribution of power within the organization (of course, if the power distribution remains stable the strategic decisions will reflect only the goals of the powerful sub-unit).

- The goals of the sub-units themselves are in part the result of a process of acquaintance (or come from hiring policies) and, in consequence, have a more or less permanent character. Thus, heterogeneities within the organization, which are partly the result of these local goals, will persist even after the factors that created them disappear (a change in ownership, for example).

- In accordance to the previous point, those individuals who have been subject to this acquaintance process for long time, or have shown particular affinity with the goals of the sub-unit, will be more biased towards them than those with less time in the organization. Thus, those with longer job tenure, or situated higher in the hierarchy, will show more the results of the acquaintance process.

- The more complex an organization is, the better suited it is for handling uncertainty. The more "organic" an organization is, the more suited it is to handle uncer-tainty.

Thus, a given organization (with its formal and informal structure) will show differential performance for different types of tasks. For example, an organization assigned to research, development and technical assistance may find it necessary to set up separate infrastructures to handle each one of these tasks.

CHAPTER II

THE SETTING
OF THE
VENEZUELAN PETROLEUM INDUSTRY

This chapter analyzes the influences of environmental factors upon the acquisition and development of technology by the Venezuelan petroleum industry. Consistent with the long standing presence of these factors, this chapter adopts an historical perspective, covering the long period preceding nationalization. Further environmental changes which occurred after nationalization are reviewed in the next chapter.

A. THE HISTORICAL RECORD[1]

In retrospect, historical elements have seemingly played a very significant role in shaping today's relationship between the oil multinationals and the Venezuelan government, as well as in determining the technological capabilities and needs of the now nationalized industry. The review of these elements, which we present in this section, will allow us to develop conclusions about their effects upon the technological strength of the Venezuelan petroleum industry at the moment of nationalization.

1. Early Concessions: 1914-1930

Although the existence of hydrocarbons in Venezuela had been known for centuries, it was not until the turn of this

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1- The prime reference in this area is Edwin Lieuwen, Petroleum in Venezuela:A History, Princeton University Press, 1954. Another rich source of historical data is, Pedro Mejia Alarcon,La Industria del Petroleo en Venezuela, Central University Press, Caracas, 1972.

century that their economic potential was recognized.[2] The first well of importance was drilled in the Maracaibo lake (Venezuela's main producing area, situated in the Western part of the country) during the year 1914. Several important discoveries followed this one and, by 1917, pipelines and terminals had been put into operation. In 1922, the dramatic blow-up of the "Barrosos" well, which wasted more than a million barrels in a week, was a turning point as it signaled to the world the immense potential of the area.

Early concessions were acquired mostly through somewhat obscure means from Venezuelans associated to the regime in power (the dictator Juan Vicente Gomez ruled the country from 1908 to 1935). Some important aspects of today's industry, the geographical distribution of concessions and the identity of the concessionaires being two examples, can be explained in terms of domestic political rivalries, or as effects of actions of foreign policy. For instance, the predominance of British interests in the early concessions can be partially explained as result of the deterioration of North America's image which resulted from one of Theodore Roosevelt's foreign policy actions, the Buchanan-Gomez

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2- One exception was a small indigenous oil operation which was started in the Tachira State in 1878. Known as "La Petrolia", it never surpassed production levels of thousand gallons a day and was closed down in 1934, after 56 years of operation (Martînez, 1969).

incident.[3]

Most of Shell's concessions derived from the so called Tregelle's concession, granted in 1909.[4] A Venezuelan, Rafael Valladares, acting as an agent for Venezuelan Asphalt, acquired these rights in 1912 and two days later transferred them to Caribbean Petroleum Co. which was, in turn, acquired later by the Royal Dutch Shell. The original Tregelle's concession occupied 12 states, amounting close to 100,000 square miles.

American interests became important only after 1919 when guidelines of the Wilson administration encouraged American companies to seek for oil rights in Venezuela. Creole Petroleum Corporation. a subsidiary of the Standard Oil of New Jersey which was to have important operations in this country, was incorporated in 1919 and a related company, Standard Oil of Venezuela, was established in 1922. Other

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3- In particular, we refer to an act of intimidation conducted by the U.S.'s battleships Maine, Desmoines and North Carolina between December 21, 1908 and February 13, 1909. Under the command of the Viceadmiral W.I. Buchanan, these three ships were anchored in front of Venezuela's main port, La Guaira, where they conducted daily artillery and landing exercises. At the end, Venezuela agreed to sign the so-called Buchanan-Gomez protocol whereby it agreed to restate the New York and Bermudez Co. as concessionaire of the "Guanoco" asphalt lake, and the concessionaire agreed to pay Venezuela, but never did so, damages for 24 millions of bolivares (Mejia Alarcon, 1972: 84-89).

4- Tregelle was a British citizen who obtained the concession on December 10, 1909, for Venezuela Oil Field exploration Co. Unable to find any oil, he was forced to return the concession two years later.

American corporations followed suit: Sinclair in 1922, Gulf in 1923 and Atlantic Refining in 1924. By 1929, there were 107 foreign companies operating in Venezuela; but only 5 exported significant amounts of oil. Interesting enough, the late entry of American firms did not result in poorer concessions because of several reasons. Among them: the oil fields in the Maracaibo lake were rich enough to leave room for all, and American firms were granted concessions in some non-traditional areas (eastern fields) which, eventually, turned out to be very productive.

At the end, the British seemed content enough with their share of Venezuela's oil resources. Their fields were the most productive at the time and wartime restrictions on the movement of equipment affected their exploration activities throughout the crucial period (from 1914 to 1918) during which they enjoyed exclusive access to this country's soil. Stuck with old fields, Shell became the first concessionaire (1958) to implement advanced recovery methods. This fact, we can speculate, explains why MARAVEN, the state-owned company which inherited Shell's operations, is the company in Venezuela with the greatest expertise in heavy oil production.

2. Contemporary History: 1930-1975

Throughout the rest of Gomez's dictatorship, which ended in 1935, the companies continued to enjoy an ideal climate.

In 1936, however, a new provisional government increased royalty rates to 15%. During these two administrations, Gomez's and successor, domestic refining was discouraged because, among other reasons, Gomez did not want large contingents of workers concentrated in few places; hence the establishment of refineries in Curacao and Aruba. After 1938, though, the first specific Hydrocarbon Law was enacted, providing for increases in exploration and production taxes, conservation of natural gas and, most important, assigning the state the task of controlling the operations of the petroleum industry.

The seminal legislation on the matter of hydrocarbon's extraction was enacted in 1943. Known as the 1943 Law, it integrated all previous legislation on the matter. All existing concessions were accommodated to the terms of the new law. Domestic refining was actively promoted (a minimum of 10% of the output had to be processed within the country). This law originated much confusion among the companies, but was accepted on the basis of promises, later fulfilled, of granting new concessions and a 40 years extension to the old ones. This period of tough bargaining by the Venezuelan government culminated in 1948 with modifications to the income tax laws which established the 50/50 principle of division of profits.

In 1948, again, a new dictatorship froze the operating terms of the oil companies until 1958. Among other things, this administration sold 800,000 hectares in concessions at a total price of 685 millions of dollars. In this occasion, the so-called independent companies (Continental, Occidental, Pancoastal, etc.) were able to acquire several important tracts. At the end of this period, Eisenhower imposed the system of import quotas for crude oil and products.

The installation of a democratic regime in 1958 inaugurated a new era in the relationship between the oil companies and the government. Since early this period the concessionaires made public their distrust for the new government. Their suspicions, based on memories of the 1948 reforms, proved to be valid: a tax reform increased the income tax rate to 67%.

Throughout the year 1959, the government made public announcement of its decision to not renew the concessions due to expire in 1983. This announcement has been considered as the main cause for a sudden reduction in the geological activity of the concessionaires (others include the granting of exclusive exploration rights to the national oil company, and the low investment allowances accorded in the tax laws). The consequences of this decline appeared rather quickly: in 1961, for the first time in the development of the oil industry, there was a negative growth of the volume of oil reserves. Parallel to this evolution, the oil companies initiated a wave of price reductions. On September 15, 1960, after three successive price cuts, and during the course of a series of meetings in Baghdad, OPEC was created with the participation of Iran, Iraq, Kuwait, Saudi Arabia and Venezuela. This organization was largely ineffective in controlling oil prices during its first 13 years.[5]

During the sixties, and despite a somewhat erratic market, Venezuelan oil production continued to grow, reaching its peak in 1970 with a daily output of 3.8 million barrels. (After that maximum, production has been steadily declining until reaching the current level of 1.8-2.2 millions of barrels per day). Several important policy actions were implemented during this decade. In 1962, a ministerial order reminded the companies that they could not withdraw from reservoirs whose limits extended beyond those of the concessions. Four years later, a circular letter from the Ministry of Mines asked the companies to give to CVP (Corporacion Venezolana del Petroleo, the original state-owned oil company) enough number of gasoline stations to represent at least 10% of the market. The next year, 1967, an amendment to the 1943 Hydrocarbon Law granted CVP exclusive exploration rights in new areas to be determined by the government. This reform allowed the state-owned company to subscribe " Contratos de Servicios, " sort of risk-sharing exploration contract with any kind of domestic or foreign partners. The major conces-

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5- For a disenting view see, M.Adelman, The World Petroleum Market, John Hopkins University Press, Baltimore, 1972.

sionaires did not show much enthusiasm for these joint exploration production agreements but several independent companies submitted bids during 1968.[6]

The decade of the sixties ended with the construction of two large desulphurizing plants built through agreements with the concessionaires. These two projects, financed with the participation of the Venezuelan government, were completed with the purpose of complying with the U.S.'s newly enacted environmental regulations on the sulfur content of fossil fuels.

Three major pieces of legislation were enacted during 1971: the Law for nationalization of the natural gas industry, the "reversion" law, and the presidential decree number 832. The last required the concessionaires to submit to the executive branch of government their annual operative plans for approval. All three pieces had a deep impact on the industry. The nationalization of the natural gas industry took a lucrative business segment of the concessionaires putting CVP in charge of the exploration, recovery, production and distribution of this resource. It is difficult to

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6- The Venezuelan version of these service contracts was analyzed by several authors (Edwards, 1971:119-20; Mikesell, 1971:438-9) and found to differ little, besides semantics, from the conventional concession agreement. This point seemed to be recognized by the main concessionaires who expressed in 1967 their unwillingness to participate in such contracts unless their terms, in their view too confining, were modified.

assess at this time the consequences of this move. At the time, however, it seemed important in the light of possible long term contracts for the sale of liquified natural gas (LNG) to the American market.[7] In terms of technology, we may assert that the suddenness of this nationalization had some effect upon the technological capacity of the industry and, in this sense, may be responsible for the high levels of assistance in gas technology which are required by today's nationalized industry.

The "reversion" law was aimed at avoiding the de-capitalization of the industry by outlawing the export of certain types of equipment deemed to be of strategic importance to the industry. This legislation was considered necessary by the government since, as we may recall, the concessions were due to expire in 1983, or earlier, if nationalization was accelerated.

Although not as polemic as the other two measures, the decree 832 (1971) was equally influential. It was enacted as a complement to the "reversion" law and contained the already mentioned provision requiring the approval by the Ministry of Mines of the companies' annual plans. To some

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7-CVP, however, was never able to sign any significant long term agreement for the export of LNG, despite a visit made by the presidents of some of the most important gas distribution companies in the U.S. during 1968 (Martinez, 1969). Most of these distributors ended up contracting with SONATRAC, the Algerian gas company.

extent, this decree can be considered as a quasi-nationalization instrument because it granted the government the capacity to veto and/or modify the activities of the concessionaires, thereby giving it true participation in the companies' decision process. In many respects, the situation of the Venezuelan oil industry was not, in practical terms, different at this time from that of several other countries which had nationalized their petroleum industries but kept the concessionaires under comprehensive general management contracts. We may add, however, that this opportunity of control was never utilized fully by the government which, incidentally, never stopped complaining about its low level of involvement in the planning of the activities of the oil industry.

In 1973, the law of "nationalization of the domestic market" was passed by congress. The provisions of this law included the transfer of all service stations to CVP. Nevertheless, it was never strictly enforced as many stations remained in the hands of the concessionaires until nationalization in 1976.

By the early seventies, the industry had developed a very large refining capacity, 1.44 million barrels per day (above 60% of today's production rate). This capacity, however, was mostly devoted to the production of heavy fuel oil for the U.S. east coast and feedstock for the refineries located at the Netherland Antilles. These offshore refineries had been designed for a lighter output, e.g. more gasoline, suplying the U.S. and European markets. At least part of the Venezuelan fuel oil output was a by-product of the production of gasoline and other light products for the local market. Whatever the cause, this high percentage of heavy products in the export mix was a cause of concern in most sectors in Venezuela who claimed that the country could have benefited more by exporting products with a higher aggregated value.

During the last five years of the pre-nationalization period, a concensus evolved within the country about the convenience of nationalizing the industry before the expiration of existing concessions in 1983. In contrast with this willingness to take over the industry, there was also widespread fear that this action could signify a drastic reduction in the oil revenue. So important was this industry considered that the government exempted it from the stringent treatment accorded to foreign investors as a consequence of Venezuela's membership into the Andean Common Market.[8]

The special status granted to the petroleum industry permitted the government to conduct all the proceedings of nationalization, and subscribe technical assistance con-

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8- This exemption was noted in the Ministerial Act No.39, dated april 2, 1976, which was based on the presidential decree No.1225 from october 10, 1975. The Ministry of Mines was put in charge of enforcing all the matters concerning Andean legislation.

tracts, without having to wait for approval from the special bureau, SIEX, which had been created to implement foreign investment regulations.

However, other aspects of the regulations of the Andean common market turned out to have negative consequences for the development of indigenous technological capacity. In particular, we refer to the rule (decree no. 1225, Oct. 1975) which prevented any party but the government from acquiring stock of foreign-owned technical service firms wishing to divest from their Venezuelan operations to take advantage of the expanded Andean Common Market. As was recognized later, this legislation ruled out private domestic participation in those firms and, thus, limited the transfer of some important expertise to Venezuelans. This legislation was amended in 1981 to permit local private firms to integrate joint ventures to provide services to the oil industry, although the government retained the first option to acquire foreign holdings (Resumen, 1981:13).

B. THE STRUCTURE OF THE CONCESSIONAIRE SYSTEM.

The two basic elements of the concessionaire system, the legal framework and the fiscal provisions, are presented below. To these two elements we will add a third, the government infrastructure required to enforce the other two. All three, we think, have influenced the patterns of production and investment and, thus, determined some of the technological needs of the industry. As for the third element, it continues to be an important influence in the conduct of the industry after nationalization.

1. The Legal Base

The system of concessions consists in the granting of temporary rights either for the exploration, production, refining, transport, commercialization, or all these operations combined, of oil. Under this system, the government retains title over the remaining oil not yet extracted. The duration of this type of agreement varies widely from one country to another, although the trend is towards reducing the number of years concessionaires are allowed to operate. In general, concessions revert to the state (with or without compensation) at the end of their term or when, in the judgement of the host state, they have not been rationally exploited.

Concessions, as a formula,are almost universally accepted within countries with a Romano-Germanic legal system for the exploitation of natural resources. For all former Spanish colonies, this concept of state ownership over natural resources was later developed into the "Ordinances of Aranjuez," and transferred to the colonies in 1784. In the case of Venezuela, the 1830 congress stated that ownership of "mines of all kinds" was vested in the state. Furthermore, this same congress acknowledged the applicability of all the "ordinances of Aranjuez" to Venezuela. Thus, we may say that the system of concessions is not an incidental legal instrument, as some literature (O'Dell, 1981) seems to suggest but, rather, a format which is well rooted in the legal, and we may add political, tradition in Venezuela and many other countries.

Besides its historical and legal convenience,[9] the system of concessions has several other advantages. First, it is relatively easy to administer, requiring mostly accountability of the royalties to be paid. For example, in exploration concessions, the fees/royalties are based on surface area. Second, the involvement of the government is virtually risk free. Third, the concession system gives the host government, by virtue of its vagueness, considerable leverage over the foreign concessionaires. Governments can, and tend

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9-For a comprehensive look at the different arrangements used in the world petroleum market see Ton O'Dell, Petroleum Exploration: The Trend Toward Service Contracts in Selected Non-OPEC Developing Countries, M.S. Thesis, Sloan School of Management, MIT, 1981 to, raise tax reference prices or the tax rates themselves as a means to increase revenue, all this without having to violate specific contractual clauses. The main drawback of the concession system is that government's role is only regulatory and it has very little influence upon the operational and strategic actions of the concessionaires. Perhaps this fact explains the image of limited sovereignty which has always been associated with concessions, as well as the clear trend towards other types of arrangement.[10]

The concept of state sovereignty over natural resources, the basis of the whole system of concessions, is in sharp contrast with what prevails in most Anglo-Saxon countries. In the U.S., for instance, title over the land confers title over the natural resources located below it and accords an unlimited right of withdrawal. One of the most important implications of this legal framework is the so-called "rule of capture" (Adelman, 1972; Ely, 1938). This rule refers to the common case in which several individuals own land or leases over a common oil deposit and implies that each one will have an incentive to drill as many wells as he possibly can in order to individually "capture" the maximum amount of

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10- It shall be noted that by the time most of Venezuela's oil concessions were originally granted, e.g. early 1900's, no other forms of agreements were available. Joint Ventures, risk service contracts, non-risk service contracts, production sharing, and other formats had not become popular, or had not even been developed conceptually.

oil before the others do the same. The results, as some unfortunate cases have shown[11], are overproduction and reduction in the amount of oil ultimately recoverable from the deposit.

It has been argued (Adelman, 1972) that the concession arrangement leads, in principle, to more controlled production pattern than in Anglo-Saxon countries, as the act of granting concessions provides the government with information to regulate production (of course, "capture" is possible if production tracts are close to each other). In the case of Venezuela, a 1959 decree (No.3825) provided for the compulsory unitization of reservoirs (i.e. concerted production by several concessionaires) exploited by more than one concessionaire.[12] In this same line, an earlier decree (1955) had limited the depth of the wells, allowing for a more strict control of production.[13]

11- We refer here to the case of the huge East Texas pool discovered in 1930 (Adelman, 1972:43). For a classic discussion of this issue see Ely (1938).

12- This unitization decree, however, provided little more than a formal record for the well-spacing and prorationing practices adopted by initiative of the companies themselves since the late twenties, time at which most of the possible damage of fields could have been made already. Further, resolution 3825 (a lesser legal instrument than a decree) of the Ministry of Development, enacted in 1951, declared that unitization was compulsory. In retrospect, however, it seems that such a move was justified because the new concessionaires, mostly independent companies, were just starting the development of new fields.

13-We may speculate that another, more realistic, motive was the preservation of the newly discovered layer of light "cretaceous" oil from (continues on the next page)

The question of whether unitization policies had some effect in the state of Venezuelan oil fields seems valid at this point, as most concessions in the western areas of the country were tightly packed around the oil reservoirs. Our interest in this question has to do with the particular technological needs, and thus expertise, which might have been associated with the prevailing methods of production. As for the traditional producing areas on the Maracaibo lake, the record (Lieuwen, 1955:44-47) shows that irrational production was the name of the game. Each producer would drill wells just to offset each other's production, and wells were allowed to flow wide open using up all the gas pressure from the reservoirs. This "promiscuous" pattern of production not only was responsible for several major fires but, also, "shortened the overall life of the field (s) and adversely affected the amount of oil recovered from the reservoirs" (Lieuwen, 1955:p.45). The situation became so bad that the three majors, Shell, Standard and Gulf, reached verbal agreements to space the wells so as to reduce obstruction with sand and fire hazards (see note 12).

On the other hand, unitization does not prevent damages to single-concessionaire deposits. It is, for instance, conceivable that some producers, pressed by the expectation of

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13-(continues from the previous page) the traditional concessionaires. This layer of new oil was found below the traditional producing deposits in the Maracaibo lake (Moreno-León, 1980:12).

a sudden nationalization, or simply by the policy of "no more concessions" implemented after 1960, could have exploited their fields in a manner that created troubles to today's nationalized industry; but in this area only speculations are possible.[14] We could safely say, however, that the early pattern of exploitation contributed to the premature ac ng of some of the traditional fields; a factor that led Shell to install in Venezuela the first (1958) large scale steam recovery unit in the world. In our opinion, this same move is responsible for the relatively high degree of Venezuelan expertise in recovery techniques suitable for heavy oil production.

2. Fiscal Policy

The maximization of oil revenues was, without doubt, the major driving force behind most of the regulations imposed by the government upon the concessionaires (Baloyra, 1974). Not surprisingly, the tax system evolved from a very rudimentary system, in which most taxes were assessed on the

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14- This question was brought up in several of the interviews within the Venezuelan petroleum industry. In all cases, experts agreed that it is impossible to prove any hypothesis of negligent exploitation using ordinary deposit data. It was argued by one interviewee that even if the withdrawal technique were found to be strange, it might have been an accepted practice at the time. Another said that there is too little formal theory (or too much empiricism) in this area to formulate charges of irrational exploitation. In any event, we may add that the government had the right, and perhaps the infrastructure, to influence production patterns, had it wished to do so.

basis of surface area under exploitation, to an elaborate income tax system. Besides the format, the amount of taxes paid by the company gradually increased from very low, perhaps the lowest in the world,[15] to very high percentages of income, 70% before nationalization. For expository purposes, it may be convenient to consider four different periods, each representing consecutive stages of development of the tax system.

The first stage, lasting up to 1904, was characterized by a very primitive tax system in which each case was discussed separately. No specific tax code or laws on the matter of hydrocarbons were developed during this period. The second stage, lasting from 1904 through 1942, can be called the indirect tax period, as no direct tax on income was levied during this period. All the government's take came from royalties, exploration and production taxes, customs, and artificial exchange rates. Several specific codes and laws were enacted to control the procedures to grant concessions and petroleum volumes, all of these important sources of taxable income. The third stage, lasting from 1942 through 1975, may be called the income tax period. Starting from a complicated schedular based tax system, the system gradually

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15- During 1922, for instance the oil companies paid between 7 1/2 and 10% as ad-valorem royalty for low cost Venezuelan oil, while the prevailing rate in Texas was between 12 and 14%. These terms were also more favorable to the oil companies than those of Mexico, a comparable risk(Lieuwen, 1955:29).

matched the principle of administrative simplicity with high tax rates. By 1970, the government had decided upon a flat rate of 60% above which other charges were levied. A problem remained, however, and it was the determination of reference prices for royalty and tax purposes.[16]

The last stage in this evolution of the tax system corresponds to the nationalized industry. Although no major structural changes were made upon nationalization, the importance of some new items, such as the income tax paid by foreign firms involved in technical assistance, increased. The nationalized firms were requested, also, to make a contribution to their holding company Petroleos de Venezuela, for an amount equal to 10% of their gross income. This flow, deductible as a cost for tax purposes, is devoted to R&D and to build a corporate-wide reserve for investment purposes.

Some maneuvers in the income tax and royalty rates took place after nationalization to compensate for some of the volatility of the market. These moves helped to put in

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16- Originally, the price of west Texan oil was used as a reference. Several market crises, however, created disagreement about which crude was to be used as yardstick. A workable formula, though, was devised in 1951. It was based on several crudes (Texas east and west, and Gulf coast) according to their density. This agreement on prices was supported by most of the parties involved until the mid sixties when the producing countries decided to set prices through negotiation with the companies. This scheme was broken again in the early seventies when all OPEC members decided to set prices unilaterally using light Saudi Arabian crude as a benchmark (Edwards, 1971:106).

evidence the dual role of tax payer and tax collector being played by the government and pointed to the necessity of implementing several important reforms. For example, it does not seem justified to maintain the same two elaborate tax control and filling systems since the government owns both. Without doubt, substantial resources could be saved by integrating the functions of both bodies, the branch of the Finance Ministry in charge of oil affairs, and the oil companies tax sections.[17] Another specific reform would be to eliminate the system of tax reference prices (artificial prices set up for tax purposes) and have taxes based on realized prices. This alone would eliminate some unnecessary bargaining between the companies and the government, as tax avoidance through transfer pricing is no longer a serious possibility within the nationalized industry.

It is quite difficult to single out specific technological consequences of tax policies. The government, for one thing, always considered them to be effective and in repeated occasions it chose tax instruments where other policies could have done the job.[18] Still, it is possible to specu-

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17- At this level of analysis, it is impossible to reach specific conclusions about the resources to be saved by these reforms. Taxation could be acting in the form of an incentive, thus have some efficiency properties.

18- In 1962, for instance, the government exempted exploitation taxes accruing in the production of gas which was to be transferred between companies for re-injection purposes.

late about the general effects of some parts of Venezuela's tax system. For instance, we may say that the small investment allowances, only 20% of gross income before 1975,[19] were a contributing factor in the low levels of capital investment of the industry during the years prior to nationalization. In this sense, tax policies can be partly blamed for the technological obsolescence of some of the equipment and plant of the industry. And obsolescence also meant that Venezuelans were not exposed to the operation of modern equipment.

3. Regulatory Infrastructure

The development of the Venezuelan petroleum industry was accompanied by the growth of a whole infrastructure. Parallel to such growth, the focus of governmental intervention was broadened gradually from a pure interest in tax revenues to include labor relations, conservation, international relations with other producers and, finally, direct state participation in the industry. The institutional structures described here are important not only because of themselves but because of the fact that they remained without change throughout the process of nationalization.

At the beginning, e.g. during Gomez's dictatorship, the granting of concessions was completely in the hands of the

19- One important exception, introduced in 1975, allowed complete deduction of certain types of equipment provided that it had been approved by the Ministry of Mines and Hydrocarbons. However, the large amount of paperwork required for obtaining exemptions discouraged the concessionaires from using this tax saving device.

head of state and only occasionally delegated to the ministers. Originally, regulation was effected without the support of any infrastructure, as a sort of ad hoc appointment of the ministers. This situation, added to the absolutism of Gomez's regime, weakened considerably the position of the Ministries.

The lack of infrastructure facilitated widespread corruption. The dictator Gomez even created a private corporation, The National Petroleum Company (NPC) to act as an agent for the sale of concessions. Headed by three puppet directors, this company became, *de facto*, the official grantor of concessions during the late twenties (Lieuwen, 1954:36). Most oil leases were received by the NPC and, through its two offices in New York and London, posted for bidding. As for the procedures, we can quote Lieuwen:

> "the companies most adept at adjusting themselves to the ways of the corrupt government fared best; as accomplices of the crime they got the lion's share of good lands and reaped the rewards of the future. Three big American companies (Standard Oil of New Jersey, Standard Oil of Indiana, and Gulf) obtained their lucrative leases in the corrupt-concessions era of the Gomez regime [1923-1929]. Shell rested on its plentiful grants received earlier" (pp.37-38, parenthesis ours).

As the land for concessions ran out and the world entered the deep recession, it became clear that any additional revenues were to be obtained through taxation. As early as 1930, the government created the Technical Office of Hydrocarbons to ensure the compliance of several legal instruments enacted by the state.

The interest in knowing the extent and characteristics of the oil deposits, of great importance in the design of tax policies, was renewed after Gomez's death in 1935. This new interest led to the creation of the Consultation Department of Mining and Geology, attached to the Development Ministry, in 1936. This new office managed to prepare the first geological map of Venezuela in just one year.

As the complexity of the industry increased, so did the need for a long term perspective in the design of oil policy. In response to this necessity, a National Commission for Mining and Oil Policy was created in 1949. This process of institution building culminated with the creation in 1950 (decree 41) of the Ministry of Mines and Hydrocarbons (MMH). From this date forward, this ministry was to centralize the technical control and regulation of the oil industry. The interrelationship between the technical aspects and taxation of the industry was recognized through the creation of the Permanent Interministerial Commission between the MMH and the Ministry of Finance.

Following a trend observed in other Latin American countries, the government created in 1956 the Venezuelan Petrochemical Institute (IVP) to undertake the industrialization of that sector. Originally, this Institute built a refinery and small fertilizers complex in the Moron area. The IVP was also entrusted with the administration of a network of gas pipelines to be built later.

The emphasis in conservation, as related to commerce and use of energy, was officially recognized only in 1959 when a Coordinating Commission for Conservation and Commerce was created by the MMH. Following this lead, the National Energy Council was created the same year.

Strange enough, it was only in 1959 when the government took any steps, beyond the support of universities, to promote the generation of locally-based petroleum technology: A commission for the formation of petroleum technicians was created. This move was complemented the next year not by the government but by the National College of Engineers which created an office to grant professional status to engineers graduated in foreign universities.

The interest to participate directly in the oil business led the government to create, in 1960, the National Oil Corporation (CVP), the original Venezuelan state petroleum enterprise (decree 260, Official Gazette No.26234). This momentum was used by the oil Ministry to assume the role of negotiator-coordinator at the international level. In 1961, representatives of all Latin American state petroleum enterprises met in Maracay, Venezuela. This and other initiatives created the concensus necessary for the creation of ARPEL (Asistencia Reciproca Petrolera Estatal Latinoamericana) in

1965. This organization was created mostly to facilitate the exchange of information and technical assistance among its members. As of 1980, ARPEL had hosted, or sponsored, 29 expert meetings with the assistance of 900 specialists.

Throughout the sixties, the government extended the scope of its intervention. In 1966, it normalized the definition of oil estimates and, that same year, it reactivated the National Energy Council, organ which broadened the vision of the MMH to include aspects such as alternative energy sources, rationalization of domestic demand, etc.

As mentioned, the most important event of the sixties, in terms of the change in regulatory emphasis, was the joining of OPEC.[20] With this move, the focus of the oil policy of the state was gradually shifted out of the country. More and more energy was devoted to the defense of oil prices. By the time of nationalization, negotiating in the multilateral setting of OPEC had become the most important activity of the Minister. Paradoxically, this task was being, and still is, supported by a relatively minor Office of International Relations attached to the MMH. In this regard, we may say, institutional development laggeg behind the realities of the oil industry as the ministry remainded overwhelmingly committed to domestic issues.

20- Actually, conversations with Middle Eastern producers had been initiated in 1948, when a presidential commission traveled to the region (Martinez, 1969:94).

During the early seventies, infrastructure had to be created to guide the process of nationalization, at the time expected to occur in 1983. The Reversion Directorate was created to oversee the implementation of the law with the same name (see p. 78). This directorate disappeared with the nationalization in 1975.

As for technology, we can cite at least three initiatives taken by the government prior to nationalization which resulted in the creation of more infrastructure occupied with these matters. The first was the creation of a research and personnel development fund in the field of hydrocarbons, FONINVES (still active) which was attached to the MMH the second was the creation of the Office of the Faja, attached to the MMH, to conduct technical assessment of production and upgrading processes suitable for the exploitation of the Orinoco tar belt, a huge reserve of heavy oil. The third was the creation of the Venezuelan Institute of Petroleum Technology, INVEPET. Under a new name, INTEVEP, this institute was incorporated upon nationalization as a full fledged subsidiary of the Venezuelan petroleum holding, PDVSA.

Figure 1 depicts the governmental infrastructure which was operating at the moment of nationalization in 1976. This structure was expected to perform the functions of technical regulation of the industry (volumes, exports, etc.), energy planning and policy-making, tax collection, information collection and organization, R&D funding and administration,

FIGURE 1. GOVERNMENT INFRASTRUCTURE FOR THE CONTROL OF THE VENEZUELAN PETROLEUM INDUSTRY (circa 1975)

MINISTRY OF ENERGY AND MINES

A) Offices attached to the minister:
- International affairs
- Legal Counsel

B) Support Staff Offices: [*]
- Sectorial Planning and Budgeting
- Information
- Human Resource Development
- Library and Technical Info.
- Administration
- Foreign Investment Control
- Statistics
- Personnel

C) General Directorates: [**]
- Hydrocarbons
- Geology
- Energy

D) Decentralized (autonomous) Entities:
- Fund for the Research and Personnel Formation in the Matter of Hydrocarbons, FONINVES;
- Venezuelan Petrochemical Institute, IVP;
- Institute for Petroleum Technology, INVEPET

---INTER MINISTERIAL COMMISSION---

MINISTRY OF FINANCE: [***]
Directorate for Petroleum Collections

OTHER MINISTERIAL OFFICES:
- National Council for Scientific and Technological Research, CONICIT, (Presidency)
- Venezuelan Institute for Scientific Research, IVIC, (M. of Health)

National Congress: [****]
- Permanent Comission for Energy and Mines.
- General Comptroller's Office.

NOTES:

*: There are several other "Offices" whose hierarchical position is not well defined. For example, the Office of the Orinoco Tar Belt.

**: Each one of these General Directorates has several simple directorates under supervision.

***: This chart includes only those sections of the Finance Ministry which are directly connected with petroleum.

****: The national Congress has the ultimate control power over the activities of all the institutions shown here.

negotiation within OPEC, etc. The MMH conducted most of these activities in other fields as well, mining and petrochemicals for example. As for the figure, the "General" directorates dealt with the most established aspects of the MMH's functions, while the "simple" directorates occupied themselves with subsets of those aspects. The "Decentralized Entities" constituted organs with an "autonomous" administration (state enterprises fall into this category). Autonomous, in this context, indicates that the ministry only exerts indirect control over the activities of such organs, and parliamentary control, which applies to all the executive branch or "centralized" entities, is implemented only a posteriori, e.g. at the end of the fiscal year.

The fiscal performance of the Venezuelan-oil governmental infrastructure has been, in general, praised in the literature (Edwards, 1971; Sigmund, 1980:253). The opinion is that this system was able to extract significant portions of the companies' exploitation rent during the concessionary period. Several questions can be raised, however, about the wisdom of maintaining the same infrastructure for fiscal control after nationalization (Moreno-Leon, 1979).Some of the activities performed at the ministry, such as sectorial planning, are clearly redundant as they are being performed within the nationalized industry. Other tasks, such as fixing references prices, are no longer required because nationalization changed the situation radically (oil prices cannot be manipulated because international operations are handled at arm's length). The maintenance of a bureaucratic apparatus for these activities is not only costly but also tends to divert official attention from crucial matters, OPEC diplomacy being the foremost example.[21]

The Technological performance of the Venezuelan-oil governmental infrastructure, on the other hand, appears as quite modest. The creation of institutions directly involved in the generation of technical expertise was delayed until the late sixties, more than fifty years after oil was discovered in Venezuela! The consequences of this lack of support were made even more evident by the negative effects (in terms of technological development) of other governmental policies of an entirely fiscalist orientation, such as low investment tax allowances. As we will discuss next, this lack of emphasis in technology on the side of government was the major reason behind the relative low level of expertise in areas where the concessionaires had no particular interest but that, by virtue of nationalization, and the change of strategy brought with it, acquired first-priority status; two examples of this are exploration and heavy-crude production.

The purpose of this discussion has not been to insinuate

21- To be objective, the booming oil market of the early seventies did not provide the best of environments for learning the importance of this activity of negotiating within OPEC.

that the country completely lacked indigenous technological competence to face the many challenges associated with the operation of the petroleum industry. In fact, the fortunate coincidence of several factors led to the opposite. First, the concessionaires had developed expertise of their own throughout their many years of operation. Second, several governmental initiatives, not supported by the MMH, spun off several research groups dealing with petroleum technology.[22] Third, several universities maintained schools and research groups with interest in petroleum and petroleum related areas. What is important to note is that all this domestic expertise was developed without major encouragement from the governmental oil infrastructure.

22- Among these we can mention: Venezuelan Institute of Scientific Research, IVIC, attached to the Ministry of Health and with research groups in chemistry and petroleum; the petroleum Institute of the Zulia University, INPELUZ, a research instituted attached to Zulia University with an autonomous branch "Fundacion Laboratorio de Servicios Tecnicos Petroleros" that provides technical services to the petroleum industry. INPELUZ is renowned by its expertise in geology and petroleum engineering.

C. THE LEGACY

The historic, strategic, legal and structural elements analyzed in the previous sections defined the environment under which Venezuela took the decision to nationalize its petroleum industry. Here we complement that analysis with a description of the internal characteristics of that industry at the time of nationalization time and the present. Finally, summary conclusions are derived from this chapter.

1. The Stakes: An Obsolescent Bargain ?[23]

By the end of 1975, the Venezuelan oil industry had entered a declining phase, at least in comparison with the situation of twenty years earlier. At the same time, the Venezuelan operation constituted, by almost any standard, the most complex industry within OPEC. Here we present some facts:

In organizational terms, there were 40 operating entities in the country at the moment of nationalization (See Table 1), more than any other OPEC member (the closest,

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23- The term "obsolescent bargain" has been used in the literature in reference to the change in the nature of the concessionaire-government relationship that takes place after the initial exploration and production risks have been undertaken by the foreign company and the capital has been sunk into production facilities. The typical pattern, it has been alleged, calls for a renegotiation of the original concession's terms in better terms (for the host government). In the Venezuelan case, however, the pattern was different in that the value of the concessions had been reduced by the low investment rate of the companies. For a discussion on this issue see, for instance, Raymond Vernon (1977).

TABLE 1. OPERATING ENTITIES AT THE MOMENT OF NATIONALIZATION.

1-American Petrofina of Venezuela	a
2-Amoco Venezuela Oil Company	b
3-Ashland Oil & Refining Company	a
4-Caracas Petroleum, S.A	b
5-Charter Venezuela Petroleum Company	b
6-Chevron Oil Company of Venezuela	b
7-Compania Shell de Venezuela, N.V	b
8-Continental Oil Company of Venezuela	b
9-Coro-Maracaibo Petroleum Company	b
10-Corporacion Venezolana del Petroleo	c
11-Creole Petroleum Corporation	b
12-Eastern Venezuela Gas Transport Company	b
13-Guanipa Oil Corporation	a
14-International Petroleum Limited (Gulf)	b
15-Mene Grande Oil Company (Gulf)	b
16-Mito Juan Concesionaria de Hidrocarburos	b,d
17-Mobil Oil Company of Venezuela	b
18-Murphy Oil Venezolana, C.A	a
19-Petrobelge de Venezuela	a
20-Petroleo Bajomar, C.A	a
21-Petrolera Las Mercedes, S.A	b
22-Phillips Petroleum Company	b
23-Pure Oil Corporation	a
24-Sinclair Venezuelan Oil Corporation	b
25-Sunray Venezuelan Oil Company INC	a
26-Talon Petroleum, C.A	b
27-Tenneco Venezuela INC	a
28-Texaco Maracaibo Incorporated (Texas)	b
29-Texaco Petroleum Company (Texas)	b
30-Texaco Seaboard INC (Texas)	a
31-Texas Petroleum Company	b
32-Triangle Refineries INC	a
33-Ucar Interam INC	a
34-Union Petrolera Venezolana, C.A	a
35-Venezoil, C.A	a
36-Venezuela Canadian Oils, C.A	a
37-Venezuela Gulf Refining Company (Gulf)	b
38-Venezuela Sun Oil Company	b
39-Venezuelan Atlantic Refining Company	b
40-Venezuelan Pacific Petroleums, C.A	a

Notes: a- Companies which are not direct beneficiaries of concessions but operate under cooperation and other types of agreement with the concessionaires.
b- Concessionaires
c- State-owned corporation
d- Venezuelan privately-owned firm.

Source: Congress Act, approved December 15, 1975, in accordance with the nationalization law.

Indonesia, had only 12). Further, these entities did not operate in consortia but were very independent; their managements remained very attached to their parent corporations. The personnel of the industry, while still the largest within OPEC, was drastically and strategically reduced between 1958 (44000) and 1975 (23000). The number of expatriates was also relatively large, 500 (2nd. below ARAMCO).

In operational terms, the number of producing fields, above 80, was only surpassed by Indonesia (122) and Nigeria (119). The number of producing wells, 11400, was larger than that of all other OPEC countries combined. Of these, only 18% were under natural flow (all Persian Gulf members had close to 100% of the wells flowing naturally). Further, the productivity per well, 200 B/D average, was well below that of all other members (Iran has 17000 B/D and Saudi Arabia 11300 B/D).

In resource development terms, Venezuela anticipated a very high level of new investments just to maintain the level of reserves, proven at 18.5 billion barrels (about 21 years) in early 1976. Additional investments in production (advanced recovery) and refining (change in the output mix toward lighter products) could easily push the annual investment rate above the 1 1/2 billion mark.[24]

24-These figures do not include the "Orinoco Tar Belt," a huge deposit of extra-heavy (continues on next page)

In marketing terms, the Venezuelan industry was producing more than 22 types of crude (the closest, Indonesia, had only 11), and that made marketing very difficult. In general, the quality of the oil was very low: quite heavy and high on sulfur content. The diversification of its markets was rather low, 85 percent going to North America and the Caribbean. Finally, the high percentage of refined products rather than crude oil made sales very technical.

The political element exacerbated all the problems associated with nationalization. Even minor decisions had to be approved through long parliamentary debates. More than three months, for example, were spent in the discussion of one article of the nationalization law which conferred certain autonomy to the oil companies to conduct their daily operations. At the end of this debate, however, the government-oil companies relationship was left in more or less the same position it had been before nationalization.

As most OPEC countries, the economic importance of the oil business was staggering. In Venezuela it contributed 30%

24- (continues from previous page) oil with reserves between 0.7 and 3.0 trillions of barrels in situ. Assuming a recovery rate of 10%, well below the country's average of 17%, could easily put Venezuela at the forefront of ranking of proven reserves. However, difficult technological problems associated with the production and processing of the high sulfur, high metal crude reduce the commercial attractiveness of this oil deposit. To these investments we may add those which are required to develop Venezuela's huge reserve of extra-heavy oil, the Orinoco Tar Belt.

of the GNP, 70% of the nation's fiscal income, and 90% of the value of the country's exports. From another perspective, such a long dependence on oil production had caused profound, largely irreversible changes in the economic structure and demographic balance of the country. From a position as net exporter of food [illegible]rly in this century, the country had come to depend on imports for about one third of the food it consumes. Rapidly growing and urbanizing population meant that the nation had to commit itself to large infrastructure projects.

The technological capacity of the concessionaires varied widely: some of the largest could afford relatively independent operations while others relied upon the support of their parent corporations for even the simplest of tasks. Similarly, this capacity for autonomous operation was different in each of the segments of the oil business (exploration, production, refining, transportation, marketing, etc.). The most complete assessment of the technological situation of the industry at the moment of nationalization was made by INVEPET with the concourse of employees from all the branches of the industry and led to the publication, in April 1975, of a document entitled "Diagnosis of the Technology Transfer to the Petroleum Industry". Here we summarize the contents of such study.

In exploration technology,[25] the situation was a reflection of the gradual, but almost complete, decline of this activity. Qualified manpower, numbering about 800 during the fifties, had been reduced to 44 in 1974. Not surprisingly, serious manpower shortages were considered a certainty for any change in the exploratory activity. This situation, the report explained, was aggravated by the fact that areas of exploratory interest for the soon to be nationalized industry, and not necessarily for the concessionaires, were located in the continental shelf where the experience of Venezuelans technicians had relatively little use.

Still, the INVEPET report revealed several positive points. First, many of the exploration technicians who were still employed by the concessionaires (although in different areas) would be willing to return to their original activity. Second, as expertise was unevenly distributed across the industry, the largest companies had the capability to provide assistance to the minors. Third, many of the technologies critical for exploration, geophysical mapping, geophysical data processing and exploratory drilling being three examples, were available out of the realm of the parent corporative in relatively competitive markets. (It seemed that the parent's expertise consisted, essentially, in keep

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25- The recommendations of INVEPET's report in the area of exploration technology were supported by 187 questionnaires. Of those, 44 were answered by professionals actively involved in exploration.

ing track of all the technological advances for a proper selection of the most appropriate techniques available). With these considerations in mind, the report recommended the creation of : 1) A center for geophysical data processing, 2) a "comprehensive" geological laboratory (including units in sedimentology, stratigraphics, tectonics, aerophotography, geochemistry and petrophysics, 3) Two regional exploration Centers in the east and west (to provide technical assistance and analysis to exploration activities) and, 4) a "library" of exploration cores.

Of all the stages of the oil industry, it was production which local expertise was most readily available at nationalization time. The INVEPET report concluded that the domestic industry was able to provide the technical support required for the maintenance of the operations at the 1975 level, However, it asserted that the progressive exhaustion of Venezuelan oil deposits would eventually require the use of new and more complex extraction methods which were at the moment unknown or unavailable within the country. Very candidly, the report mentioned several areas, most of them within general engineering, in which complacency had led to the continuous use of technical assistance from the parent firms even for tasks widely known elsewhere in the country.

As in exploration, the INVEPET document reported that much of the production technology was available out of the parent corporations from specialized service firms in markets with varying degrees of competitiveness. In one particular area, transportation, the same report acknowledged that the technical support coming from the concessionaires was critical and unavailable elsewhere. In this area, at least, the recommendation was to maintain the ties with the concessionaires after nationalization.

The analysis of the technological situation in the area of refining was, perhaps, the most complete in the INVEPET report. This section of the study reviewed three areas: 1) technology used for the operation and optimization of existing plants, 2) technology used in the development and installation of new plants and, 3) technology used in the formulation of refined products. This section of the report used the concept of "tecnological" link as any existing channel for the transfer of information between the parent corporations and their Venezuelan operations, for example, technical manuals, cooperative services, technical bulletins, on-the-spot assistance, courses, etc. These links were classified according to their importance into four categories : 1) those whose absence would cause plant shut down, 2) those whose absence would reduce the efficiency of operations, 3) those whose absence would lead to a non-optimal operation, and, 4) those which are not critical. Those links included in the

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26-In some technologies, such as measurement devices for drilling, there are service firms which hold a monopoly position (Slumberger LTD) while in others the market is very competitive. For information about the holders of petroleum technology, see Hiegel (1978), op.cit.

categories 1 and 2 were considered "indispensable," those within category 3 "highly desirable," and the rest "desirable."

In this area of refining, the conclusions were very revealing. For the case of technology used in the operation and optimization of existing plants:

1) A very high proportion of the links, 70% excluding courses, were considered indispensable.

2) Of all links examined, a very high proportion, 83%, came from the parent corporations.

3) In general, these links could not be substituted easily by local expertise: only 3% could be developed within a year, 37% within 5 years and 60% would require more than five years.

4) The degree of dependence from the parent corporations increased as the links became indispensable. So, while 19% of the "desirable" links came from alternative sources, the proportion was reduced to 15% in the case of indispensable links.

5) 53% of the "desirable" links obtained from the parent corporations could be substituted from alternative sources, but that proportion is reduced to 38% in the case of "indispensable links.

6- 64% of the "desirable" links could be developed within 5 years but only 34% of the "indispensable" links could be developed within the same period.

For the case of technology used for the development and installation of new plants, the report considered that Venezuela had developed at least part of the expertise as a result of some of the expansions made to the large refineries. Nevertheless, it concluded that it was uneconomical to create a whole infrastructure for design, scheduling, project management and plant start-up whose use would be limited to sporadic refinery expansions or other projects.

In the case of technology used in the formulation of refined products, the INVEPET report reached several conclusions. First, fuel technology was well known in Venezuela and formulation was done with the participation of the clients. Second, lubricant's technology was, on the other hand, more complex and required foreign support, especially in the selection of additives. Third, the nationalization of the internal market in 1973 did not motivate all specialists to move to the national oil company, CVP. As these employees were forced out of their technical jobs to administrative or managerial positions there was a loss in the technological resource they represented. Fourth, technology for other products such as asphalts, solvents, etc. was well known in Venezuela.

In computer science technology,[27] the diagnosis revealed the following points. First, the concessionaires were

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27- This part of the study included the evalu ion of 131 questionnaires which were filled out within 8 concessionaires.

self sufficient in administrative systems. Second, the parent corporations produced the main part of the technological support required for operations (exploration, production and refining). Third, the parents benefited considerably by the large scale of their operations: they were able to maintain a body of program development specialists, to centralize information about suppliers of computing services and products, and to contract the use of proprietary software under preferential terms. Fourth, as a consequence of the economies of scale they were able to realize, the parent corporations developed important software which was being used in 1975. Much of this technology, however, could be developed in a medium term if Venezuela re-created some of the same conditions prevailing in the parent corporations.

As we see, the industry was about to face the challenge of nationalization while suffering from a series of shortcomings. Some of these limitations were related to the geological structure of Venezuelan oil fields while others could be thought of as long term consequences of government policies. Still other shortcomings, could be related to the position of the Venezuelan oil companies as extractive subsidiaries of multinational oil companies. Whatever their origin, though, all these factors configured a very difficult situation for the industry. On the one hand, it had to take care of a complex operation without the help it had grown accustomed to while, on the other hand, the penalties for because of the fundamental role occupied by the industry in the Venezuelan economy. As we will see later, the industry showed that the magnitude of its strengths matched the requirements of this job.

2. <u>Summary</u>

In our opinion, the analysis presented in this chapter reveals the pervasive influence that historical, legal and political elements, that is exogenous elements, have had in the development of the Venezuelan petroleum industry. As far as technology is concerned, we have to recognize that the analysis shows only few cases where policies have generated specific responses. There is, on the other hand, abundant evidence on general effects of governmental policies which we will complement with material from the next chapters to produce specific conclusions. A summary of the main points of this chapter follows.

The structure of the Venezuelan oil industry during the concessionary period was set early in this century. As mentioned, the status of the diplomatic relationship between the home countries and Venezuela influenced the entry order for the oil companies. Thus, British concerns entered first, struck oil soon thereafter, and maintained a virtual monopoly of the concessions until war conditions and, most important, a concerted effort of the U.S. government changed the situation. Nevertheless, enough time had elapsed to allow the

British to consolidate their operations; and this provides one explanation as to why the oil companies did not form consortia (as they did in the Middle East) but opted to remain independent, and very competitive, entities.

Competition in the Venezuelan market, however, did not adopt the pattern usually discussed in economic theory. In this case competition was visible only in the form of little cooperation among firms (even in matters of common interest, such as government relations) and professional-like rivalries among managers. Aggressive price cutting was not observed frequently, as this would have undermined the worldwide cartel which existed for most of the concessionary peri . This fragmentation of the Venezuelan petroleum industry, in clear contrast with the worldwide integration of producing companies, had at least two important consequences.

In the first place, the local subsidiaries remained extremely dependent on their parent corporations. Contrary to those countries in which producing consortia were established, each producing operation remained small in relation to the global operation of the multinational oil companies. Hence, there was never a real need for developing strategic capabilities in the Venezuelan subsidiaries. One important exception was the Shell operation, which was converted into a regional center for South America. But, then, Shell was not an American firm so the provision of support from the parent was costly. In the second place, the local subsidiaries did not develop strong technological capabilities, not only because of their extreme reliance on their parents but, also, because of the impossibility of sharing any technical resources with each other.

This singular structure of the Venezuelan oil industry suggests the existence of some special characteristics. Among these, we can mention the closeness and openness to American firms, a factor which reduced the costs of direct control. As we said, the opposite situation occurred in the most independent of the Venezuelan operations, that from Royal Dutch Shell. Another characteristic, might have been the low quality of the Venezuelan crude, which limited its demand outside the oil firms. In sum, the characteristics of the Venezuelan market ensured a self-enforcing situation of dependence.

The entry of small firms and the so-called independents was delayed until the forties and fifties and, then, on a marginal scale. This fact meant that the largest U.S. firms and the Royal Dutch Shell dominated the Venezuelan oil scene throughout the whole concessionary period, although as separate entities. Thus, from an organizational perspective, nationalization implied taking over a set of medium-size firms with highly consolidated operations, culture, administrative procedures, etc., involved in active "competition" among themselves and with a fringe of smaller companies . As we show in later chapters, this structure has had long-lasting consequences in the behavior of the industry which are noticeable even after nationalization. In particular, we refer to the existence of significant barriers for the adoption of consistent industry-wide strategies, and communication in general, which are related to differences in orientation and organization among the different nationalized companies.

The concessionary system provided the legal basis that supported direct governmental intervention since the beginnings of the industry. While trying to obtain evidence linking this form of government control to a rational pattern of oil production, we found, very interestingly, that the companies themselves adopted the first initiatives in this area through unitization (1927). Explicit governmental policies dealing with orderly exploitation of the fields were enacted soon thereafter. Still, there is not enough evidence to support the view that this legislation saved the fields from permanent damage, if there was any (one possible reason: it was enacted too late).

On the fiscal side, the Venezuelan concessionary system was quite effective in obtaining revenues from the companies. This success, we commented, may have come at the expense of slowing down some critical activities of the industry, in particular capital investment for developing the fields. In this sense, we argued, the development of indigenous technological capabilities could have been delayed because it took more time for Venezuelans to use several sophisticated technologies than otherwise. At the end, the government recognized this possible negative effect of taxation by providing tax deductibility in several specific areas.

Another consequence of Venezuela's success in revenue collection, as well as other restrictive policies toward the industry, is the contentious character of the government-industry relationship. This mutual dislike is so open that is reasonable to speculate that the reluctance of the central administration to introduce obvious improvements to the tax collection system is based on prejudices developed during the concessionary period (for example, that the oil companies are out to cheat the state, or are mere instruments of imperialism). The same comment applies, in reverse, to the oil industry. The evidence shows (see next chapter), that the economic realities of a country entirely dependent on oil production have prevented this overtly acrimonious relationship from producing much more than verbal debates.

The Venezuelan government was slow in implementing measures that could have counteracted the negative side effects of its fiscal policies. As far as technology is concerned, it failed to generate incentives or legislation that would have led the companies to do any local R&D and, furthermore, delayed the creation of any significant R&D infrastructure of its own until the late sixties. Our argument is strengthened further once we consider the fact that some important legislation passed by the government, in particular the pseudo-nationalization decree No.832 of 1971, did not bring any significant changes in the technological strategy of the concessionaires. In short, the government did not utilize all the tools it had to influence the behavior of the industry.

Our description of the technological situation of the industry before nationalization reveals that those areas of greater weakness were somehow connected with strong government intervention. The scarce capacity in exploration, for example, could be explained by saying that the state petroleum corporation, CVP, did not do a good job when it took over the exploration activities. Of course, we have to admit that veral legal and political obstacles, such as the need for congress to approve all exploration-related contracts, contributed to the poor performance in this area. Nevertheless, it was clear that the nationalized industry could not operate efficiently without a continuous technological input from foreign sources and, in particular, from the parent companies.

By way of conclusion, we may say that, by 1975, the Venezuelan oil government infrastructure had been designed to provide the technical support necessary for maximizing tax revenues. This predominant orientation meant that certain functions such as energy planning, R&D planning, international negotiation, etc. were underdeveloped within the public sector at the moment of nationalization (and some still are) even though they were to become crucial in a state owned enterprise.

CHAPTER III

THE NATIONALIZED INDUSTRY: A NEW ORDER

A. ORGANIZATIONAL MEANING OF NATIONALIZATION

As mentioned, information processing (IP) constitutes a powerful framework for the analysis and design of organizational structures. In our case, this framework will permit us to propose a consistent set of strategic recommendations to improve the effectiveness of the industry to perform its tasks within the nationalized setting. A first step in that direction is to describe the process under review in terms of IP's basic descriptive dimension, uncertainty. Before going any further, however, we proceed to define uncertainty in a manner which is popular among organizations's theorists:

> "Uncertainty is the difference between the amount of information required to perform a given task and the amount of information already possessed by the organization." (1)

The main effect of nationalization on the Venezuelan petroleum industry was to increase the level of uncertainty faced by the industry in general and its managers in particular. This increase in uncertainty came from five basic sources. First, the "externalization" of transactions previously held within the context of the concessionary-subsidiary rela-

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1- Galbraith (1977:5). This definition of uncertainty is admittedly different from that accepted in other fields such as finance, where uncertainty is associated with variability in cash flows. However, new developments in the theory of firm as an environment for the sharing of risk, wherein all transactions can be expressed in contractual form (see Fama, 1980, for example), promise to close the gap between the two definitions of uncertainty.

tionship. "Externalization," in this context, refers to the movement to the open market of such transactions. Second, the course of several developments in world oil markets, although not associated with nationalization per se, has constituted a disturbing factor in recent years. Third, the change in status from privately-owned to state-owned, what we may label as increasing "social-responsibility," provides additional constraints for decision making; these constraints include different attitudes toward organized labor and environmental-safety rules, as well as an increased propensity for government intervention in decision making (which in a nationalized setting the government has the legal right to do). Fourth, some elements of the strategy adopted by the nationalized industry increased the possibilities of disagreement and confusion among its managers. Fifth, several geological characteristics of the Venezuelan oil deposits that, again, have nothing to do with nationalization, represent additional sources of uncertainty.

Externalization

The increase in uncertainty coming from the externalization of transactions previously held within the context of the concessionaires has been particularly notorious in two markets: the oil market and the technology market. In both cases, the nationalized industry has been forced to deal at arm's length for the acquisition or sale of goods and services that were previously obtained through corporate channels. In the sale of oil products, for example, dealing with new clients calls for the processing of additional information regarding clients' credit ratings, their preferences about quality, future characteristics of the market (to set contractual; discounts or premiums), etc.[2] Furthermore, current conditions of world markets call for the implementation of active marketing strategies which are highly demanding in terms of information.[3]

Externalization: Technology

The acquisition of technological inputs represents another instance in which "externalization" has largely increased uncertainty. One obvious reason is that much of the now-negotiated technical assistance used to be obtained promptly and at very low cost to the Venezuelan oil companies, as an internal flow from the parent corporation. Another, less obvious, source of added uncertainty has to do with the development of basic technology required to keep the industry competitive in the long run.

2-This is particularly true in the case of Venezuela because the government, as a matter of national policy, has consistently discouraged spot sales of crude oil (Venezuela is OPEC's member with the largest percentage of oil sold under long terms contracts). Sale under long term contracts demands more information than do spot sales.

3-It is certainly true that much of this activity was previously performed by the subsidiaries themselves. Still, it seems safe to state that many of the marketing guidelines that used to be prepared at headquarters are now prepared by the affiliates.

The effect of these two "technological" sources of uncertainty is exacerbated by the fact that they pose conflicting demands on the organization while, at the same time, being highly interdependent.

Diversification of the sources of technical assistance, not a costless alternative,[4] can effectively reduce the first type of uncertainty, but is of little help in the second. First of all, the number of providers of basic petroleum technology is limited, thus diversification would provide few gains even if completed. Further, the potential benefits of acquisition, e.g. licensing, of basic technology are limited because they only apply to existing, not future technologies.[5]

Developments in World Oil Markets

The erosion of OPEC's market power resulting from increases in non-OPEC production and conservation efforts by consumers, have certainly complicated the marketing of oil. To the normal seasonal fluctuations in demand, we have to add those coming from the moves of competitors and

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4-The costs of this strategy are several: costs of obtaining information to evaluate alternative sources and to negotiate, plus the costs associated with adapting unconventional technology to existing operations.

5-Cooperative research agreements promise to be of some help but are, again, limited because no external research partner is likely to accommodate to PDVSA's long-term research interests.

from the economic situation of consumers. Due to its high output of refined products, Venezuela is most sensitive to recessionary situations in consuming countries.[6]

Increased "social responsibility"

The status of state-owned enterprise implies the observance of a series of social goals to an extent which is not observed in private firms. For example, the attitude toward organized labor (in Venezuela highly influenced by the political parties) has to be more moderate now than before nationalization. Further, knowledge of this fact invites opportunistic behavior on the side of the unions.

Another consequence of added "social responsibility" is that the nationalized industry faces an increased risk of punishment for any eventual violation of safety and environmental rules. This aspect promises to become more critical as PDVSA speeds up the development of the Orinoco Tar Belt, as well as other large construction projects with potential to change the urban and rural landscapes.

Finally, the status of state-owned enterprise, coupled with a very conservative financial strategy on the

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6-Recent research (Owsley, 1979) contends that the uncertainty associated with oil markets may be increasing as a result of the marketing strategies of the national oil companies. The reason, it is alleged, is that by selling their oil independently, instead of using the channels of the majors ("participation oil" and the like) OPEC's nationalized companies may be forcing the creation of a competitive market.

side of PDVSA (which leaves considerable amounts of cash in PDVSA's hands), increases the risk of fund-seeking intervention by the government. It is true that the central government could raise funds elsewhere, but there are strong political disincentives against the floating of bonds in international money markets because all sizeable emissions have to be cleared by congress.

Elements of Strategy

Several strategies adopted by the industry to straighten up its organizational structure have largely increased the uncertainty associated with decision making. To the contingencies normally associated with the operations of the industry, these strategies have added the possibility of disagreement among managers accustomed to different corporate styles. This effect is observable within PDVSA's affiliates as well as at the corporate level where group decision making is very frequent.

Geology

The advanced age and technical characteristics of Venezuelan oil fields, combined with low level of exploration performed during the immediate pre-nationalization period, created a climate of uncertainty about the size and recoverability of the petroleum reserves. To these two factors we may add the uncertainties derived from the low availability of qualified personnel in exploration, many of whom had shifted to other occupations as a result of the contraction of this activity.

As we see, nationalization profoundly changed the context for decision making within the industry. In almost any instance, decisions became more complex and demanding in terms of information. Thus, substantial changes in structure were necessary for the industry to maintain its effectiveness under the new circumstances created by nationalization.

In the rest of this chapter we examine the influence that explicit elements of corporate strategy and structure have had upon the operations of the industry in general, and upon its technological function in particular. To this end, we separate the analysis in two parts which correspond to consecutive periods of the industry. In the first, we analyze the early choices of strategy and structure made by the industry in response to its original concern for continuity. In the second, we analyze the effect of several additional strategies which were adopted in response to a new concern for efficiency that evolved later in the industry. The effects of functional strategies are analyzed in the next chapter.

B. THE CONCERN FOR CONTINUITY

Given the paramount role played by oil in the Venezuelan economy, it was only natural for the industry to start its operations guided by a concern for operational continuity. As described in this section, this preocupation may have been cause for delay in the implementation of some obvious, if necessary, measures which were required to rationalize the structure of the petroleum industry.

1. THE CREATION OF THE "HOLDING"

As mentioned, by the early seventies most political sectors in Venezuela shared the desire to nationalize the oil industry before 1983, the expiration date for most concessions. There remained, though, considerable disagreement about the design of the process itself. Critical areas, such as compensation (amount and mode) and the structure of the nationalized industry, remained as the subject of heated, if highly rethorical, debates. The unstructured process of nationalization that ensued can very well be described as a series of attempts made by the executive branch and the industry to accommodate the many diverging interests surrounding the different issues; and the same comment applies to some elements of the resulting structure, for instance, to the ambiguous design of the interface between the government, represented by the Ministry of Energy and Mines (hereinafter

MEN), and the industry.

While reviewing the Venezuelan nationalization process in general is beyond the scope of this work, and good references are available elsewhere (Petras, Morley and Smith, 1977; Sigmund, 1980), it is appropriate to describe some of the proceedings leading to the creation of the state-owned industry because these became an important source of strategic concern to its management. Then, following this description, we complete our analysis of the original structure of the industry.

Technically speaking, the nationalization was completed through a two stage process. First, a "holding" company was created with the name of Petroleos de Venezuela (PDVSA) on August 28, 1975. The ranks of PDVSA were filled with personnel from the concessionaires and from related sectors such as the Ministry of Mines and Hydrocarbons. In a second step, PDVSA acquired the 40 operating companies (see table 1, page 102) and reunited them into 14 affiliated companies, as shown in figure 2. In this manner, all the personnel of these companies was smoothly transferred to work under the guidance of PDVSA. This process, in itself, was very unusual, as it occurred in a staged fashion during a period of 4 months. Indeed, experience shows[7] that these nationalizations tend to

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7-For a recent look at several processes of nationalization of foreign investment in Latin America see, for example, Sigmund (1980), op. cit..

FIGURE 2. NATIONALIZATION OF FOREIGN OIL COMPANIES.

CREOLE PETROLEUM CORPORATION	---> LAGOVEN
AMOCO VENEZUELA OIL CO	---> AMOVEN
COMPANIA SHELL DE VENEZUELA NV* CONTINENTAL PURE OIL CO* UNION PETROLERA*PETROLEOS BAJAMAR CA* TENNECO*AMERICAN PETROFINA*PETROBELGE DE VENEZUELA	---> MARAVEN
MURPHY OIL*VENEZOIL*ASHLAND REFINING*VENEZOLANA PACIFIC* VENEZOLANA CANADIAN*SUNNY VENEZOLANA*TRIANGLER REFINERIES	---> ROQUEVEN
TALON PETROLEUM	---> TALOVEN
MITO JUAN CONCESIONARIA DE HIDROCARBUROS	---> VISTAVEN
MENE GRANDE OIL COMPANY OF VENEZUELA*GULF INTERNATIONAL*GUANIPA OIL CORPORATION	---> MENEVEN
S.A. PETROLERA LAS MERCEDES	---> GUARIVEN
VENEZUELA SUN*CHARTER PURE OIL	---> PALMAVEN
VENEZUELA ATLANTIC REFINING CO* UCAR INTERAM*SINCLAIR VENEZUELA OIL CORPORATION	---> BARIVEN
MOBIL OIL CO DE VENEZUELA	---> LLANOVEN
CHEVRON OIL CO DE VENEZUELA	---> BOSCANVEN
CORPORACION VENEZOLANA DEL PETROLEO	---> CVP
TEXAS PETROLEUM CO*TEXACO PETROLEUM* TEXACO MARACAIBO*CORO-MARACAIBO PETROLEUM*TEXACO SEABOARD	---> DELTAVEN

SOURCE: Moreno-Leon (1981), op. cit.

be dramatically fast. The procedure had several advantages: first , the "holding" company had some time to acquire experience in its functions before nationalization, second, it was spared the considerable legal costs of liquidating the concessionaires plus incorporating new companies and, third, as no liquidation took place, there was no special need to pay termination benefits to the workers, a very costly proposition for an industry with more than 20000 employees.[8]

In selecting the way of organizing its oil industry, the Venezuelan government had, in principle, many choices available. This selection, however, was made more difficult by the lack of any consistent model for the organization of state-owned enterprises (hereinafter SOEs). Some of the structural dimensions to consider are shown below:[9]

- Legal format: There is almost universal agreement about the superiority of the corporative format, with its own legal title different from that of the state, over the so-

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8-We may add, however, that the employee's fund, which amounted to 0.5 billion dollars was available in its entirety, as required by law. The costs associated with paying the fund were not only administrative but financial, as this operation would have implied terminating the portfolio of the employees'fund investments.

9-The literature dealing with the organization of SOEs is extensive. General works in the subject can be found, for instance, in the United Nations' literature (see U.N.,1974), and in a compilation prepared by Shepherd (1976). Two studies on the organization and management of state-owned petroleum enterprises are Grayson's (1981), which deals with European firms exclusively, and a compilation prepared by the United Nations' Centre for Natural Resources, Energy and Transport (U.N., 1978).Other works deal with more specific aspects such as the experience in the use of (continues on the next page)

called "institutes," which are dependent on other branches of government. Within the corporative format there are two choices, the commercial or joint stock company, and the public corporation. Of these two, the most common is the latter. In Venezuela, the corporation is, also, the most common format used for industrial SOEs, although the original petroleum SOE, CVP, functioned as an "institute" until 1975.

- Control_system: In most countries, SOEs' ultimate accountability is based on the parliament. However, institutional factors limit such control to little more than sporadic audits and questioning of SOEs' top management. As such, governments tend to exert control through a variety of mechanisms which include ascription of SOEs to functional ministries, such as transportation and health, to development ministries or "funds," the case of Argentina's "Ministerio de la Economia" or Venezuela's "Ministerio de Fomento," to generic ministries devoted exclusively to SOEs, the case of Italy and Spain. Another system is based on an office dependent on the parliament, such as US's General Accounting Office and Venezuela's General Comptroller's Office. In the case of Venezuela, the most used modes for the control of SOEs are those of the functional ministry and the development ministry; no ministry for SOEs has been created, although proposals have been made for the creation of a permanent ministerial organ for the control of SOEs (Viloria, 1980).[10]

- Use_of_a_"holding": In principle, this choice is related to a desire of increasing the coordination between the activities of SOEs (Viloria, 1980), and to the need of a buffer between the SOEs and the central government (Mallon, 1981). Actually, the creation of "holdings" has

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9-(continues from the previous page) "holdings" to centralize the control of the state over these enterprises (Viloria, 1980), alternative modes of control (Ghai, 1982; Brewer-Carias, 1969; Hofstede, 1981) and performance evaluation (Mallon, 1981; Warwick, 1979), etc.

10-It is important to note that these control schemes, practi-tioners and theoreticians agree, cannot work in the absence of managers and government officials that accept a more or less clear division between the responsibilities of policy determination and planning. Too frequently, power conflicts between the government and the enterprise become the sole concern of the control body, a situation which obscures the real issues of production and technology (Ghai, 1982:70). Recent arguments posit that the basic problem is to have managers "internalize," (that is adopt as their own) principles of efficiency together with the public goals of the SOE. For a look at this argument, see Mallon (1981) op.cit.

a lot to do with the aforementioned issue of control. In terms of their nature, these "holdings" show great variability: from merely financial, the case of Italy's IRI, to tightly controlled structures, such as Italy's ENI. In Venezuela, there is very little experience with this form of organization. Perhaps several existing development funds can be considered as financial holdings. A recent proposal, shown in Moreno-León (1981:464), calls for a four-tier structure for SOEs: A Ministry of Energy and Basic Industries (1) would supervise two "holdings of holdings" (2). These last two would supervise the sectoral holdings (3) which, in turn, would supervise the SOEs (4).

- Integration: This choice refers to the creation of structures (such as committees, task forces, etc.) to integrate the functions across divisions in a holding.

- Diversification: The degree of diversification varies widely among SOEs. In the case of petroleum SOEs, the usual choice for diversifying moves is some other areas in the energy business (atomic, electrical, etc.), and recent work done by Teece (1978) shows some correlation between this type of diversification and innovativeness. It is possible, however, to find SOEs with involvement in textiles (ENI) and trading (Veba).

- "Divisionalization": This choice is related to the problem of autonomy of the divisions from the central office. The issue is whether to create separate autonomous divisions instead of functional departments (Chandler, 1963; Williamson, 1975). In this regard, there is almost universal agreement about the superiority of the divisional form above a certain size. In Venezuela, though, there has been some disagreement about this issue.[11]

- Vertical integration: As a rule, petroleum SOEs tend to be integrated vertically.

- Autonomy: In practice, the degree of autonomy granted by governments to SOEs tends to be more dependent on the attitudes of the central government than on existing legislation. In part, these attitudes respond to cultural factors . Two basic patterns of autonomy in SOEs have been observed: the European, characterized by very autonomous SOEs, and the Latin American, characterized by a strong dominance of the executive branch (Vernon,

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11-For arguments in favor of the divisional structure in the Venezuelan oil industry see, Quiroz (1982) and Villalba (1982-a).

1980:31). Another determinant of autonomy is the personality of the chief executive because governments, in their bid for dynamic and competitive SOEs, have frequently chosen venturesome entrepreneurs for helmsmen. Very frequently, these executives have been able to gain enough independent support for themselves to enjoy considerable autonomy. [12] In Venezuela, the degree of autonomy enjoyed by SOEs, and the choice of top personnel to head these enterprises, is consistent with the Latin American pattern mentioned earlier.

- Technology: As any other enterprise, SOEs are faced with the choices of acquiring or developing the technological inputs they require. The most common choice is a combination of both alternatives. For the case of nationalized SOEs, the choice tends to be reduced to acquisition because of the low level of technical expertise and because the idiosyncratic nature of their operations ties them to their former parent corporations. For those SOEs committed to developing their own technological capacity, several structural choices are relevant: centralization or decentralization of R & D, functional or project organization of these activities, etc. In the case of Venezuela, there was almost no experience in the organization of R & D within SOEs before nationalization. Most of the industrial SOEs, for example aluminiun and steel, depend heavily upon foreign sources of technology.

- Participation of political interests: By their own nature, SOEs respond to the political, thus partisan, interests of governments. The ability to enforce any particular political orientation, however, is related to the mode in which the political interests participate in the decision making of these enterprises. The channels available for influence are many: membership in the control body (congress, for instance), membership in the board of directors, control over the hiring practices for both managers and blue-collar workers, budgetary control, unionization (if unions are controlled by political interests), etc. In Venezuela, all these channels are active, and the unions tend to be subject to partisan influences.

In practice, the choices of different patterns of organi-

12-A look at individuals such as Enrico Mattei of ENI(Italy), Victor de Metz of CFP (France), Pierre Guillaumat of SNEA (France), Lords Kearton and Balogh of BNOC (England), and Arve Johnsen of STATOIL (Norway) would validate this assertion. For a more detailed look at this type of influences, see Grayson (1981:19) op cit.

zation available to PDVSA and its affiliates were fewer than this list may lead to think because some combinations were unfeasible. Furthermore, some choices were reversible, for example, a decision to put politicians in the board could be reversed.

2. PDVSA's Model

From an organizational perspective, perhaps the most important decision taken during nationalization was to maintain the administration of the industry as close as possible to the way it was under the regime of concessions. This decision minimized the "cultural risk" (Stonich, 1982:36) associated with the change in ownership, at least during the initial stages of the operation of the nationalized industry. In the words of one of PDVSA's directors, Alirio Parra, preserving the administrative order conferred PDVSA four characteristics which differentiated this company from other SOEs:

> "1- PDVSA was constituted as a profit-making enterprise which depends on its own resources for financing.
> 2- Thanks to its independent administrative system, the company is free from political interference.
> 3- The managerial orientation is economical instead of political.
> 4- The basic competitive incentives are maintained."
> (Quoted from Grant, 1981:16)

In terms of the structural dimensions mentioned before, the main features of PDVSA's organizational model are:

- Legal_format: It has a dual nature. Although incorporated as a commercial company, PDVSA's stock is owned entirely by the Venezuelan state and its shares are non-transferable. This duality is notorious in several aspects: while its employees are not considered public servants, its directors are appointed by presidential decree; while the stockholder's meeting decides the creation or termination of affiliates (congress is excluded from such a role), the Ministry of Energy and Mines (MEM) retains veto power over PDVSA's annual plans. [14]

- Control_Body: PDVSA is commercially audited but must submit its yearly plans to the MEM for approval. The MEM remains, as before nationalization, the main body in charge of the technical control of the industry. Besides its ability to change the statutes, congress plays a relatively marginal role in the control of the industry through the General Comptroller's office.

- The_use_of_a_holding: PDVSA was constituted as a "holding" company with the objective of "Coordinating planning and supervising the activities of the entities it owns; as well as to ensure that the activities of these entities in the areas of exploration, exploitation, transportation, manufacture, commercialization, or any other area related to petroleum and other hydrocarbons, are executed in a regular and efficient manner." (Decree No.1123, Art.2, dated August 30, 1975). In our view, the continuous references of oil executives regarding "political interference" and "bureaucratic rules" suggest the role of PDVSA as buffer between the companies and the government. As to the role of the "holding" in the planning process, it appears that PDVSA participates by bringing the vague governmental guidelines into the more concrete objectives required by the industry.

13-PDVSA's bylaws, which are similar to those of any private corporation, are shown in the presidential decree No.1123, dated august 30, 1975, and published in the official Gazzete, No. 1770.

14-As Zakariya (1978) shows, this format is only rarely found in state petroleum companies. As for Venezuela, it is unique since no other SOE has its shares nominated in favor of the Republic of Venezuela. For a detailed analysis of the legal regime applicable to PDVSA, see Brewer-Carias (1977), op.cit.

- Integration: Figure 3 shows the abundance of integrating devices which were built into the structure of PDVSA. Each directive committee is constituted by members of the board of directors and supported by a staff body known as "co-ordination" which is headed, naturally, by coordinators. According to one of PDVSA's former directors, Gustavo Coronel (1982-b), the idea of functional coordinations attached to the holding company was borrowed from Shell International; and the integrating activity of such co-ordinators, through committees made up by members of the operating companies, was borrowed from Exxon. [15] The effectiveness of these integrating devices will be discussed further (with emphasis in the technology area) in later chapters.

- Diversification: As stated in its bylaws, PDVSA cannot engage in activities outside petroleum and other hydrocarbons. While this statute excludes diversification into areas such as atomic energy and electricity, which appear to be jurisdiction of the MEM, it allows PDVSA to operate in petrochemicals and other chemicals.

- Divisionalization: PDVSA's organization is clearly divisional. Functions are not integrated beyond what is allowed by the committees and each division (affiliate) is allowed freedom in its interpretation of corporate-wide plans.

- Vertical integration: PDVSA is vertically integrated, although it is clearly more developed in the upstream (production, refining) than in the downstream (manufacture, marketing) stages.

- Autonomy: PDVSA is relatively autonomous from governmental intervention, at least by local standards. As mentioned, the involvement of the executive branch in planning is limited to the enforcement of vague policy guidelines. Another way of influencing the activities of PDVSA is through the appointment of the directors. In general, the Venezuelan government has not pursued this possibility,

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15-A look at Chandler's classic study (1962:218-221) shows that, indeed, the integrating functions performed by the so-called "group system," created in the Standard Oil during the thirties, are similar to those of PDVSA's coordinations. We may add that similar parallelism can be found in many other structural aspects of both companies. This is not surprising since, as we know (Galbraith, 1973), all these integrating devices are commonplace within large divisionalized companies.

FIGURE 3. PDVSA's STRUCTURE

```
STOCKHOLDER ( MEM )-----> ASSEMBLY
                              |
                          PRESIDENT------VICE PRESIDENT
                              |
        ------------BOARD OF DIRECTORS
        |                     |
        |             EXECUTIVE COMMITTEE
        |                     |__________
        |                      _________|_________
        |                     |                   |
        |                     |  14  AFFILIATES   |
        |                     |  ( see figure 2 ) |
        |                     |___________________|
        |                              ^
 ----------------------------------    .
|                                  |   .
|  DIRECTIVE COMMITTEES ( 17 ):    |   .
|  Exploration, Production, Orino- |   .
|  co Tar Belt, Refining, Inter-   |   .
|  national Marketing, Commerce &  |   .
|  Supply, Petrochemicals, Fi-     |   .
|  nance, Planning, Organization & |   .
|  Human Resources, Industrial     |   .
|  Safety, Rationalization, Urban  |   .
|  Development, Computation &      |   .
|  Systems, Technological Develop- |   .
|  ment [a], External Relations,   |   .
|  and Contracting Commision [b].  |   .
|__________________________________|   .
              :                        .
              :                        .
      LIAISON DIRECTORS                .
              |                        .
 ----------------------------------    .
|                                  |   .
|  "COORDINATIONS":                |   .
|  Planning, Organization & Human  |.......
|  Resources, etc....[c]           |
|__________________________________|
```

NOTES:

a-This committee includes the presidents of all the affiliates.

b-This commission includes more directors than the others plus the presidents of all the affiliates and external members.

c-Not all directive committees have a corresponding "coordination." For instance, the planning "coordination" deals with technological issues.

SOURCE: Grant (1981).

although recent events may reveal a disturbing trend towards more active intervention (Coronel, 1982-a; De Walle, 1982). As far as top personnel is concerned, the first round of appointments epitomized the conciliatory spirit which pervaded government and industry ranks, as it consisted of a team of highly experienced executives, many of them retired from the active oil ranks. Clearly, this was not the type of entrepreneur found in other petroleum SOEs. While this choice seemed appropriate for the difficult early stages of nationalization, it was apparent that the industry would find it difficult to take future appointments of this nature; prefering instead more entrepreneurial managers, and drawn from the industry itself.

- Technology: PDVSA is committed to developing its own technological expertise, while, at the same time, maintaining the continuity of its operations. This dual purpose calls for twin strategies for the acquisition and development of technology. As for acquisition, PDVSA subscribed technical assistance contracts with all but one (Atlantic Richfield) parent corporations. As for development, PDVSA decided upon the creation of a single R&D unit. This unit, known as INVEPET (see figure 1, page 97), was at the time ascribed to the MEM. In later sections we will describe in detail the integration of this unit into PDVSA.

- Participation of political interests: Political interests have the capacity to enforce their will in PDVSA's decision-making process through the formal channels provided by the nationalization law. These channels include: veto power of MEM over PDVSA's plans, appointment of the President and other members of the directory, congressional subpoena, unionism, etc. Originally, PDVSA managed to keep most partisan interests out of the industry. Even the veto power from the MEM seemed like mere formality. According to Coronel (1982), the first round of appointments indicated that the post of Vice-President was reserved for an executive congenial with the party in power. In a similar vein, the Petroleum Workers' union was granted direct participation in PDVSA's top decisions by appointing its leader to the board of directors. In the light of the experience of other Venezuelan SOEs it is still surprising the little interference of political interests in the management of the industry. One clue can be found in the comprehensiveness of the nationalization process which left all parties satisfied with their involvement in the petroleum industry.

As we see, the most remarkable characteristics of PDVSA's original structure were, first, its dual emphasis in autonomous management of the divisions and integration of functions across those same divisions, and second, its relative independence from political interference. Regarding the first characteristic, we may say that maintaining managerial independence of the divisions did not need any encouragement from the "holding" because of the historical rivalries among the divisions which were described in the previous chapter. However, this same reason makes functional integration a very difficult task which requires continuous encouragement and the creation of formal structures.

The issue of functional integration deserves further attention at this stage.[16] A comparison between PDVSA's integrating devices with those of other large enterprises (Chandler, 1962:205-221) shows more than superficial differences. In particular, we refer to the lack of support staff beyond that one devoted to the tasks of integration. For example, Standard Oil of New Jersey, a firm which served as a model for PDVSA's structure, has central advisory bodies (the so-called "coordination department") in addition to the inter-divisional liaison committees (the so-called "group system"), which is in charge of integrating the functions across the corporate structure.

At Standard (today's Exxon) the function of the liaison

16- Of course, the problem of functional integration in technology will be fully covered in a later chapter.

committees (equivalent to PDVSA's "coordinations") is to pool expertise for the evaluation of investment proposals, e.g. integrate functions, and not to provide direct support to the top management. This task is assigned to the central staff, represented by the "coordination department, which is the one which brings operative information to the attention of top management. In turn, the central staff acquires its operative-level information through its participation (as observer) in the activities of the liaison committees. This structure permits the use and processing of information derived from the activity of the committees for corporate-wide planning without substantial time commitments by the directors of the corporation.[17]

Without adequate staff support to planning, general managers may be drawn to direct involvement in the operative-level activity of the committees in order to obtain accurate information for planning or other activities, even at the risk of losing their strategic perspective.[18] Alternatively,

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17-To be objective we must recognize that PDVSA has a "coordination" devoted to planning. Its role, however, seems to be more the integration of divisional ("corporate" in PDVSA's jargon) plans than the provision of general support to the directory.

18-This is the case of the "corrupted" multidivisional (M) firm described by Williamson (1975:148-153). In this type of firm (no ethical connotation is involved here) general management has become extensively involved in operating affairs and, consequently, unable to properly allocate responsibilities between the short and long-run matters. In short, the corrupted divisional firm lacks "strategic decision-making capability" (Williamson, 1975:149).

corporate management can use bodies created for other purposes, even corporate-wide planning, for the gathering of information relevant to their own planning process; or, quite simply, formulate strategies based on inaccurate information. Both alternatives are, of course, bad. The first represents a misallocation of scarce managerial resources, while the second may lead to inconsistent strategies.[19] Based on this structural analysis, we can say that if PDVSA were to become involved in a comprehensive planning process, of the kind observable in the large oil companies, it would be at the expense of engaging general management in operative affairs or, using Williamson's (1975:148) words, at the expense of "corrupting" its divisional structure. Evidence presented in the next section will allow us to pursue this issue further.

Finally, we may say that analysis of PDVSA's model does not show any structural reason for the low level of political interference in its management. As it was, the structure of this SOE appeared quite vulnerable to partisan influence in several respects: the appointment of top management, the issuance of strategic guidelines at the ministry level, congressional auditing, union pressure, etc. In the light of such vulnerability, we contend that the low

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19-We may point out that the events which led to divisionalization in all the cases studied by Chandler (1962) were traceable to the use of inaccurate information. The case of Standard Oil, today's Exxon, is noteworthy because it involved an inventory crisis.

level of political interference in PDVSA's affairs observed during the early days of nationalization was due more to attitudes of the political sectors than to explicit elements of strategy/organizational structure. In our words, all the sectors involved shared a common concern for maintaining the continuity. Hence, the maintenance of this state of affairs would require either changing the structure to prevent political intervention, or continued fulfillment of politicians' expectations abuut the conduct of the petroleum industry.

3. Early Balance

By most counts, the balance of the early years of the nationalized industry is very positive. This result becomes even more remarkable if we take into account the depressed market conditions the first semester of 1975.

Petroleum production, which at the start of the year was at the depressed level of 1.5 million barrel per day (MBPD), increased to 2,1 MBPD during the second quarter. All other areas of activity evolved in a normal fashion.

Following recommendations made before 1976, the industry secured technical support for its operations through a series of agreements which became active at the moment of nationalization (for the sake of consistency, we will delay the analysis of these early technological agreements to a later section). As for developing its own technology, PDVSA finally assumed responsibility over the Venezuelan Institute for

Petroleum Technology, INTEVEP.

However, the early operation of the "holding" revealed the existence of some structural problems. Some of these problems, which relate to the issue of functional integration, might have affected the strategic orientation and planning capabilities of top management. Other problems, on the other hand, could be related to the ill-preparedness of governmental infrastructure for its role under the new, nationalized order.

From his experience as director, Coronel (1982-b) poignantly describes how the functional coordinators had developed an "excessive interest in the day to day activities of the operating companies (page I-5-11)," and how the "organization of the 'holding' lacked an efficient information system (page II-2-23)." The final result was that some top managers became too involved in the activities of some of the "coordinations" which, in turn, were not fulfilling their integrating role. In that author's view these two negative characteristics had originated from the idiosyncracies of PDVSA's personnel that, he contended, had facilitated the centralizing tendencies of some members of the board of directors. In our view (which is supported by arguments from the last section), the structure of the holding played a role in stimulating this distorted behavior by the directors.[20]

20- To be objective, drive toward centralization by headquarters is a common trait of (continues on the next page)

From another perspective, the involvement of top management with integration activities could have weakened the planning function at the corporate level. However, a look at the relevant legislation shows that the "holding" was not designed to play a significant role in strategy formulation. PDVSA cannot, for instance, conduct a meaningful portfolio analysis. As we commented, its activities are confined to the hydrocarbon field and any departure from the traditional line of business would have to come as an iniciative of the executive branch or congress. Further, PDVSA cannot formulate corporate goals, as these are received as policy guidelines from the executive branch via the MEM (Moreno-Leon, 1981). In contrast, the situation of the affiliates was one of almost complete freedom in the formulation of their operative plans.

The situation we have just described, where top management plays a marginal role in formulating strategy, runs counter to the accepted wisdom of the theoreticians and practitioners in the field of corporate strategy (Hofer and Schendel, 1978). Actually, recent research (Kinnunen, 1976) has shown that corporate boards which play a ratifying rather than formulating role are quite common among large divisionalized companies. Indeed, there is a whole body of literature, whose

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20- (continues from the previous page) divisional enterprises or, for that matter, of any organization. For a discussion on the role of structure to control this tendency, see Mintzberg (1979) origins are traceable to Lindblom (1959) and Quinn (1980), which claims that this absence of grand corporate strategy is beneficial. Writers such as Abernathy & Hayes (1981) and Pascale (1982) have argued that emphasis in grand strategy may be a cause for US decline in productivity vis a vis Japan. Still, this pattern of strategy formulation just described might have been unique enough for the oil industry to make PDVSA inmune to allegedly strong (Huff, 1982) industry influences. In this light, it is noticeable that the Venezuelan company has not followed the common track of diversifying into alternative energy (coal and so forth).

PDVSA's top management quickly recognized the presence of some sort of coordination/integration problem. One of the adopted remedies consisted in formalizing the relationship between the board of directors and the presidents of the affiliates. This led to the establishment of the so-called "extended" directory. This organ, which encompases PDVSA's directory plus the presidents of the affiliates, meets once a month. As stated previously, we do not believe that integration problems can be adequately resolved by involving top management in the process of integration. In our view, this solution is just too costly in terms of managerial time.

This discussion brings us to another set of issues as it appears that the aforementioned problems of integration and planning did not affect the company's overall performance.[21] A close look at the situation reveals that low performance may have not been observable in this case because of the very high margins obtainable in the petroleum market for low-cost producers, and because of PDVSA's posibilities of sparing some of the costs of low functional integration.[22] We refer to the availability of a pool of high-level technical expertise at essentially no cost through the technical assistance contracts subscribed between PDVSA and the ex-concessionaires. This outside help might have allowed PDVSA to maintain decision quality without the need to pool or "de-incorporate" internal resources (that is, integrate them). Evidence to be presented in the next chapter lends support to this last possibility by showing that the operating affiliates systematically obtained technical assistance in areas where equivalent expertise was available elsewhere in the industry (availability of such expertise is another matter which will be discussed).

21-Low functional integration can affect performance in a variety of ways. A most obvious one is through a lowering in the quality of investment decisions which results from not using all the talent potentially available in the organization. Decision quality can be maintained by hiring permanent outside help from a "superior" soource, or by contracting it on a project-by-project basis. In both cases, a substantial cost may be involved.

22- As we will show later, low integration in the technology function can be associated with real costs. besides the cost of choosing the wrong technology, little integration is associated with searching and contracting costs which arise because the different organizational units (divisions or "affiliates" in our case) do not share information about the suppliers of technology.

Summing up, we can say that PDVSA's performance during the early years of nationalization testifies the appropriateness of its organizational structure to handle the environment of the industry at that time. Two problem areas, functional integration and strategic planning were identified, but they may not have caused observable effects on performance for reasons exposed above. Finally, we may comment that the high degree of autonomy enjoyed by the industry during this early post-nationalization period could not be explained as a consequence of organizational structure. Thus we are led to think that a concern for continuity on the side of political sectors must have played a major role in maintaining this situation.

C. THE CONCERN FOR EFFICIENCY: RATIONALIZATION

The positive balance of nationalization brought a renewed sense of confidence to the management of the Venezuelan petroleum industry. This set the stage for the adoption of several daring strategies aimed, in general, toward increasing efficiency and long-term stability of oil revenue. As part of the concern for efficiency PDVSA initiated the process known as organizational rationalization, while the interest in long term stability supported the drive toward diversification of oil markets and of sources of technical assistance.

As shown in figure 4, nationalization was followed by a reduction in the number of subsidiaries (or affiliates) to a final number of four. The objective of this process, officially known as "Rationalization," was to consolidate some of the original operating companies into larger, more efficient entities. Some affiliates fared better during rationalization than others because they resulted from the union of entities which were either related (through oil supply contracts) or very unequal in size. In practice, rationalization meant that the cultural features and administrative procedures of the smallest companies disappeared, dominated by the larger ones. In one instance, CORPOVEN, the size of the 6 original companies was very similar. As of today, this company has not been able to stabilize its structure.

FIGURE 4. THE PROCESS OF ORGANIZATIONAL RATIONALIZATION

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EARLY AFFILIATES                                   CURRENT AFFILIATES
1976                 1977          1978             1979

        [a]    [b]                                        [c]
LAGOVEN(41)-[136]--┐
                   ├->LAGOVEN-------------------->LAGOVEN
AMOVEN(.32)-[1]----┘                                ( 43% )

MARAVEN(26.1)-[26]-┐
                   ├->MARAVEN-------------------->MARAVEN
ROQUEVEN(1.16)-[1]-┘                               ( 25% )

TALOVEN(.07)-[1]----┐
                    │
VISTAVEN(2.53)-[4.6]┤
                    >MENEVEN--------------------->MENEVEN
MENEVEN(11.50)-[164]┤                               ( 17% )
                    │
GUARIVEN(.20)--[2.9]┘
                                 [b]
PALMAVEN(6.38)----->PALMAVEN-1.5┐
                                │             [b]
BARIVEN(1.17)-----┐             >LLANOVEN-2┐
                  ├->LLANOVEN--1┘          │
LLANOVEN(3.10)----┘                        │
                                           >CORPOVEN
BOSCAVEN(1.54)----┐                        │ ( 15% )
                  ├->CVP-1------┐          │
CVP(1.25)---------┘             │          │
                                >CVP-1-----┘
DELTAVEN(3.63)----->DELTAVEN-1.5┘

INTEVEP ------------------------------------->INTEVEP
                                              [d]
                              PEQUIVEN--->PEQUIVEN
                                              [e]
                              BARIVEN---->BARIVEN
                                              [f]
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NOTES:

a) percentage of total oil production in 1975 (adds 100%).
b) relative size, measured in terms of 1975 oil production.
c) percentage of total oil production as of 1979.
d) INTEVEP, an R & D subsidiary, was transferred to PDVSA in 1976 as a fundation. Incorporated as a subsidiary in 1979.
e) PEQUIVEN, a petrochemical subsidiary, was ceated by transferring to PDVSA the assets of the Venezuelan Petrochemical Institute in 1977.
f) Bariven is an affiliate created in 1977 with the purpose of centralizing contracting and purchasing activities.

Thus, PDVSA settled down with a multidivisional structure. Different from most cases, the criterion for divisionalization was neither geographical nor product-based, but cultural. That is, the divisions were formed so as to constitute culturally homogeneous entities. The resulting divisions correspondeo to the largest of the pre-nationalization companies. In terms of "corporate culture," one affiliate, LAGOVEN, seems close to Exxon, another, MARAVEN, seems close to Shell, and another, CORPOVEN, seems close to Gulf. The fourth operating affiliate, CORPOVEN, does not show a definite orientation, although CVP, by virtue of its originally large personnel body, appears to be dominant influence.

Two more divisions, BARIVEN and INTEVEP, were created following functional criteria. The creation of Bariven, a centralized contracting-procurement subsidiary, breaks with established patterns of organization in the world oil industry. On the other hand, the case of INTEVEP, a central R&D affiliate, is quite common. Exxon, Gulf, Mobil and Shell, to cite just a few oil companies, have central R&D divisions.

Finally, PDVSA diversified its operations by incorporating the Venezuelan Petrochemical Institute (IVP) as a full fledged subsidiary in 1977. This decision was very controversial because of the poor financial situation of the IVP, and because of PDVSA's refusal to consolidate IVP's accounts with its own "until the process of reorganization and revitalization of this affiliate is completed" (Annual report, 1980). Nevertheless, PEQUIVEN provided PDVSA with facilities (some are partially owned) for the production of ammonia, urea, chlorine, caustic soda, polystyrene, high-density polyethylene, low-density polyethylene, polypropylene, propylene, ethylene, polyvinil chloride, isoprene, polyisoprene, phtalic anhidride, dodecil bencene, tripolyphosphates, ferrous sulphate, glycols, caprolactam and other petrochemicals.

The process of "organizational rationalization" we have just described can be interpreted as a measure for the reduction of uncertainty at the corporate level. Instead of dealing with 14 subsidiaries, now PDVSA had to concern itself with only 4, PEQUIVEN, plus the other two functional affiliates. Rationalization, however, came at the cost of increasing uncertainty at the affiliate level where the focus of possible culturaly-based disagreement was now located. This cost may appear in several forms: low level of commitment to strategies, little coordination between departments (for example, between refining and marketing), etc. The available evidence seems to support this contention, as CORPOVEN remains as the low-performing affiliate.

1. Performance

Following the trend established during its first year, the nationalized industry continued to show a startling record in most areas. We may add at the outset that neither PDVSA nor any of its affiliates has entered general management c- tracts. This assertion, nevertheless, does not include several forms of management assistance received in areas such as project management, management information systems, personnel, etc.

In regard to exploration, the industry has been able to reverse the declining trend in reserves. Between the years 1979 and 1980, PDVSA found 1.88 billions of barrels of new reserves representing a net addition of 1.09 billions to the total of 18.78 billions of proven reserves.[23] Gas reserves have increased dramatically with some new offshore discoveries.

In regard to production, the industry has been able to maintain the production levels and increase that fraction coming from the Orinoco Tar Belt (see note II-24) to an amount of 100,000 barrels per day. In refining, the industry has satisfied all the demand for products while keeping on schedule a huge process of revamping the refineries. This project, which consumed US $ 686 million during 1980 alone, will change the product mix towards a much lighter one. In some instances, this objective has required investment in the order of 5000 dollars per daily barrel of product.

In regard to petrochemicals, PDVSA has been successful in

23-This figure does not include the Orinoco tar belt.

its revitalization of PEQUIVEN. In 1981, for the first time PEQUIVEN turned a profit. During that same year, exports of petrochemicals allowed non-traditional exports from the public sector to surpass those from the private sector, again, for the fist time in contemporary history.

In regard to commercialization, the industry has diversified its exports to the point that now it sells oil to about 100 different clients. Of these exports, only 45% goes to the ex-concessionaires. Since more than 60% of Venezuela's proven reserves come in the form of heavy crudes, PDVSA has tried, we may add successfully, to increase its colocation of heavy oil in world markets to the point that today they constitute 58% of the export mix. In the course of this strategy PDVSA has entered some innovative marketing schemes which involve the financing of client-owned facilities for processing Venezuelan heavy oil, joint ownership of offshore refineries, etc.

In the area of public affairs management, the industry has not performed as well. Records from recent parliamentary debates (Grant, 1981; Resumen, 1982) show that the locus of criticism to the industry has been broadened to include, in addition to leftist parties, some elements of the mainstrean parties. The nature of these debates is surprisinly similar to several others conducted during the early sixties under the concessionaire regime. In both cases, the arguments started from the perception that the industry was illegaly witholding information from the government. In the first occasion, the issue was the companies' refusal to provide the government with the information required to control their operations. In the second, it was the refusal to give top management salary figures. As a byproduct, rumors have circulated about illegal commissions and conspiracy with the ex-concessionaires. While none of these accusations has proven to bear any truth, they certainly affect the credibility of the industry in the eyes of the public at large, and set the stage for more active intervention by political sectors.

What most of the debates reveal is that, by far, the petroleum industry continues to be a foreign element in Venezuela, and that, unless PDVSA's executives apply some corrective measures to the situation, frictions are likely to remain with the public sector. The prospect of a severe crisis is exacerbated by several factors. First, the implementation of government policies is highly dependent on the industry's strategies because of the size of oil revenue. Second, there is a marked lack of concensus among the different political parties in regard to oil policy. Given the propensity of Venezuela for changing administrations from one election to another, there is a chance of finding a government in serious disagreement with ongoing PDVSA's projects (approved by the incumbent administration), especially if they require heavy investment outlays. Third, as we discussed before, the structure and functioning of PDVSA is completely vulnerable to the possibility of open political intervention. In this sense, the situation has not changed much since nationalization.

2. Summary

The analysis presented in this chapter suggests that many of the strategic and structural choices of PDVSA were dictated by exogenous factors. These exogenous factors comprise legal incompatibilities, historical rivalries, governmental policies (enforced by the Ministry of Energy and Mines), etc. Hence, the fitness of PDVSA to its environment, the match between "informational requirements and information processing capabilities" (Galbraith, 1973), was to a large extent out of the control of its managers.

Nevertheless, the succesful performance of the industry during the period described here leads us to think that, despite all the changes associated with nationalization (externalization and so forth), the industry matched the informational demands of its external and internal environment. Many of the internal requirements (cultural rivalries, need to share scarce technical resources, etc.) were satisfied with the selection of a multidivisional structure and, gradually, with the strategy of organizational rationalization. For the case of external requirements, we believe that the match of processing capacity was the result of changes, in PDVSA's environment. As we said, the political-regulatory ranks gave PDVSA a break, and the world oil market was largely favorable during this period. Using Mintzberg's (1981) words, "contingent" instead of "design" factors were the main determinants of PDVSA's success during the early nationalization period.

Following the same line of argument, we may expect that, as the same elements that determined PDVSA's early success return to their historical position (with the government typically asking for more revenue), the industry will be forced to develop more explicit responses to its environment. At the general level discussed here, these responses may include offices for public affairs management and defining, with more precision than now, the role of government in strategy formulation.

Nevertheless, it is possible to classify PDVSA's strategy as one of cost leadership (Porter, 1980: 35) in the world petroleum and petrochemical industries. The exploitation of its non-conventional oil reserves, however difficult and different from current operations it may be, does not constitute a true diversifying move because it does not involve a change of industry. This same comment applies to PDVSA's involvement in petrochemicals but because of different reasons: 1) it is clear that PEQUIVEN's acquisition was not requested by the executive branch; 2) the scope of this operation is relatively small.

Cost leadership strategies are most demanding in terms of technical expertise and capital investment they require. Strong R&D and basic engineering are required for the creation and preservation of cost advantages, while heavy investment is necessary for the updating and building of plants. Additionally, factors which are indigenous to the Venezuelan oil industry increase the "technological content" of a cost leadership strategy. The decline in the volume of conventional, light, oil reserves in a country with abundance of heavy crudes, combined with worsening market conditions, is pushing towards a heavy reliance upon difficult technologies for enhancing and upgrading heavy oils. Ignoring these technological realities would not necessarily erode Venezuela's market share but would, certainly, reduce PDVSA's income generating capacities.

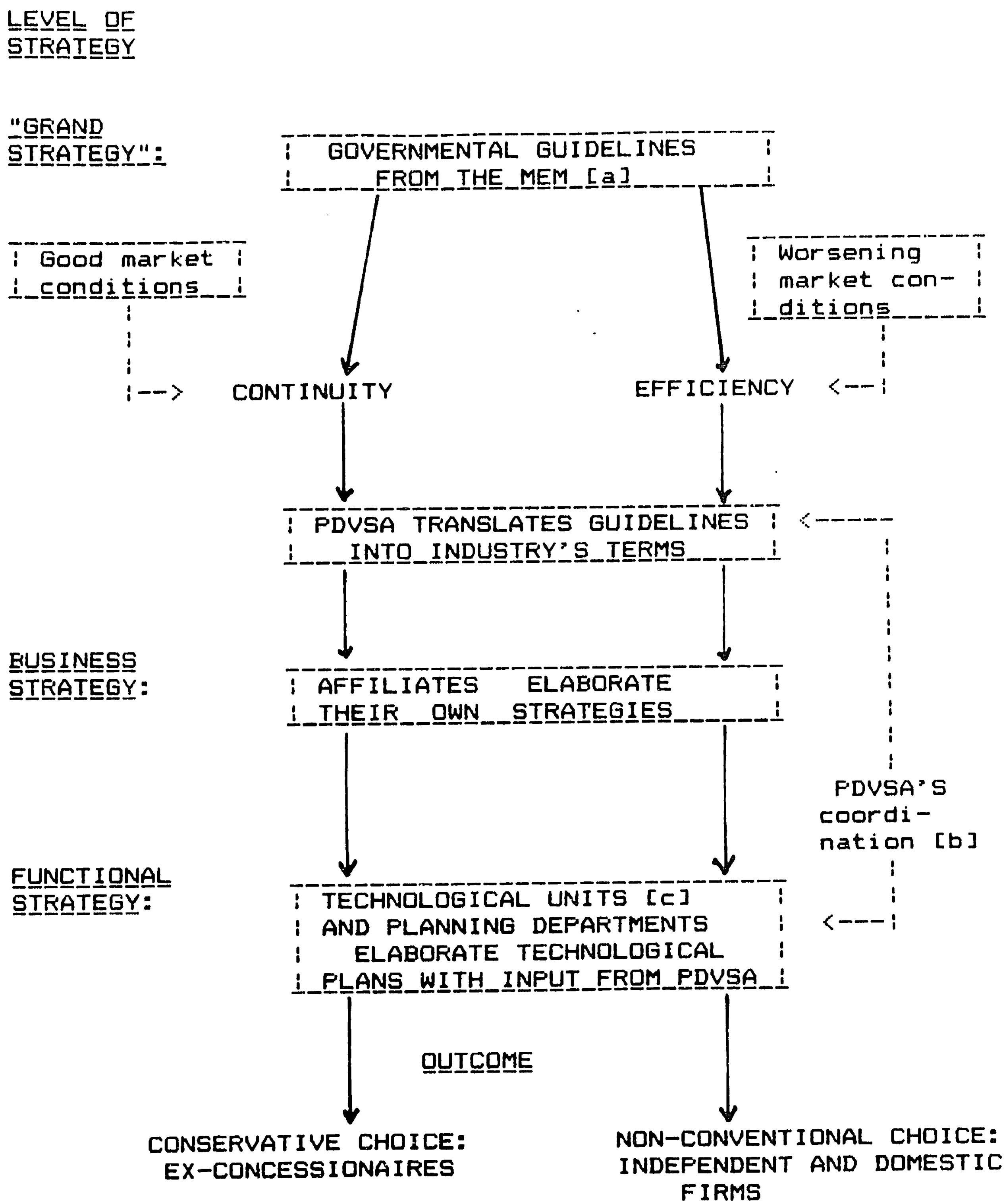
We can further categorize the strategic influences so far described by saying that the making of corporate strategy within PDVSA clearly corresponds to the "transactional" or "governmental politics" model described in chapter I. In our case, the relative power of the parties who bargain to decide about strategy is delineated in the nationalization law and corresponds, to a certain extent, to the historical trends described in chapter II. The making of functional strategies, on the other hand, corresponds better to the "organizational process" model described earlier in chapter I. In this case, elements of corporate culture of historical origins (see chapter II) may be important determinants of the final form of these strategies. Thus, while each affiliate may adopt the same type of strategy in response to the call for "continuity" by the government, each one resolves this requirement in its own way: LAGOVEN with Exxon, MARAVEN with Shell, MENEVEN with Gulf and CORPOVEN with Mobil and Sunoco.

The strategy factor (corporate-level strategy) played an important, although indirect, role in defining the preference for traditional sources of technology. By stressing the importance of continuity the management surely stimulated the choice of the most reliable sources of expertise which, in this case, were represented by the ex-concessionaires. From another perspective, by stressing continuity the industry did not generate many technological needs that were beyond the capabilities of traditional sources. Figure 5 delineates the main strategic levels of PDVSA and summarizes the mechanisms through which the elements we have described here influence technology choice.

Another element of strategy which is likely to affect the technological strenght of the industry is the legal limitation toward diversification. As mentioned, diversification into some areas, alternative energy sources for example, is associated with innovativeness in the case of petroleum companies (Teece, 1978).

Finally, the description of PDVSA's structure shows that there is, indeed, a lot of cultural diversity among its employees. While the strategic response to this situation, divisionalization on cultural-historical lines, has done a lot to amegliorate possible conflicts, it has perpetuated differences among the affiliates. Because of this image of "melting pot," PDVSA does not show a "strong culture" which Deal and Kennedy (1982) have found associated with highly innovative firms.

FIGURE 5. INFLUENCE OF STRATEGY UPON TECHNOLOGY CHOICE



NOTES: a- Ministry of Energy and Mines
b- See figure 3 and chapter IV, sec.B for details.
c- See chapter IV for details.

CHAPTER IV

FUNCTIONAL STRATEGIES:
TECHNOLOGY

In this chapter we document the current practice of the Venezuelan petroleum industry for the acquisition of technology. This examination includes, 1) a review of the technological objectives of the industry, 2) a study of the organization created by the industry to acquire technology, including the types of contract used and the organizational units created to this effect, and, 3) a quantitative analysis of the patterns of technical assistance received by the industry.

This chapter serves two purposes. First, the examination of the patterns of technical assistance provides important insights about the nature--individual versus structural--of the factors which influence the acquisition of technology. Therefore, it helps in the development of research questions. Second, the observance of the practice of the industry in this area provides information which is relevant for the research design used in this thesis.

A. TECHNOLOGICAL NEEDS AND RESPONSES.

It is unnecessary to invoke complicated analyses to conclude that PDVSA's main corporate objective is to maintain (continuity), or increase (efficiency) the level of profits available from its operations.[1] Because of its con-

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1- As said before, this objective is equivalent to output maximization by virtue of two factors. First, PDVSA has no control over prices, as these are set by the MEM in accordance to OPEC guidelines. Second, the characteristics of the world oil market tend to disconnect prices from output.

dition of state-owned enterprise, the importance of its operations for Venezuela and the technical characteristics of its oil deposits PDVSA is forced to incorporate several other constraints to its corporate planning function. It must, in the first place, pay special attention to the development of new domestic reserves. It must, in the second place, develop a capacity for exporting heavy and extra-heavy varieties of crude (this is because these types of oil comprise two thirds of Venezuela's reserves). It must, in the third place, pay special attention to the environmental consequences of its operations, even if local enforcement of such rules is negligible. It must, in the fourth place, satisfy the needs of a domestic market that is growing very fast (at least 9% annual growth).

The interdependence among all these elements, strong need to maintain continuity of operations, predominance of heavy oil reserves, environmental restrictions, high growth rate of local market, etc., has clear implications for technology strategy. Despite the lack of explicit statements in this area,[2] we may conclude that PDVSA needs technology in the following areas:

i- Production: to maintain/optimize the production in aging oil fields. Some of the specific techniques include:

2-This list of needs has been derived, in part, from the transcript of a conference delivered by PDVSA's president, General (ret.) Rafael Alfonzo Ravard, on Octo[illegible]r 3, 1975. This transcript as well as many others appear [illegible] Cinco_Años_de_Normalidad_Operativa, Ediciones Amon, Caracas, 1981.

analysis of monophasic and polyphasic flow in vertical and deviated wells, computation and validation of methods to obtain precise values for some important parameters (dynamic pressures, friction loss, gradient plots, etc.), gas-lift and pumping methods (surface and submerged), and methods for controlling sanding of wells, and the use of additives, among others.

ii- Exploration: to cover the 85% of the Venezuelan territory which has not been subject to intensive exploratory work. Some of the most important oil basins to be explored are located offshore; thus some non-conventional exploration methods may be required.

iii- Drillir to optimize drilling under the prevailing conditions in both the traditional and non-traditional producing. Some of the technical needs include: mud and cement analysis, methods to increase production by hydraulic impact, techniques for offshore drilling, jet drilling methods, drilling with abrasive particles, turbo drilling, etc.

iv- Processing of heavy oils: to develop methods for the processing of heavy and extra-heavy oils, to utilize the by-products of such processing, and to satisfy the needs of the domestic market without hurting export quality. In particular, this requires techniques such as hydrogenation, cracking and other processes which are effective with crudes bearing high concentrations of metals and sulfur; and methods for the use of coke and asphaltenes in energy and industrial applications and for the use of the sulfur derived from the upgrading of these heavy oils.

v- Urbanism: to organize the several urban nuclei that are being created as a result of PDVSA's operations.

vi- Refining and petrochemicals: to maintain/increase productivity in the operaton of refineries and petrochemical plants. In particular, this requires techniques for process simulation, dynamic optimization and control, as well as proprietary chemical processes.

vii- Project management: to successfully complete the various large-scale projects being undertaken by the industry.3

3-It is noticeable that this list (derived from Ravard's speech) does not mention any specific needs in "soft" areas such as marketing.

The diverse character of PDVSA's technological needs has influenced the choice of the suppliers of technology as well as the modes in which these technologies are acquired. Based on patterns of technology contracting which are well established within the world oil industry (Hiegel, 1978:85), we may expect such needs to be matched with the suppliers in the following manner:

Item -i-, production, calls for the use of comprehensive contracts with the former concessionaires, who are the ones with first-hand experience with Venezuelan oil fields.

Items -ii- and -iii-, exploration and drilling call for the use of specific contracts with firms specialized in the area, as is common practice in world oil industry.

Item -iv-, processing of heavy oil, calls for the use of cooperative and specific research agreements with all the possible sources of technology in this area: ex-concessionaires, other oil companies chemical engineering process firms, universities and research centers. The reason for this multiplicity of instruments and sources is that the technology in this area is still underdeveloped.

Item -v-, urbanism, calls mostly for the use of comprehensive contracts with firms specialized in construction and urban design.

Item -vi-, refining and petrochemicals, calls for the use of both specific (licensing) and comprehensive contracts with the former concessionaires, other oil companies and chemical engineering firms. The choice of contractual instrument will depend on the particular process under consideration, or whether or not such process is in place. Most needs on process control/optimization can be handled through specific contracts.

Item -vii-, project management, calls mostly for project contracting/subcontracting with some of the former concessionaires and construction firms with experience in large project management.[4]

As is often the case, neither PDVSA nor its affiliates have produced specific statements of technological strategy, although the negotiation activity has been well coordinated under corporate guidelines, Since the Venezuelan industry does not seem equipped to provide itself of all the types of technical assistance mentioned above, a technological strategy would have to include a set of recommendations about which technologies are to be provided/developed internally and

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4- This list excludes several types of arrangement which are standard in the world oil industry: concessions, joint-production ventures, risk-service contracts, etc. The reason for this ommision is that some of them are ruled out in the nationalization law while others, although permited, are so sensitive politically that it is unlikely that the industry will ever use them. In any event, these arrangements, collectively referred to as "petroleum development contracts," are not considered good vehicles for the transfer of petroleum technology (Zakariya, 1982). For a comprehensive review of these contractual arrangements in the oil industry, see O'Dell (1981).

which ones are to be acquired from external sources. In the case of PDVSA, choosing the appropriate combination seems bounded by the following dimensions:

- The technologies themselves (in which cases internal expertise is sufficient),
- Contractual mode (sometimes dependent on the other decisions),
- Source of the technology (sometimes, there is more than one source)
- National security and related questions (a consequence of PDVSA's status as a SOE).

Nevertheless, PDVSA has responded to its technological requirements by entering into a number of arrangements with a variety of suppliers of technical assistance. Furthermore, this company has undertaken the task of developing a good portion of its own technology through the creation of an R&D affiliate, INTEVEP.

In the rest of this chapter we describe: first, the basic contractual formats used by PDVSA for the acquisition of technical assistance, second, the organizational infrastructure created to negotiate these contracts, third, the evolution of such contracts in subsequent negotiations and, finally, the resulting patterns of technical assistance received by PDVSA.

The material presented in this chapter is partly derived from a series of open-ended interviews conducted with industry's officials involved in the process of acquisition of technology. These interviews included questions about each one of the following issues:

- the organization of the unit to which he or she is attached,

- activities carried out by this unit,

- scope of these activities (ex-concessionarias or all sources, technical assistance or all transfers)

- access to directory of the affiliate,

- participation in the negotiation of technical assistance agreements (with the concessionaires or independent firms),

- origin of negotiation guidelines,

- frequency of negotiations and term of the contracts,

- negotiation process and responsibility for results,

- contents of the contracts,

- relationship with INTEVEP,

- use of the agreements of technical assistance (accountability of the services, evaluation)

- reasons for use of technical assistance (absolute shortage vis a vis temporal need),

- substitutability of the different agreements,

- emphasis in diversification of sources,

- selection of sources for technical assistance (different suppliers, locus of decision, trends, etc.).

Officials at the corporate level were interviewed about the coordination of the activities of the different affiliates. In addition to these interviews, internal reports about usage of technical assistance were reviewed.

B. ORGANIZATION FOR NEGOTIATION

1. Contractual Formats

Each year, the Venezuelan petroleum industry obtains about 3 million man-hours of technical assistance from foreign sources.[5] This assistance comes in the forms of outright consultancy, expatriates, assistance in procurement, assignments abroad, courses, etc. In terms of areas of activity, the assistance covers all the spectrum of activities related with the oil business, from exploration to refining, to marketing.

The operation of the industry during all these years has revealed two important facts about technology contracting. First, no single source is able to provide the totality of the services by even one of PDVSA's affiliates. It seems that the former parent corporations either subcontracted many of the services provided to their Venezuelan subsidiaries, or were able to realize economies of scale in the development of technologies for their worldwide operations which are unavailable to the nationalized industry. Second, no single contractual mode is appropriate for all situations. While umbrella-type contracts provide flexibility, their implemen-

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5- This number is, of course, very subjetive as it includes a variety of services of a different nature. Of these three million, about 85% is not recurrent (that is, does not belong to a continuous program of technical assistance). The rest corresponds to services which require continuous technical input, for example, the testing of catalysts .

tation is difficult because the vagueness of their wording makes it difficult to ensure compliance.[6] Further contracting may be necessary to fill in the gaps left by the vague clauses. Two other possibilities are to rely on mutual trust, or on knowledge of each other's operations, both of which can surely evolve after more than 60 years of continuous relationships. If neither of these two conditions is met, for example, when the source of the technology is an unrelated party, other types of specific contracts may be more appropriate because they set specific guidelines for compliance. In consequence, changes in the pattern of technical assistance imply changes in the contractual formats used for this purpose.

The agreements subscribed by PDVSA fall into the following categories:

Technical assistance contracts ("convenios de asistencia tècnica) or CAT's.

These are comprehensive umbrella-type contracts which cover a wide range of services. These contracts constitute the closest possible contractual approximation to the parent-subsidiary relationship which existed before nationalization.

6-From another perspective, the costs of "codifying" these vague contracts to provide for all future contingencies may be too high. On the other hand, the drawing of specific contracts permits the "codification" of only those areas where there is an interest in maintaining the relationship between the parties. For a look at this issue, called the "presentiation problem," see McNeill (1974) and Goldberg (1976).

As we discuss later, the comprehensiveness of these contracts has several costs.

In most cases, the main agreement only serves to set the general terms for the transfer of technology, while the specific services to be provided are included as appendices. Typically, these contracts are bi-annual with automatic renewal for a one-year period. Originally, this was the only type of contract signed with the concessionaires and, in most cases, covered only technology already in place. All new or old technologies not being used, for example, refining processes not installed at nationalization, had to be acquired through separate agreements.

Although the substance of the CAT's has changed considerably since the first ones were signed, their basic organization includes:

a) presentation of the parties;

b)definitions (what is meant by "technology, technical assistance, confidential information," etc.);

c) scope and objectives;

d) description of the services (a long chapter that also set a limit for the assistance provided under the terms of the contract. Additional requests had to be negotiated separately);

e) access to proprietary information (varies widel', it referred to the use of patents owned by the transferor);

f) payments and modalities of payment, it may or may not include base payments, dollars per man-hour, commission for procurement with or without limit on the total amount of purchases covered by the contract, frequency of payments, etc.);

g) confidentiality;

h) guarantees;

i) force majore (noncompliance due to external causes);

j) availability to affiliates;

k) miscellanea (several items including rescision, jurisdiction, arbitrage, etc.);

l) annex.

All of PDVSA's 14 original affiliates subscribed [illegible]'s with their former parent corporations at nationalization. In the original version, these contracts contained a series of negative provisions; among these:

- payment for services rendered was made in the form of a royalty tied to production volume. As of early 1978, the service fees were 13.3 cents per barrel produced, plus another 5.5 cents per barrel to account refining assistance. A cost-escalation clause might have pushed these figures up. Overall, technical assistance fees amounted to about US $ 160 million per year, equivalent to about 1.6 % of the value of the production.
- assistance received by any of PDVSA's affiliates could not be made available to the other affiliates.
- costs were determined unilaterally by the providers of

technical assistance.

- all liabilities associated with the procurement/purchasing services rested upon PDVSA.

The original versions of the CAT's were criticized on several grounds. As for the compensation aspects, the political left (Proceso Politico, 1977) actively claimed that these contracts represented little more than a disguised way of compensating the multinational oil companies for the nationalization of their assets. From a different perspective, the little connection between the payments, tied to volume, and the amount of services rendered may have encouraged excessive dependence on the CAT's, therefore limiting PDVSA's development of its own technological capabilities.

Specific Contracts

These are contracts signed with the purpose of getting one particular type of service. Among these we include technical assistance agreements, patent (license) agreements, know-how agreements, engineering service agreements, etc. They follow no consistent pattern either in format or substance. All new technologies, or just those without previous use in Venezuela, are subject to this type of contract.

Research Contracts

These are similar to the previous type but oriented toward R&D. They put strong emphasis in the exchange of personnel (the only exception in this regard is a contract signed with

Exxon Research). The following institutions, among others, have signed research contracts with PDVSA: Massachusetts Institute of Technology (Department of Civil Engineering), Stanford University, Chemical Systems, University of Mainz (Germany), University of Tulsa, New England Coastal Engineers, and most Venezuelan Universities.

Technical Cooperation Agreements

These are very general agreements that define areas of common interest and serve as umbrella for more specific contracts in the research area. They are usually signed with state-owned organizations such as Petro-Canada, Alberta Oil Tar Sands Authority (AOSTRA), U.S. Department of Energy, Institute Francaise du Petrole, Vera Obel (West Germany), and Venezuelan Universities.

"Technical" Sales

This is a new kind of agreement whereby the sale of hydrocarbons under long term, preferential, terms is linked to the provision of some technological input. One recent example is an agreement signed with Elf-Aquitaine calling for the sale of 35000 b/d of extra-heavy oil (10 degrees API) for 7 years. Under this agreement, Elf-Aquitaine will conduct a feasibility study for the construction of a refinery in France for the processing of heavy crudes. The contract includes, also, the design of special tankers for the transportation of the viscous crude.

As we see, PDVSA has entered all types of agreements commonly observed for the transfer of technology, with the exception of trademark-copyright agreements. Of these contractual formats, the CAT's represent a cheap and convenient format for the transfer of operational technology, as there is no necesity to set up separate negotiations each time that tecnical assistance is required. As mentioned, this convenience might have come at the cost of encouraging excessive dependency from the other party who subscribed the CAT.

All of the aforementioned types of contract constitute very traditional formats. They belong to either the fixed-fee or the cost-plus-fixed-fee types.[7] In theory, the use of incentive contracts could lead to a more effective technology transfer process (George Washington University, 1963). For instance we can think of a payment formula which incorporates incentives for the provision of the latest technological advances to the recipient of the services, and for technological learning by this same recipient.

There is, however, a fundamental problem with the implementation of incentive-type agreements. We refer to the need to devise a payment formula tied to the performance of the

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7- Actually, PDVSA originally subscribed a variant of the fixed-fee type which was based on a royalty tied to output. However, the informational problems of an ex-ante determination of the royalty rate which are found in these contracts are similar to those found in the typical fixed-fee contracts.

receiver. In the case of a relatively well-known receiving firm, such as the US department of defense (where incentive contracting is common), it is not very risky for the supplier of the service to rely on the performance of the other party for the calculation of his/hers revenues. In the case of the Venezuelan oil industry, however, there are so many uncertainties associated with PDVSA's operations that it is very unlikely that any provider of technical assistance, if at all, would agree to have his/hers payments tied to this company's performance.

2. Technological Units

The number and diverging nature of the agreements signed by PDVSA and its affiliates means that there cannot exist a sole, centralized, structure capable of negotiating and supervising all them. Many small operating units have been empowered to contract for the provision of services; and this is the way it should be to maintain flexibility. However, the importance of the CAT's justifies the creation of an infrastructure to support their negotiation and supervise their use.

At the corporate level, PDVSA has created a committee of Technological Development. This office is headed by a full-time member of the board of directors and includes the presidents of all seven affiliates among its members. This committee has the permanent support of an executive secretary and other staff members which are located within PDVSA's planning coordination (see fig. 3).[8] In addition to this office, called "Gerencia de Desarrollo Tecnològico," there is a "cupola" committee which includes most members of the committee plus 6 more members of the board of directors and top managers from the affiliates.

The section of the planning coordination in charge of technological assistance has several functions. First, it serves as a bridge among the different negotiating teams (although communication through this channel seems to be sporadic). Second, it performs and circulates a bi-yearly evaluation of the utilization of the CAT. Third, before each negotiation rounds starts, it provides the affiliates with a set of guidelines which may include, among others, maximum allowed fee per manhour, interaction between sale and technology contracts,[9] procurement fees, priorities, etc. The "cupola" committee, on the other hand, oversees the negotiation process itself but the responsibility for the results remains in the affiliates.

At the affiliate level, PDVSA has created organizational

8-Note, however, that this support is less than that received in other areas where there is a separate "coordination" to support the directory's committee. For a description of this structure of committees, see sub-section III-B-2.

9-For instance, this author has found documents indicating the convenience of negotiating the technology agreeements <u>before</u> any type of commercialization contract in order to take advantage of the situation of world petroleum markets.

units for handling technological matters. These units vary widely in their organization and authority from affiliate to affiliate. In some instances, such as MARAVEN's, they are located very high in the hierarchy while in others, such as LAGOVEN's, they constitute relatively minor units. In other two cases, MENEVEN and CORPOVEN, the units enjoy relatively high positions in their respective hierarchies but the first is much more organized. Table 2 depicts some characteristics of these units.[10]

The units for technological affairs ("unidades de asuntos tecnologicos" in Spanish) perform their functions with varying degrees of effectiveness. These functions include: 1) negotiation of the CAT's and other major technological agreements with the participation of top management from the own affiliate and from PDVSA ("cupola" committee); 2) periodic evaluation of the utilization of the CAT's as well as of the quality of the services received from foreign sources; 3) coordination of inter-affiliate technological exchanges, including those with INTEVEP; 4) coordination of technical training, whether covered by the CAT's or not; 5) conduct, or assistance in the conduct, of searches for alternative technology sources; 6) centralization of requests for technical assistance which are covered by the CAT's and other

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10-Data from Table 2, as well as the contents of the next paragraphs, were gathered from a series of interviews conducted with the heads of the units for technological affairs during the first two weeks of October, 1981.

TABLE 2. SOME CHARACTERISTICS OF THE TECHNOLOGICAL UNITS

	LAGOVEN	MARAVEN	MENEVEN	CORPOVEN
NAME OF THE UNIT	"Unidad de Planificacion Tecnologica"	"Unidad de Asuntos Tecnologicos"	"Gerencia General de Tecnologia"	"Departamento de Tecnologia"
ACCESS TO BOARD OF DIRECTORS	three tiers below directory; indirect access	headed by a director	two tiers below directory	department level one tier to directory
CAT's UNDER SUPERVISION	Exxon William Bros. Bechtel	Shell	Gulf	Mobil, British Petroleum; Sun, Chevron[1]
CAT's EVALUATION PROGRAM; FREQUENCY	objectivity put in doubt by the own unit; Semestral freq.	the most complete in the industry; the questionaire focuses on alternative sources; semestral	good; all activities centralized at the unit, possibly overburdened; two questionaires, periodic and semestral	disorganized; highly affected by the situation of the affiliate; semestral
CAT's UTILIZATION [2]	95 % +	95 % +	71 %	70 %
OTHER	Exxon's CAT probably not to be renewed		tends to obtain very good terms	problems in the the negotiation with Mobil.

NOTES:

1-The CAT's with SUN and Chevron were not renewed after 1979.

2-The term "utilization" is defined on page number 181.

contracts with foreign participation; 7) preparation of statistics.

The negotiations with the ex-concessionaires are conducted every two years (except Exxon's last CAT which is valid for only 18 months). As narrated by interviewees, the Venezuelan opening position is usually very low in regard to compensation. The two parties have tended to reach their agreements at a point usually located between two extreme proposals: the low one coming from the Venezuelan side, and the high one coming from the foreign side. The technological units have been instructed by PDVSA's committee (the corporate level) to concentrate on the general agenda and to leave the details to the functional committees located at PDVSA (see figure 3).

In many occasions, foreign negotiating teams are constituted by employees formerly assigned to Venezuela with long-standing ties in this country, including friendship with their Venezuelan counterparts. It is conceivable that these informal relationships might have influenced the outcomes of the negotiations. This situation, however, is becoming less frequent as Venezuelans and foreigners are promoted out of negotiating functions.

The task which occupies the units for the most time is that of evaluating the CAT's. Evaluation, in this context, refers to the use of surveys and other available information to 1) calculate the percentage of the maximum amount of services obtainable through the contracts that was actually utilized (this corresponds to the term "utilization"); 2) derive data about the quality of the services rendered by foreign providers; 3) compute aggregate statistics of the users by function, rank, etc.; 4) examine the circumstances which lead to requesting technical assistance from the traditional sources, including possible search for alternatives.

The analysis of the questionnaires by the units is a highly involved process of content and data analysis. To reduce their expenses in time and resources, two of the units, MARAVEN's and MENEVEN's, have either redesigned or prepared two versions of the survey's questionnaire. In the case of MARAVEN, the questionaire was modified from a large, comprehensive design, aimed at obtaining almost any type of data, to a shorter version focused on obtaining information about technological alternatives. In MENEVEN, on the other hand, there are two versions of the questionnaire: a simple one designed for the semestral evaluation, and a more complex one to be filled before each negotiation round starts.

The surveys ("evaluaciones") are used to obtain information which, allegedlly, will help define the amount of serv-

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11-This assertion is drawn from the interviews as well as from the reading of some internal documents ("Informe Gerencial Utilizacion C.A.T. MENEVEN-GULF y Fuentes Alternas"). The wording of a MENEVEN's document is clearly appologetic when it refers to a 71% utilization figure for the year 1980.

ices required, their quality and other appreciations about the CAT's which may be useful for negotiation. Three affiliates, CORPOVEN, MENEVEN and LAGOVEN, have put special emphasis on the issue of utilization of the agreeements.[11] In one affiliate, MARAVEN, the emphasis has shifted towards obtaining information on the search for alternative technology sources.

The emphasis in computing "utilization" figures for the CAT's does not seem, in this author's opinion, justified after the changes suffered by the original contracts. Initially, when payments were linked to oil production, it was entirely logical to maximize the use of services which were being paid anyway, even if this strategy openly discouraged the diversification of technology sources. In the newly negotiated CAT's, where payments are linked to services rendered, there are no savings, only costs, associated with a strategy of maximizing "utilization" of the CAT's.

From another perspective, low levels of utilization of the CAT's can be used to provide, in case it is allowed by the contracts, services to other affiliates. This possibility is corroborated by the fact that CORPOVEN and MENEVEN, the two subsidiaries with the lowest level of "utilization," provide abundant technical assistance to other affiliates through their CAT's. Evidence gathered from the interviews and the nature of the assistance provided by MENEVEN (placement of other affiliate's employees in courses prepared by GULF) seem to indicate that this interaffiliate transfer is more circumstantial than anything else. These exchanges, however, could be used to pave the way for a much more formalized system of interaffiliate exchanges.[12] Further discussion of this issue will be left to the next chapter.

The units are also in charge of coordinating exchanges with INTEVEP. In general, the position of the affiliates in regard to this affiliate is ambiguous. While all seem to agree that INTEVEP is necessary for the industry to develop technological competence, they also appear critical of INTEVEP's qualifications for the performance of services to the industry. Comments on the high cost, slowness and low quality of services were made during the course of interviews. In this regard PDVSA does not seem different from most corporations: attitude conflicts are quite common between practical and research ranks. One side complains about the lack of interest of the other in practical matters and of its lack of experience, while the other refuses to handle what it considers routine work.

One important mission of the units is that of centralizing

12-At this stage most affiliates seem reluctant to set up any formal system for the promotion of inter-affiliate exchanges of technology, even if it is allowed by the newly subscribed CAT's or the technology is of domestic origin. Most interaffiliate contacts occur through the system of committees-coordinations whith has been set up at the corporate level (see figure 3), and deal with operating questions, not with information to be used in the diversification of sources of tecnical assistance.

information about the requests for technical assistance coming under the CAT's or other contracts. This data includes, also, information about the different providers of technical services, that is, about alternative technology sources. In one way or another, all units have organized their data banks so as to help in finding alternative technology sources; this, however, with varying degrees of sophistication.

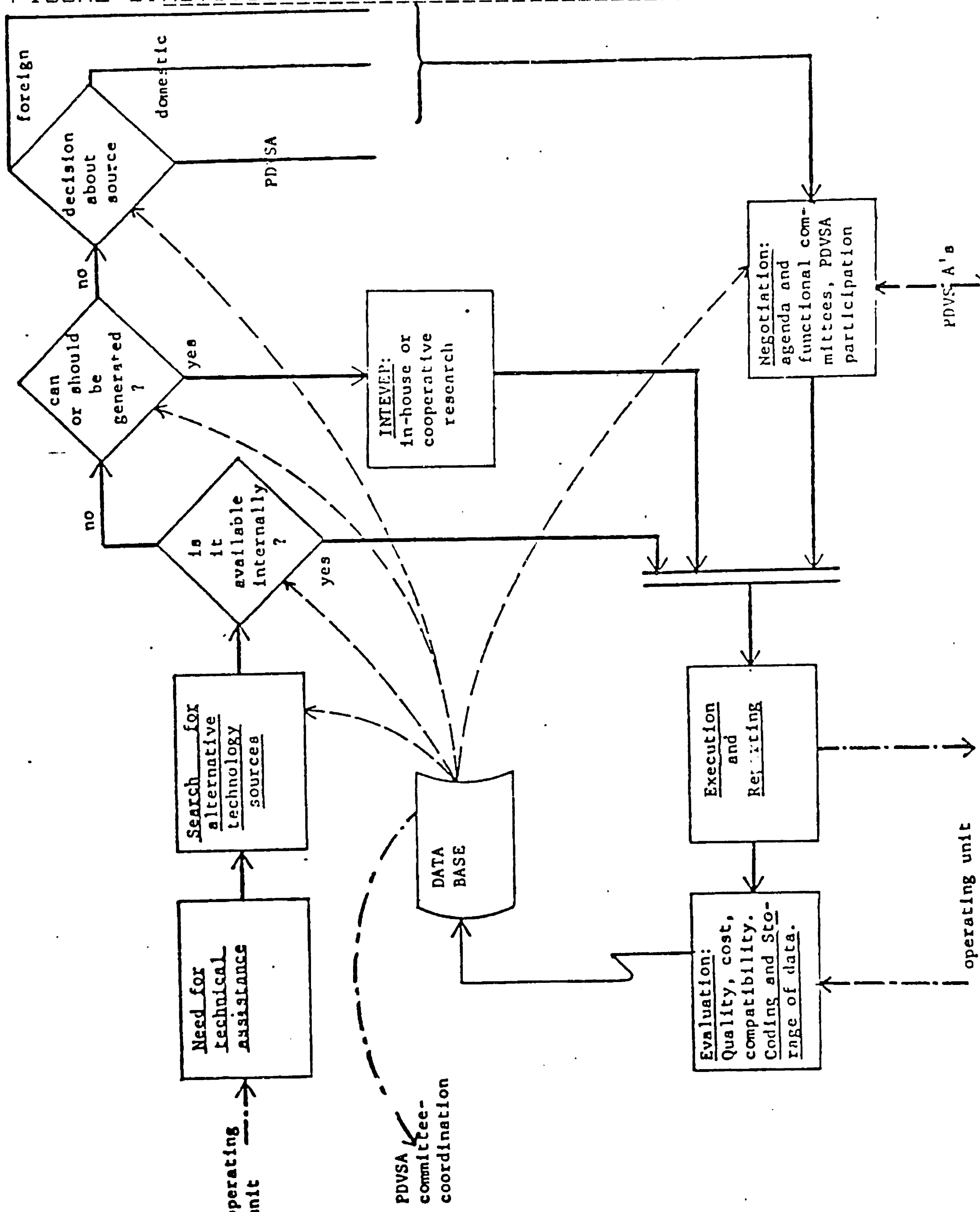
Ideally, this information should be extensive, including not only the identity of technological providers but also references to quality, price, and local experience. Further, data sould be normalized to facilitate retrieval and usage by the other units. Unfortunately, no unit has developed a system that approaches the ideal design (MENEVEN has perhaps the most developed of these systems, but it lacks comprehensiveness and normalization). The underdevelopment and incompatibility of the different information systems represent a major obstacle for diversifying technology sources. Underdeveloped information systems, also, negatively affect bargaining because negotiators are maintained unaware of their technological choices.

In addition to poor or inaccesible information, several unresolved organizational dilemmas further hamper diversification of technology sources. One of these dilemmas is the lack of definition about which level, whether operating units, or technology units, or managerial levels, etc., should concern itself with the search for alternative technology sources. Knowledge about the technologies to be serviced is greater at the lowest level of the operating units of users, but the information about alternatives is limited (the opposite is true at the higher level of the technological units). Note that, unless the technological units develop their information systems, they have no legitimate claim for conducting the searches for sources of technical assistance. More discussion about this topic is forthcoming in later chapters.

To summarize, PDVSA has created offices to deal with the negotiation of the CAT's and other contracts at both the corporate and affiliate levels. The first type is in charge of coordinating the activities of the different affiliates' units, but the responsibility for the results of the negotiations remains in the hands of the affiliates. Still, the role of PDVSA in maintaining common standards for the outcomes of negotiations seems important. The second type of office, the units for technological affairs, plays the central role during negotiation. Besides negotiating the CAT's, these units are in charge of a host of other activities such as evaluation of the use of the CAT's, information collection and centralization, search for alternative technology sources, etc.

Figure 6 shows, in an idealized manner, the set of activities performed by the units for technological affairs. The

FIGURE 6. ACTIVITIES OF THE TECHNOLOGICAL UNITS



NOTES: -This is an idealized picture of the steps that the units should perform in response to requests for technical assistance. It does not necesarily reflect the current activities of all the units.

-The dashed-pointed lines indicate those information flows with the rest of the organization.

-The dashed lines indicate those instances where the data base of the unit is most important.

flowchart format illustrates the interdependence of these activities and highlights the important role played by the information bank in the hands of the technological unit. It is clear, for instance, that poor information will affect the quality of the early decisions and, thus, the quality of the whole sequential process.

3. Performance of the Units

The bargaining performance of the units has been quite satisfactory. Without exception, all renegotiations of the CAT's have led to improvements in the terms under which the affiliates receive their technological assistance. As a result of the first renegotiation, conducted in 1977, the volume of the payments made to the ex-concessionaires was greatly reduced, in some cases to about half of what was being paid.[13] The next re-negotiation, completed in 1979, resulted in a large reduction in the amount of services covered by the CAT's and in a basic change in the mode of payment, from a production royalty based on production levels to a fee based on the services actually rendered. This was a most important change because it removed a strong disincen-

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13-The large reduction of the payments for technical assistance led some critics of the industry to renew their accusations that the CAT's constituted very little more than instruments for providing the ex-concessionaires with additional compensation for nationalization. Several interviewees, some of them voluntarily, advanced the opinion that the original CAT's constituted a form of "insurance."

tive (already discussed) against the diversification of technology sources.[14]

The reduction of the services contracted under the CAT's was in part the result of the success of a strategy of diversification of technology sources. During this round of negotiations new CAT's were signed with firms other than the ex-concessionaires. This new breed of CAT's involved major international oil companies such as British Petroleum, and major engineering firms such as Bechtel and Williams Brothers. The orientation of some of these new contracts, particularly Bechtel's, is somewhat different from that of those signed with the ex-concessionaires in that they involve a different range of activities such as urban design, project management, etc. The complementary, rather than substitutive, character of these contracts leads one to think that the reduction in the scope of the original CAT's has something to do with the development of indigenous technological capacity. The growth of the volume of services performed by INTEVEP to the other services is an indication of this evo-

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14-To be objective, we should add that the contracts still include a base payment. This payment, however, does not appear to be strong incentive for using the services of the CAT's for at least two reasons. First, its size is small relative to the total payment. Second, the base payment is divided in monthly installments, so that no large sums of money are "exposed." In fact, the presence of the base payment may be considered as an "optical" device to reduce other parameters of the contracts, such as dollars per manhour or commission rates for procurement, while maintaining constant total payments. These represent points of potential conflict among affiliates as well as with political sectors.

lution .[15]

The secund renegotiation also resulted in an elimination of the restrictions against inter-affiliate transfers. It is now possible, for instance, for LAGOVEN (former Exxon's subsidiary) to obtain assistance from Gulf Corporation via MENEVEN, or British Petroleum via CORPOVEN.[16] The petrochemical affiliate, PEQUIVEN, is an important beneficiary of this inter-affiliate transfer. We may add, however, that PEQUIVEN's operations are supported by two additional CAT's subscribed in 1979: one with PHILLIPS Petroleum, and the other with SNAMPROGETTI (an Italian engineering firm).

In addition to the operating affiliates, INTEVEP has, as stated before, signed numerous agreements/contracts with all sort of research institutions. Furthermore, most CAT's (with the exception of Exxon) provide for the participation of INTEVEP's personnel in research projects and other related activities in the facilities of the foreign companies. This is, we may add, a matter of corporate policy.

15-One additional explanation, that the "missing" services are obtained under "specific" contracts with the ex-concesionaires and other firms, has surely some merit. However, most specific contracts deal with new areas (exploration for example) or with proprietary process technology, neither of which was ever included in the original CAT's.

16-There are some limitations in the contract signed with Exxon regarding the intra-corporate transfer of process technology.

In sum, the negotiating efforts of PDVSA and affiliates have virtually eliminated all contractual obstacles for the diversification of technology sources (The changes made to the CAT's are summarized in table 3). Now it is at least possible to evaluate different technological options on the basis of their own merits, without contractual incentives in favor of any particular source. Furthermore, the menu of alternatives has been expanded to include operating know-how from several competing oil companies that would have been unavailable through arm's length transactions. In short, PDVSA's affiliates enjoy technological possibilities that in many respects are better than those of independent firms.

At this stage it is impossible to explain completely the reasons behind PDVSA's success as a negotiator. Endogenously, it is likely that the existence of long standing ties between the parties to the negotiations influenced the outcomes, as many former expatriates were included in the negotiating teams of the ex-concessionaires. Strong differences in language, risk aversion, knowledge, etc., which constitute a standard problem during this type of negotiations did not appear serious in this case.

Another endogenous determinant of negotiation success might have been the formality which was given to the negotiating activity within PDVSA's ranks. The creation of all these committees and "coordinations" permitted the constitution of stable, homogeneous (Villalba, 1982-b) negotiation teams,

TABLE 3. CHANGES TO THE CAT's SINCE 1976.

1976

- -12 CAT's (all with former concessionaires)
- -Payments based on output
- -Inter-affiliate transfer disallowed

1979

-9 CAT's:	4 with former concessionaires (Exxon, Shell, Gulf and Mobil). 1 with a new petroleum company (British Petrolum). 2 with non-petroleum companies (Williams Brothers and Bechtel) 2 for PEQUIVEN, the petrochemical affiliate (Phillips Petroleum and Snamprogetti).
-Payment:	Basic payment for non-quantifiable items. Payment based on services rendered (dollars per man-hour, course-day, commission for purchases, etc.)
-New items:	Project management, Urbanism (Bechtel).
-Many specific contracts:	with oil companies (Exxon, for changing the refining pattern) with engineering companies (Fluor, Foster Wheler, Pace Engineering, Badger, etc.)

thus allowing for experience to accumulate. Finally, some aspects of PDVSA's strategy seem, in retrospect, outstanding. For instance, the decision to have negotiation teams concentrate on the major points considerably reduced the complexity associated with technical issues.[17]

Exogenous factors played an equally important role in the success of PDVSA's negotiating strategy. Again, these factors are difficult to quantify. However, there is evidence indicating that PDVSA conciously used its market power to extract better terms from the ex-concessionaires during the course of the second renegotiation (see note 9). Interesting enough, one interviewee attributed recent changes in the relationship with Exxon (it is quite probable that such CAT will not be renewed) to a shift in the market power caused by the current worldwide oil glut.[18]

17-This negotiation strategy appears even more remarkable once we consider that it ran against well-rooted tendencies of top management towards centralization. Members of the operative ranks had to get involved in the negotiations (and had access to sensitive information) to resolve the technical issues. For a discussion of the behavioral implications of this strategy, as well as others, see Villalba (1982) op.cit.

18-Another exogenous factor which, in our view, played an important role was the strong political debate which was associated with the CAT's since the beginnings of the nationalized industry. While the criticism of the opposition parties surely had no direct bearing on the negotiating table, it represented an element which pressured PDVSA to obtain better terms.

C. PATTERNS OF TECHNICAL ASSISTANCE

In this section we present a series of tables which describe the magnitude and nature of the technical assistance received by PDVSA during the year 1980. Most ost of the figures concern the CATs, However, information about other channels for technical assistance is presented also. The data shown here illustrate the conclusions of the previous section, and raise a series of questions which will be investigated in the next chapter.

The information of the tables was derived mostly from a series of bi-yearly reports prepared by the technological units. These documents, entitled "utilization reports," constitute the main piece of information on technological issues brought to the attention of the management of the affiliates. These reports serve as the basis for sporadic industry-wide compilations prepared at PDVSA and INTEVEP.

The "utilization reports" contain the following information:

1) Overall amounts of technical assistance received under the CAT's, percentages of contractual maximum actually used ("utilization"), assistance received from other external sources (domestic and foreign), assistance received from within the affiliates, participation of other affiliates in the use of the CAT's, break-down per function of the assistance received from the CAT's. All this with varying degree of completeness from one affiliate to another.

2- In three cases (CORPOVEN, MARAVEN and MENEVEN) they include a list of the specific services, and their amount, actually received by the units. From these, only two

(MARAVEN and MENEVEN), list also those services received outside the CAT's. CORPOVEN's report just gives the names of the providers of technical assistance.

3- One report (LAGOVEN's) provides historical information spanning more than two years. another, CORPOVEN's, provides only information from the past year.

4- All four utilization reports provide information about how the services were evaluated. However, only MARAVEN's indicates this for each specific service.[19]

In general, the "utilization reports" reflect an "accounting orientation." We use this term to indicate an emphasis in just quantifying the amount of technical assistance (perhaps for calculating compensation to be paid) at the expense of showing other information (or just presenting it differently) useful for other purposes. The main proof of this orientation is the already mentioned business of calculating utilization.[20] Another example of "accounting orientation" is the lack of historical information which could be useful to detect negative trends or even learning processes.

19-All other information appearing in this thesis had to be requested separately. Note that, given the differences between the reports from one affiliate to another, some information which had to be specially requested from some affiliates was available in the utilization reports of others.

20-For unique, e.g. idiosyncratic, services the percentage of utilization is a truly useful measure for what it shows the amount left of a valuable or unique resource. For generic items "technical assistance" calculating "utilization" is pointless, or even negative, as is costly and discourages the use of alternative sources. For this research, however, having utilization figures is a bonus because allows us to check whether the use of alternative sources of technical assistance occurs because of its unavailability through the CAT's (the case if utilization is consistently 100%) or because of a genuine desire to do so.

The information presented here constitutes only an approximate picture of the technological situation in the Venezuelan petroleum industry because of several reasons. First, the affiliates do not use uniform criteria to categorize the different types of assistance. Some affiliates may consider as exploratory activities what others consider as production or, as LAGOVEN and MARAVEN do, consider exploration and production as a single category of activities (in some lists this was not the case). This forced us to review the descriptions of the specific services prior to classifying them into separate categories of technical assistance. Second, the largest share of the technical assistance received by the companies is internal (see tables 4 and 5), for which there is very little information. Third, while the information presented here is authentic, inconsistencies in the format of the "utilization reports" led us, in some occasions to extract numbers from several sources in others, to manipulate those figures (as indicated in each case). Finally, technical assistance includes many items which are not measured in man-hours. We refer to the presence of expatriates, the assigment of PDVSA's employees to the installations of the international company, courses in Venezuela and courses abroad. However, most of these items refer to long or mediun term technical necessities, thus we

TABLE 4. GLOBAL VIEW OF THE CAT'S (1980)

CAT (AFFILIATE) [a]	TECHNICAL ASSISTANCE (M-H)	EXPATRIATES (NUMBER)	PROCUREMENT (VALUE US$)	ASSIGNMENTS ABROAD (M-M)	COURSES ABROAD (D-M)	COURSES VENEZUELA (D-M)
Exxon (LAGOVEN)	4870.	74	91.74 (MM)	132	505	1948
Shell (MARAVEN)	50253	66	72.8	45	1044	1820
Gulf (MENEVEN)	21424	43	53.2	86	258	2140
Mobil (CORPOVEN)	4863	5	- - -	16	405	- - -
B.P. (CORPOVEN)	403	- -	- - -	- -	35	- - -
W.B. (LAGOVEN)	56170	3	0.52	12	- -	- - -
Bechtel (LAGOVEN)	40783	6	22.74	21	- -	- - -
Snamprogetti (PEQUIVEN)	92768	- -	- - -	- -	- -	- - -
Phillips (PEQUIVEN)	46212	- -	- - -	- -	- -	- - -
SUB-TOTAL CAT's	361,579	193	241	279	2247	5908
FOREIGN CONTRACTING OUT OF CAT'S	3,022,000	39 [b]				
DOMESTIC CONTRACTING OUT OF CAT'S	659,000					
INTEVEP	343,000					
INTERNAL, AFFILIATES	6,318,000					
TOTAL	10,318,000					

NOTES: [a]: M-H = man-hours
M-M = man-month
M-D = man-day
[b]: This figure corresponds to special contracts held by LAGOVEN

TABLE 5. TECHNICAL ASSISTANCE PER SOURCE (1980)

SOURCE	PERCENTAGE (MAN-HOURS)			
	LAGOVEN	MARAVEN	MENEVEN	CORPOVEN
CAT'S [A]	14.2 [B] (280000)	6.0 (50253)	13.5 (21424)	5.2 (18000)
FOREIGN NO-CAT'S	67 (1322000)	63.2 (527647)	5.4 (8576)	20.1 (69000)
INTEVEP	5.3 (105000)	10.8 (90000)	30.9 (49000)	27.2 (93000)
DOMESTIC FIRMS	13.0 (256000)	20.0 (167495)	50.2 (79535)	47.4 (162000)
TOTAL	100.0 (1963000)	100.0 (835395)	100.0 (158535)	100.0 (342000)
PERCENT OF ALL TECHNICAL ASSISTANCE	59.6	25.1	4.8	10.4

NOTES:

[A]- These figures do not include courses, assignments abroad and expatriates.
[B]- This figure includes two "non-traditional" CAT's subscribed with Williams Brothers and Bechtel. If we leave the CAT with Exxon alone within this category and put the other two within the FOREIGN NO-CAT category we obtain the following results (for LAGOVEN only):

CAT's	2.5 %
FOREIGN NO-CAT	79.1 %

may say that the technical assistance[21] described here is a good measure of the operational, e.g., short term, requirements.

1. Technical assistance (overall patterns)

Tables 4 and 5 show that the CAT's represent a small proportion of the technical assistance received by PDVSA's affiliates: 8.9% of the assistance received from sources located outside the industry and only 3.5% of all the assistance received by the industrty. The same conclusion is arrived at when we compare the CAT's with other assistance from foreign sources (only 10.7% of the total).

Despite their reduced scope, the CAT's are key sources of technical assistance to the industry for at least three reasons. First, they provide, for the most part, expertise which is not easily available elsewhere, particularly about proprietary processes or about Venezuela's own oil fields. Second, they permit the Venezuelan industry to maintain continuous contact with the ex-concessionaires which may be useful in other areas. Third, as the 1975's INTEVEP report discussed (see chapter II), the CAT's cover some technolo gies which are crucial to the industry and whose absence

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21-As indicated earlier, the technical assistance item includes: 1) consultations via telex, phone, or any other channel, 2) trouble shooting, 3) technological auditing, 4) visits by experts, etc. In short, it includes, any activity related to technical support with the exception of courses, expatriates, assigments abroad and courses.

would jeopardize the continuity of the operations; thus, it appears justified to use the "secure" CAT's instead of incidental contracts to obtain these crucial technologies.

We believe, however, that the numbers presented in the previous paragraphs underestimate the scope of the CAT's by a large margin. Several other forms of assistance provided under the CAT's (expatriates, procurement, etc.) may represent much more sizeable channels for technology transfer than technical assistance itself.[22] Furthermore, the permanent character of the CAT's means that they can provide much more learning opportunities than other, more temporal, channels for technical assistance.

A detailed study of the assistance received through courses, assignments abroad and expatriates could provide insights into the process of learning. As for courses, it is impossible to reach solid conclusions because we lack detailed information about their content and participants.[23] The same comment applies to assistance received from expatriates. Interestingly enough, the number of expatriates in LAGOVEN, MARAVEN and MENEVEN matches the size proportions

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22-Indeed, the cost of these items represent 75% of the total value of the CAT's. This figure, however, represents a quick, dirty calculation which should be taken with care.

23-In this particular, historical information about the courses and activity of the expatriates could be especially useful. For instance, data about the organizational position of the participants in regular courses could reveal learning processes.

(measured by production volume) of these affiliates up to the second decimal! These proportions are (by rough estimate):

	SIZE	EXPATRIATES
LAGOVEN/MARAVEN	1.71	1.71
LAGOVEN/MENEVEN	2.6	2.6
LAGOVEN/CORPOVEN	2.77	22.6 (does not follow the pattern)

We have no particular explanation for these occurrences.

2. Use of the CAT's per function

Table 6 shows the use of the CAT's per functional category. It seems quite clear that there are significant differences as to how these agreements are used within the affiliates. There is only one exception, Mobil, to the fact that production is the most important item in these contracts as it comprises, on the average, 64% of the technical assistance received through the CAT's. The next item in importance is refining with 19.7% of the total, in this case with significant variability among the affiliates (low: Williams Brothers' 5.6%; high: Mobil's 57%). The other items, marketing and "others" represent only marginal contributions.

Manipulations of the numbers of this table 6 to show the pattern of technical assistance per affiliate instead of by CAT's produces very interesting results which are shown in table 7. The proportions get much closer to each other. This result may seem to support the argument that the CAT's are substitutes of each other and that, contrary to our earlier

TABLE 6. USE OF THE CAT's PER FUNCTION (1980)

- man-hours -
(%)

	EXXON	BECHTEL	W.B. [a]	SHELL	GULF	MOBIL	SUN [b]	B.P. [c]	TOTAL
EXPLORATION	10132 (20.8) [d]			7844 (15.6)	4502 (21.0)	266 (5.7)	346 (4.6)	11 (2.7)	22336 (10.6)
PRODUCTION	20712 (42.5)	24290 (75.4)	39530 (74.7)	32626 (65.1)	10660 (49.8)	1417 (30.4)	6134 (82.0)		134538 (64.1)
REFINING	17823 (36.6)		2964 (5.6)	9342 (21.9)	6220 (29.0)	2670 (57.3)	758 (10.1)		41395 (19.7)
MARKETING		7382 (22.9)	3000 (5.7)				96 (1.3)	392 (97.3)	10775 (5.1)
OTHERS [e]		557 (1.7)		335 (0.6)	42 (0.2)	310 (6.6)	144 (1.9)		806 (0.4)
TOTAL	48703	32229	52870	50148	21424	4683 [f]	7478	403	209850 [g]

NOTES:

[a]- Williams Brothers Co.
[b]- Contract expired in 1979, still operational during early 1980.
[c]- British Petroleum Co.
[d]- Proportions between exploration and production extrapolated from first semester. Total figures, however, are actual numbers.
[e]- Includes general services such as fire safety.
[f]- The use of this contract almost doubled from 1979 to 1980.
[g]- Two other CAT's used by the petrochemical subsidiary (PEQUIVEN) have been excluded: with Phillips petroleum (46000 man-hours) and Snamprogetti (93000 man-hours).

SOURCE: "Utilization Reports," PDVSA.

TABLE 7. FUNCTIONAL USE OF THE CAT's PER AFFILIATE (1980)

(Percentages)

	LAGOVEN [a]	MARAVEN	MENEVEN	CORPOVEN [b]
Exploration	7.6	15.6	21.0	5.0
Production	63.1	65.1	49.8	60.2
Refining	15.5	18.6	29.0	27.3
Marketing	7.8		0.2	3.9
Others	.4	0.7		3.6
Total	100%	100%	100%	100%

NOTES

[a] includes CAT's with Exxon, Bechtel and Williams Brothers.

[b] includes CAT's with Sun Oil (now expired, but used in 1980), Mobil and British Petroleum.

comment, the reduction in the use of the CAT's is not an indication of learning but, rather, the result of switching from one source to another. However, the fact that the total amount of technical assistance received by LAGOVEN (shown in figure 7) increased dramatically throughout this period makes this doubtful.[24] Moreover, the analysis of the specific services brought within the realm of these CAT's shows that they cover very different areas of expertise. Hence, in LAGOVEN's case, we may conclude that the new CAT's did not substitute for the services bought by the old ones but, instead, complemented them.

The case of CORPOVEN is quite the opposite of LAGOVEN. Historical data (just for the years 1979 and 1980) show that the use of Mobil's CAT increased dramatically (by 67%) the same year that the one with Sun Oil was cancelled (1980), even though the total amount of technical assistance received by this affiliate actually declined by 22%. Thus, in CORPOVEN's case, the CAT's appear to be used as substitutes and not as complements to each other.

3. Technical Assistance Per Source

The analysis of the technical assistance per source permits us to compare PDVSA's patterns with those prevailing in

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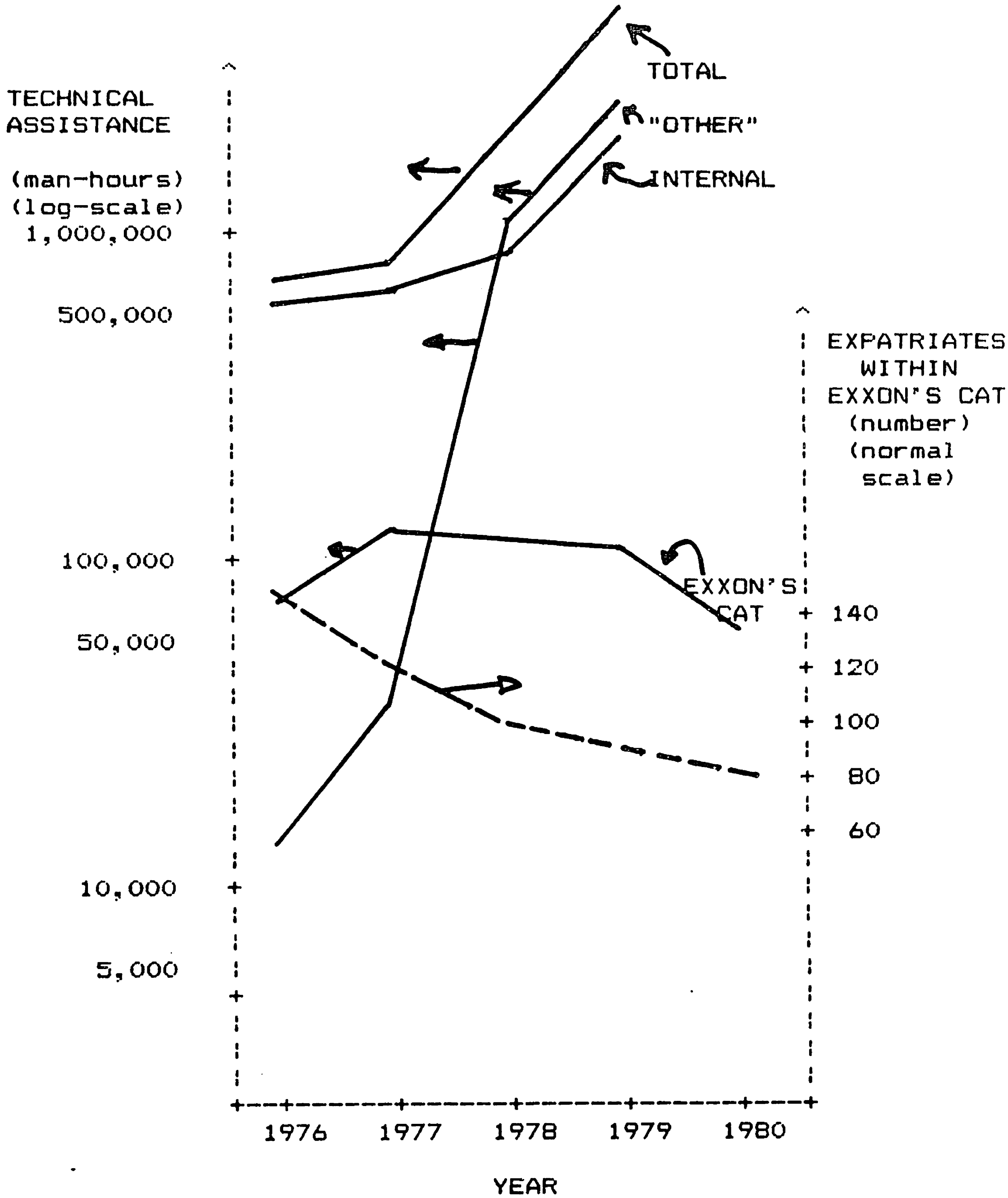
24-Even if the services brought under the new CAT's (William Brothers' and Bechtel's) replicated exactly the ones of the old Exxon agreement we could not consider the contracts as substitutes because they could be used to provide just larger amounts (no quality) of technical support not available within LAGOVEN's.

FIGURE 7. EVOLUTION OF TECHNICAL ASSISTANCE: LAGOVEN'S CASE



the world petroleum industry. Unfortunately, we do not have enough information to make a comprehensive analysis of this issue (his is not included in the utilization reports). For each affiliate we would require the shares (%) of technical assistance per function <u>and</u> per source, as well as a detailed knowledge of the use of different sources for technical assistance worldwide. However, the limited information we have permits us to analize the cases of two affiliates, MARAVEN and CORPOVEN.

In the case of MARAVEN, the use of the CAT's follows the prevailing trends: In exploration, for example, 9% of the technical support comes from the oil companies (within the CAT's), and this figure matches very closely what Hiegel (1978) considers as the average for the industry, 10%. In the case of MENEVEN, however, the use of the CAT's for exploration is much more intense as this affiliate acquires about 25 % of its technical support for exploration through the CAT with Gulf.

The differences between the affiliates are equally notable when we compare global technical assistance across sources. As table 5 shows, the two largest affiliates obtain a very large share of their technical support from foreign sources, above 70 % if we include the CAT's, while the two smallest rely mainly on domestic sources, about 70 % on the average. This is an odd result because it tells us that MARAVEN and LAGOVEN are much more dependent upon foreign sources than

MENEVEN and CORPOVEN. However we must be very cautious in reaching such a conclusion because the main difference appears to be the use of independent sources (we presume engineering and others) and not from the CAT's which, as we remember, represent small portions of the total technical assistance bill. Moreover, the largest affiliates could be satisfying their requirements with their own internal resources.

The previous result can be explained from the supply side by saying that perhaps the largest companies occupied all the available domestic sources and that, because of this, they had to go abroad to obtain more assistance. This argument, however, does not explain why there was anything left to the smallest affiliates; or why all affiliates use about the same amount of domestic technical assistance. Another explanation is endogenous: by virtue of their administrative sophistication, the two largest affiliates have been able to contract with foreign sources that the smallest ones could not find or unable to afford.

As we see, the examination of the overall patterns of technical assistance per source leaves several unanswered questions. In the next chapter we undertake an exhaustive analysis of the organizational factors behind the choice of these sources of technical assistance. We believe that this approach is potentially much more useful than trying to analyze the availability of technical assistance in both domestic and international markets (e.g. an analysis of supply).

4. Cross-Utilization of the CAT's

As mentioned, the agreements negotiated after 1979 allow any affiliate to use the CAT's subscribed by any of the others. As table 8 shows, such inter-affiliate transfer encompasses a multitude of services but, with few exceptions, remains as a marginal activity. Furthermore, most of the instances of cross-utilization consist of manuals, computer programs (all of which are IBM-compatible), and courses; that is, do not involve the transfer of operative technology or direct interaction among members of the operating ranks.

Of all PDVSA's affiliates, CORPOVEN is the only one receiving any considerable amount (in relation to its size) of technical assistance under CAT's other than its own. In this case, the technical assistance received from Bechtel (1100 man-hours) and Williams Brothers (4000 man-hours) serves two primary purposes. First, it compensates for the termination of Chevron's and Sun Oil's CAT's during the year 1980. Second, it provides expertise for some of CORPOVEN's new projects in the Orinoco tar belt.

Table 8 shows, also, that INTEVEP is the main beneficiary of inter-affiliate technical assistance. The effect of Exxon's restrictions against R & D exchanges are clearly

TABLE 8. CROSSED UTILIZATION OF THE CAT's (1980)

SOURCE \ RECIPIENT	LAGOVEN	MARAVEN	MENEVEN	CORPOVEN	INTEVEP	PDVSA	PEQUIVEN
LAGOVEN (EXXON)		central field Block V project Manuals	computer-based model for production			Manuals	
MARAVEN (SHELL)	Study of Quiriquire field.		Manuals	Auditing for deep drilling	1 Expatriate. 1 Assignment to Shell (The Hague)		
MENEVEN (Gulf)	18 D/year courses	18 D/Y courses (Nanopaleontology) Manuals		21 D/Y courses	4 D/Y courses 144 m-h assistance	24 m-h Assist. + 43 m-h (MEM) 5 D/Y courses	1 Expatriate.
CORPOVEN (Mobil & BP)		technical assistance(BP)	computer programs (Mobil)		computer programs (Mobil) Training (Mobil) Cooperation (BP) Visits (Mobil) Courses (Mobil)2	advise in sea transportation. (BP)	computer programs
LAGOVEN (Bechtel)		1170 m-h		1100m-h	7710m-h		2200m-h
LAGOVEN (W.B.)				4000m-h	200m-h		

NOTES:

m-h = man-hour
D/Y = man-days

portrayed: INTEVEP receives no assistance through the agreement with Exxon. In this regard, we may discard any possible unwillingness on LAGOVEN's side because, as shown in table 8, this affiliate provides technical assistance to INTEVEP through its other CAT's with Bechtel and Williams Brothers.

5. Summary

The numbers presented in this section reveal that, in terms of size, the CAT's represent only a small fraction of the total technical assistance received by the Venezuelan petroleum industry. Thus, their importance must come from the crucial nature of the technologies they provide.

However, the CAT's with the ex-concessionaires do not appear as indispensable as pre-nationalization writings would lead us to think. CORPOVEN's case shows that these agreements can be substituted with each other or with assistance from other affiliates (which, in turn, may be using their own CAT's for that purpose). Moreover, the case of LAGOVEN shows that additional CAT's can be used to acquire new expertise unavailable through the traditional agreements.

From another perspective, the patterns analyzed in this section show that some learning must be taking place as LAGOVEN was able to reduce its use of Exxon's CAT even in the face of increased requirements for technical assistance (

and, as we commented, the new CAT's with Bechtel and Williams Brothers brought different types of assistance). We want to point out, however, that this conclusion is limited by our lack of detailed knowledge of the different channels for technical assistance available within the affiliates themselves.

The patterns of technical assistance by function (e.g. exploration, production, refining, marketing, etc.) reinforce our presumption, brought by the geographical and geological proximity of the oil fields, that the technological requirements of the affiliates are very similar. In all cases, the affiliates tend to use the CAT's in the same fashion, with production being the main area and refining the second.

On the other hand, the pattern of technical assistance by sources (e.g. CAT's, independent foreign firms, domestic firms, etc.) reveals significant differences among the affiliates. Some affiliates, the two largest, rely much more on foreign sources than others, the two smallest. While this result is somewhat weakened by our relative ignorance of each affiliate's internal technical assistance and by the aggregated nature of the data, it is strong enough to suggest interesting questions for research. In particular, this result calls for a more detailed investigation of the factors which determine the selection of sources for technical assistance.

Our interest in more research is awakened further by our observation that the affiliates, in general, have not taken more advantage of their advances in negotiation. We refer to the fact that inter-affiliate transfers remain a marginal activity. As it may be obvious to the reader, this is also a problem of selection of technical assistance and will be investigated in the next chapter.

We may conclude this chapter with the main research questions brought by our examination of the patterns of technical assistance received by the Venezuelan petroleum industry. These are:

- Why the different affiliates consistently use different sources to satisfy similar technological needs. In short, why do they have different technological preferences?

- Why the affiliates are not engaged in more inter-affiliate technology transfer, even if it comes at no cost.

Given the availability of sources for the technologies studied in this last section, these two questions suggest that individual and organizational elements are, in PDVSA's case, major influences during the selection of sources of technical assistance. The next chapter addresses those influences.

CHAPTER V

SELECTION OF SOURCES FOR TECHNICAL ASSISTANCE

In this chapter we seek to explain two interrelated set of phenomena. First, we want to know why the industry has not exploited a set of advantageous contractual clauses from the CATs which allow the transfer of technology among the affiliates of PDVSA. Second, we want to know the reasons behind the disparate technological preferences of PDVSA's affiliates to satisfy similar technological needs. As mentioned before (chapters I and IV), we have taken the first observation to mean that the major barrier to the transfer of technology to PDVSA is internal, not located at the negotiation stage.[1] The second observation reenforces that same belief, as it indicates that these barriers are related to the identity of each affiliate.

Here we study the nature of these internal barriers to the transfer of technology by examining the impact of individual and organizational elements upon the patterns of technical assistance received by the industry. As suggested by our conceptual framework, we hypothesize that individual characteristics of managers have a major effect on the selection of sources of technical assistance. In order to determine if this is the case, we examine specific choices of technical assistance using information gathered directly from the industry's records. This information comprises data about the nature of the technical assistance received, the individuals

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1-This may not be the case for assistance acquired from sources other than the concessionaires.

who make the selection and the organizational sub-unit in which they area located. Our research design ensures, 1) that comparisons are made only among similar technology and, 2) that each technology is available from several suppliers.

A. THE EMPIRICAL STUDY

Our central hypothesis is that the pattern of selection and evaluation of technical assistance can be explained in part as a function of several characteristics of decision makers and of the organizations where they are located. In the case of PDVSA, The following characteristics appear as relevant:

1) Differences in corporate culture, traceable to the different background of each affiliate, could bias technology choices even if the necessary information is available.

2) Incomplete or distorted information could limit the number of choices available to decision makers.2

3) Scarcity of qualified personnel because of the execution of large projects or substantial increases in the level of activity (for example, more exploration or more refining) could lead some affiliates to contract for outside help even if the required expertise is potentially available within the organization.

4) Differences in organizational structure among the affiliates could mean that employees with different hierarchical rank and/or background could be making the selection of sources for technical assistance based on dif-

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2- Note that, analytically, it is impossible to separate the role of corporate culture in distorting the information for making these choice-of-technology decisions from its role in the definition of the criteria itself which is used for technology evaluation.

ferent criteria.[3]

4) Finally, administrative compatibility between the source and receiver of technical assistance (same invoicing systems, for example) can override techno-economical criteria.

The experimental design used in this chapter is comprehensive enough to capture and, sometimes, differentiate among the most important of these effects.

1. Assumptions and Hypotheses

In our analysis we attempt to test two interrelated hypotheses. The first is that personal "differentiation," e.g. differences in cognitive and emotional orientation (see Section I-C), is associated with consistent differences in decision making among an organization's sub-units.[4] This hypothesis is implicitly assumed to be true in much of the literature on organizations when it is argued that decision processes depend on "rules" which are, in turn, defined by the sub-units making these decisions (Cyert and March, 1962).

The second hypothesis is that this "differentiation" has a cultural component, which is observable after we control for the characteristics of the organization. Because of its

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3- Note that this possibility implies that choice criteria is a function of the hierarchical status. Another explanation is that as the source of decision moves up within the hierarchy the nature of decision process changes from being of the "organizational process" type to the "transactional" type.

4- Note that we are not saying whether these differences lead to "good" or "bad" decisions.

psychological nature, this cultural component may be observable even after a drastic change in the situation which created it, a change in ownership --nationalization--, for example.

In order to test these two assumptions to the study of technological decisions within the Venezuelan petroleum industry we have to rely on two assumptions. The first is that these biases are observable providing that: i) the analysis be limited to low level, operative decisions; ii) some control and/or account is made for content differences among these operative decisions; iii) some control and/or account is made for structural variables. Provision -i- reduces variability due to bargaining among units, as the "transactional" view (Section I-B) holds. Provision -ii- takes into account that some decisions may require different backgrounds, or may be associated with varying levels of uncertainty. Provision - iii- accounts for other possible effects related to organizational structure.

The second assumption is that the observed choices of technical assistance are not severely constrained by the lack of alternative suppliers, or by the existence of other contractual relationships with the receiver and potential suppliers of technical assistance, for example long-term crude supply contracts. We believe that this assumption is valid for at least two reasons. First our analysis is confined to operational assistance where suppliers are, in general, plentiful. In those cases that involve proprietary technologies (Shell's alquilation units, for example), the assistance is provided to the old, mature, processes which were being used before nationalization, for which it is relatively easy to obtain independent assistance. In any event, our analysis would capture the existence of a monopolist owner of technical expertise because all three affiliates would have to select the same source for technical assistance. The other reason for supporting this assumption is that the affiliates consistently reported that, for most of the year 1980, they utilized less technical assistance than the maximum allowed under the terms of the technical assistance contracts --CAT's--. As is well known, these same affiliates have signed long-term crude supply contracts with the former concessionaires.

The two hypotheses involve the influence of "differentiation" upon the choice of sources for technical assistance. Intuitively, we may separate "differentiation" into two dimensions: an individual one, hereinafter called "integration," and an organizational or structural one, hereinafter called "context."

"Integration" is associated with the progressive match or "acculturation" of an individual with his or her work environment. Hypothesize that this match is related to job tenure, hierarchical status and professional background. Job tenure is likely to increase the degree of congruency between the goals of individuals and those of the organization.[5] Hierarchical status, although closely associated with job tenure, defines certain individual characteristics acquired from the exercise of positions of power.[6] Professional background defines the character of important relationships with peers, professional values and, of course, the nature of the tasks performed by those individuals.

In order to test our hypotheses, we have broken them down into a set of narrower, more testable statements. For the purposes of this research, *"traditional"* sources of technical assistance corresponds to the ex-concessionaires. The term *"directly proportional"* refers to the probability of choice, *not* to the value of the dependent variable.

H1-The probability of selection of a given class of source for technical assistance is a function of the job tenure of the selector.

H1'-The probability of selecting a traditional source of technical assistance is directly proportional to the job tenure of the selector.

H2-The probability of selection of a given class of source of technical assistance is a function of the hierarchical status of the selector.

5- Job tenure determines the length of exposure to the culture of an organization. This exposure is associated with a process of "acculturation" known in the literature as "socialization" (Van Maanen and Schein, 1979). This concept should be distinguished from "integration," which is a status *not* a process concept.

6- This characteristic is called "inclusiveness" by Van Maanen and Schein (1979), op.cit.

H2'-The probability of selecting a traditional source of technical assistance is directly proportional to the hierarchical status of the selector.

H3-The probability of selection for a given class of source of technical assistance is a function of the professional background of the selector.

H4-The probability of selecting a given source of technical assistance is a function of the existence of any previous corporate affiliation with that source. [7]

H4'-The probability of selecting a given source of technical assistance is augmented by the existence of a previous corporate affiliation with that source.

The dimension of "context" can be associated with organization-wide incentives, pressures, etc., which may affect the pattern of selection sources for technical assistance. This set of incentives can be associated with the availability of existing technical resources and with status-related incentives.

To explore the relative influence of context, we formulate the following set of statements:

H5-The probability of selecting a given class of source for technical assistance is a function of the degree of availability of indigenous technical resources. [8]

7- This hypothesis attempts to capture the "acculturation" or "socialization" process described earlier.

8- Note that any experimental verification of H5 and H5' requires the existence of at least a partial measure for the availability of technical resources. This measure, which should relate to the perceived size of of a "unit" of technical assistance, and to the the overall capacity of the organization to provide the technical assistance by its own, is described later in the sub-section V.A.3.

H5'-The probability of selecting traditional sources of technical assistance is directly proportional to the degree of availability of indigenous technical resources.

Besides the hypotheses about technology selection, we have considered it important to include several testable statements about the evaluation of the technical assistance received. It is expected that the testing of these hypotheses will shed some light on the nature of the process of selection of sources for technical assistance which is, after all, an evaluation process.

The development of testable statements is, in principle, more difficult for technology evaluation than for technology selection because there are two opposite processes associated with term of employment. The first, which is the "acculturation" process described earlier, would appear to produce biases in favor of the supplier (assuming that it was formerly related to the receiver). The second, which is learning, would seem to increase the chances of unbiased decisions. In our hypotheses we reflect the belief that the first process, "acculturation" or "socialization" related to the time of employment, dominates the second.

H6- The evaluation of a given technical assistance project is significantly related to the job tenure of the evaluator.

H6'- Evaluators with long job tenure will tend to give favorable evaluations of those services provided by the traditional sources for technical assistance.

H7- Professional background is significantly related to the pattern of evaluation of technical assistance.

H8- previous affiliation with the source of technical assistance is associated with favorable evaluations of the technical assistance received.

A meaningful testing of these statements requires the use of a research design which controls for differences among the various types of technical assistance. Such a design, together with the operationalization of the hypotheses, is described next.

2. Research Design

To test the above hypotheses, we must relate choices of technology made in different corporate sub-units (divisions in our case) to several characteristics of those who make the decisions within each sub-unit, as well as several of some characteristics of those sub-units.

The unit of analysis used in this study is the <u>technical assistance project</u>, hereinafter called <u>TAP</u>. This term denotes a quantum, or instance, of technical assistance performed within any of PDVSA's affiliates. For the purposes of this research, the following services qualify as a TAP:

i- consultations, either by phone or telex;

ii-assignment of PDVSA's personnel to facilities owned by the supplier for on-the-job-training;

iii- assignment of the supplier's personnel to PDVSA's facilities for medium-term stay (up to a year);

iv- short-term visits of technical personnel for on-the-spot problem solving (trouble shooting, for example);

v- contracted data and sample analysis (geophysical data interpretation, for example);

vi- maintenance of production, refining and shipping facilities;

vii- design of unsophisticated equipment (similar to the one in use);

viii- computer programs; and

ix- other services not included in the above items, but of operative, routine nature.

Each TAP is associated with a source of technical assistance and with an _ex post_ quality evaluation.

This list _does not_ include the following services: commissioned research, design of new or sophisticated equipment, management of large scale projects (which may be composed by a combination of various TAP's). For the purposes of this particular analysis, the categorization of a service as technical assistance is made from the point of view of the recipient. In other words, we are not interested in whether the provision of a given service requires the supplier to conduct R & D or other sophisticated activities. While this is not the case with traditional sources, the ex-concessionaires, and other large petroleum or engineering firms, providing routine services, it is a frequent and confusing occurrence within INTEVEP. In this case, the lack of experience, and of redundant research capacity, sometimes forces this affiliate to conduct R & D for the provision of services which may be routine for other suppliers.[9]

The term <u>parallel technical assistance projects</u>, abbreviated as <u>parallel TAPs</u>, refers to two or more TAPs which involve the same type of technical expertise (in other words, they are "technologically equivalent") and are completed within different organizational sub-units. Figure 8 illustrates this concept.

We intend t study the impact of behavioral and organizational variables upon technology choice by comparing the demand conditions for a large number of <u>parallel</u> TAP's organized in set of four, one per each affiliate. For the purposes of this work, the "demand conditions" consist of information about the background, hierarchical status and the organizational context of those individuals who made the choices of the sources for technical assistance during the

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9- Two examples of service oriented R & D are physico-chemical methods for the analysis of crudes and fractions, and computer-based simulation of oil deposits. In the first case, the special characteristics of some Venezuelan heavy crudes forced INTEVEP's researchers to develop their own methods of analysis. We have to mention, also, that some research effort has been spent in the normalization of methods for the determining the physical and chemical properties of crudes and products, because the affiliates had inherited disparate testing procedures from their former parent corporations. Apparently, this was a source of confusion that made it difficult to compare crudes and other aspects of production among the affiliates. In the case of simulation, this was an activity formerly conducted within the parent corporations. Hence, there was a need to develop simulation capabilities within the nationalized industry.

year 1980. To this end, we completed the following process:

1- We obtained information about the nature of all the TAPs reported during the year 1980. For each TAP, this included some knowledge about the technological content of the service rendered or, depending on the case, the equipment serviced. Note that this number of TAPs, about 800, constitutes the whole universe under examination. Thus, no sampling was done, in strict sense. An overall description of this group of projects is presented in appendix A).

2- Starting from the whole universe of TAPs, we selected only those which, according our criterion, were parallel Originally, it was hoped that the matching among TAPs could be made directly. However, it was found that the description of the TAPs was made in a different manner within each affiliate. Thus we had to define 45 "generic technologies" (see appendix A for the list). Those TAPs which corresponded to the same generic technologies were considered to be parallel. The end result of this process was a total of 88 projects per affiliate, i.e. 352 TAPs. The reduction in the original number of TAPs was due to the fact that most of the projects from any given affiliate had no technological matching and, therefore, could not be grouped into sets of four parallel TAPs. As appendix A shows, the remaining projects are well distributed across the operational areas which are typical of most oil companies: exploration, production, refining, marketing, computing, etc.

3- A list of the resulting parallel TAPs was sent to the affiliates accompanied of several forms of data collection. These instruments are shown in appendix B.

4- Finally, the instruments were received back with the information originally requested. Unfortunately, the sample was reduced further because of two reasons: underreporting and the elimination of a whole data set (from CORPOVEN). More details are presented within appendix A. Note, however, that the data was requested in a highly disaggregated form, much more than it is necessary (or allowed) for any sound statistical analysis. [10]

10- We refer to the classification of some variables into a large number of categories. This leads to an excessive number of degrees of freedom for the small number of data points available. This problem is resolved by aggregating the data into broader categories.

FIGURE 8. WHAT IS A TECHNICAL ASSISTANCE PROJECT (TAP) ?

key (per affiliate):
TAP'S NAME

Source:
Number of man-hours (M-H)

	CORPOVEN	LAGOVEN	MARAVEN	MENEVEN
1	CORE ANALYSIS Source: Mobil 556 M-H	CORE ANALYSIS Source: Exxon 2000 M-H	CORE ANALYSIS Source: Shell 2730 M-H	CORE ANALYSIS Source: Laboratorio Petrofisico de Venezuela 720 M-H
2	....	GAS-LIFT METHODS Source: Exxon 20 M-H	GAS-LIFT METHODS Source: Shell 30 M-H	....
3	HEAT TRANSFER IMPROVEMENTS Source: Mobil	HEAT TRANSFER IMPROVEMENTS Source: Exxon	HEAT TRANSFER IMPROVEMENTS Source: Lummus	HEAT TRANSFER IMPROVEMENTS Source: Van Dam/ Mechanical Associates

NOTES:

1- is a parallel TAP
2- is not a parallel TAP
3- is a parallel TAP

The design described here has several advantages. In the first place, it relies almost completely on objectively measured data, much of which is regularly collected as part of the normal operations of the entities under study. The weakest measure, hierarchical status, is based on a multiple-choice questionnaire _but_ is is used only for comparative purposes.

Another advantage of our design is that it eliminates the content of the technical assistance itself from the analysis. Therefore, it minimizes the effect of an otherwise unexplainable source of variance. Furthermore, the matching by generic technologies permits us to compute a measure of the availability of internal expertise (this measure is described in detail in the next sub-section).

The research design described here fulfills a fundamental condition for experimental validity, namely, that the hypotheses are refutable by means of simple tests. In our case, the individual hypotheses can be rejected by confirming the condition of marginal homogeneity in our sample. That is, by showing that there is a high probability of equal response across populations.[11] The sign and magnitude of the dependence can be inferred from the parameters of the model. Interestingly enough, it is only necessary to disprove mar-

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11- Population, in this context, refers to a portion of the sample for which all the independent variables, or effects, have the same value.

ginal homogeneity in just one of the hypotheses to reject the hypothesis that the choice of technical assistance responds exclusively to technical criteria.

Of course, the significance of these test depends on how well the research design is able to control the type of technology being selected. In the original research design, referred to as ideal (see appendix C), this control is likely to be very strict. In the research design actually used it is necessary to check whether this is the case through an additional test (see appendix C for further description, and sub-section V-C-1 for the results of the test).

Our design has, of course, several potential weaknesses. In the first place, it assumes that the decision under study is an individual one (the questionnaire asked for data about the selector of the source; however, in case of doubt, it asked for data about the chief of the relevant operating unit receiving the service). In reality, the selection of a source of technical assistance may be a group decision. This problem could be avoided by using a probabilistic model, or another analytical device, to describe the group decision process. We do not think that this approach is justified in our case for the following reason. The proxy for the selector, the unit's chief, has to approve the decision even if he is not the selector. The possibility that the selector has been transferred out of his post certainly exists, but we included a question on this respect.

Finally, we can mention two other potential weaknesses of this design. First, the randomness of the sample under scrutiny could be questioned if differences in corporate affiliation, i.e. culture, result in the use of very different technologies to solve similar problems. This could have led us to drop TAPs which are "parallel" in the sense that the sources for technical assistance are exchangeable. This problem would not introduce biases but would further reduce the generality of our tests. We believe that our definitions of generic technologies are broad enough to eliminate this possibility. The last weakness is the inability to control entirely for technology. As we mentioned earlier, it is statistically impossible to perform a test using technology as a categorical variable (with 40 different levels, one for each generic technology), given the small number of observations of our sample.

3. Variables

As mentioned, we want to establish the type of association between attributes of the TAPs and attributes of 1) those individuals responsible for the selection and evaluation of TAPs (called "selectors") and, 2) characteristics of the organizational context in which these decisions are made. The dependent variables --attributes of the TAPs-- in this study are the following.

TSOURCE=Class of the source of technical assistance for the ith TAP conducted during 1980. This is a categorical variable which adopts values between 1 and 3. These values correspond to the following categories:

1-former concessionaire
2-independent foreign firm
3-domestic firm

TEVAL= Selector's evaluation of the ith TAP. This is a discrete, ordinal-type of variable which adopts values between 1 and 4. These values correspond to the following levels:

1-deficient	("deficiente")
2-mediocre	("regular")
3-good	("bueno")
4-excellent	("excelente")

These values correspond exactly to those reported to the technological units by the actual users. [12]

The independent variables used in this analysis are the following.

TENURE= TSOURCE's selector job tenure in the oil industry. This is an interval type of variable. It intends to capture the effect that the term of employment, thus the length of exposure to corporate rules and orientation, i.e. to corporate culture, may have upon the selection of TSOURCE for the ith TAP, and the evaluation TEVAL of the same TAP. This variable adopts the following values:

1=less than a year in the job,
2=between 1 and 7 years,
3=between 7 and 10 years,

12- Note that this variable corresponds to an ex post evaluation of the same ith TAP. Therefore it does not influence the choice of the source resulting in TSOURCE. Nonetheless, we have collected data for this variable 1) to account for the possibility of biased evaluations of the TAPs and, 2) to see in future analysis whether the evaluation of the TAPs has influence on the subsequent decisions about technical assistance. The first type of study requires an statistical analysis parallel to that of TSOURCE, while the second uses TEVAL as an independent variable.

4=between 10 and 20 years,
5=more than 20 years in the job. [13]

BGROUND=<u>TSOURCE's selector professional background</u>. This is a categorical variable. It is intended to capture the influence that psychological orientation due to academic background may have on the choice of sources for ith TAP, and on the evaluation TEVAL of the same TAP. The values adopted this categorical variable are many, and are shown in the appendix B (within the table of codes for data collection). [14]

AFIL= <u>Identity of TSOURCE's selector affiliate</u>. This is a categorical variable. It is intended to capture the effects that differences in corporate identity may have on the selection of TSOURCE for the ith TAP, and on the evaluation TEVAL of the same TAP. Together with TENURE, this variable permits to examine the effects of the cultures related to each value of AFIL. The values adopted by this variable are:

1=CORPOVEN
2=LAGOVEN
3=MARAVEN
4=MENEVEN
5=INTEVEP
6=PDVSA

AVAIL= <u>Index of relative project size, or availability</u>. This is a ratio-scale variable defined as the reciprocal of the percentage of "utilization" (see chapter IV) per operational area --exploration, production,etc.-- divided by the total number of man-hours used in the generic technology of the ith TAP and multiplied by a

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13- The coding of TENURE (see appendix B) used four digits to indicate whether the selector had moved recently from one affiliate to another. Those selectors who had changed affiliates recently were dropped from the sample to avoid confusion about the identity of the organizational influences studied here.

14- The effect of professional background on the choice of technology has been studied by Wells (1974) for a sample of Indonesian firms from different industries, that is, not a very controlled sample. That study, however, is not parallel to ours, as it analyzed the effect of background upon the capital intensiveness of the technologies selected.

factor of 100. In equation form:

$$\text{AVAIL} = \frac{\begin{pmatrix}\text{maximum number of man-hours}\\ \text{allowed by the CAT within}\\ \text{the operational area}\end{pmatrix}}{\begin{pmatrix}\text{number of man-hours}\\ \text{actually used within the}\\ \text{same operational area}\end{pmatrix}} \; \frac{\begin{pmatrix}100\\ \text{scaling factor}\end{pmatrix}}{\begin{pmatrix}\text{total number of}\\ \text{man-hours used}\\ \text{in the generic}\\ \text{technology } i\end{pmatrix}}$$

This variable is intended to capture the effect that the overall availability of technical resources within the selector's affiliate may have on the choice of TSOURCE for the ith TAF. This variable is a proxy for organizational "slack" (see chapter I) which assumes that technical resources are abundant when an affiliate has used only a small amount of the services available within the CATs. The term at the right indicates that this "slack" is specific to each technology, i.e. that "slack" can be greater in some areas of expertise than others. This variable is continuous.

HSTATUS=<u>TSOURCE's selector hierarchical status</u>. This is a discrete, ordinal-type of variable. It is intended to account for the presence of biases in technology choice which depend on the organizational status of the selector The values adopted by this variable are the following:

1=secretary, administrative assistants,
2=junior technical personnel;
3=senior technical personnel;
4=middle management 1 (this number refers to data collection code, defined in appendix B);
5=middle management 2 (same comment applies);
6=middle management 3 (same comment applies);
7=top management.

The final result of collecting and codifying the data as we indicated is the following set of matrices:

$$\begin{pmatrix} TSOURCE_1 & TEVAL_1 \\ \vdots & \vdots \\ TSOURCE_i & TEVAL_i \\ \vdots & \vdots \end{pmatrix} \begin{pmatrix} TENURE_1 & BGROUND_1 & AFIL_1 & AVAIL_1 & HSTATUS_1 \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ TENURE_i & BGROUND_i & AFIL_i & AVAIL_i & HSTATUS_i \\ \vdots & \vdots & \vdots & \vdots & \vdots \end{pmatrix}$$

where the subscripts indicate that the data is collected for each TAP.

4. Test Model

The purpose of our experimental tests is not the development of structural models of the process of technology choice. Instead, our interest is to study the influence of several individual and organizational (or structural) variables on the selection of sources of technical assistance within the Venezuelan petroleum industry.

Our tests are based on a simple linear-probability model. In other words, we want to examine whether the probability of selecting a given source of technical assistance, herein called TSOURCE, is a linear function of a set of individual and organizational variables. In equation form, our model can be expressed as (with the exception of AREA, all variables have been described in the previous section):

F=F(TSOURCE)= F(TENURE, BGROUND, AFIL, AVAIL, HSTATUS, AREA)

where: F(TSOURCE)= density function for TSOURCE,
AREA= operational area (exploration, production, refining, etc.) where the TAP is rendered.

The reasons behind the choice of this type of model, as well as for the inclusion of the variable AREA, are discussed in appendix C. For the moment, it is convenient to indicate that AREA has been added to control for variations in the type of technology being selected. A test for the goodness of such control is also provided in appendix C.

The response of the dependent variable in our test model does not differentiate between the affiliates. In other words, it considers that the level of response for TSOURCE (=1) is the same for Shell than for Exxon, and for Gulf. Nevertheless, this model allows us to test all our hypotheses.

The model used to analyze the evaluation of sources for technical assistance is a general linear model:

TEVAL = F(TENURE, BGROUND, AFIL, AVAIL, HSTATUS, AREA)

(The symbols have the same meaning as in previous models)

The characteristics of the tests to be performed here are different than in the case of TSOURCE because TEVAL is a numerical, although discrete, variable. The model is not probabilistic in the same sense described earlier.

The hypotheses described earlier can be operationalized as follows:

<u>For the selection of sources of technical assistance</u>

H1- (about job tenure) accepted if the effect of TENURE is deemed significant.

H1'- (about job tenure, proportionality) accepted if the sign of the significant parameters of TENURE is negative.

H2- (about hierarchical status) accepted if the effect of HSTATUS is deemed significant.

H2'- (about hierarchical position, proportionality) accepted if the sign of the significant parameters of HSTATUS is negative.

H3- (about professional background) accepted if the effect of BGROUND is deemed significant.

H4- (about previous affiliation) accepted if the effects of TENURE and AFIL are deemed significant.

H4'- (about previous affiliation, proportionality) accepted if H4 is accepted and the sign of the significant parameters of TENURE is negative.

H5- (about availability of technical resources) accepted if the effect of AVAIL is deemed significant.

H5'- (about availability of technical resources, proportionality) accepted if the sign of the significant parameter of AVAIL is negative.

For the evaluation of technical assistance

H6- (about job tenure) accepted if the F statistics for TENURE is significant.

H6'- (about job tenure, proportionality) accepted if H6 is accepted and a two-way table reveals this tendency.

H7- (about professional background) accepted if the F statistics for BGROUND is significant.

H8- (about previous affiliation, proportionality) accepted if the F statistics for AVAIL and TENURE are significant.

The rejection of the specific hypotheses (H1', H2', H4, H5', H6') is automatic once the corresponding general hypothesis has been rejected. In other words, once we have found out that a given effect is insignificant, it is unnecessary to explore the sign of the associated parameter.

5. Estimation Procedure

The choice of the method of analysis is largely determined by the characteristics of the sample. Let us review them (See Appendix A for details of the sample):

i- Two dependent variables, one categorical (TSOURCE) and one ordinal (TEVAL).

ii- Five independent variables; two categorical (BGROUND, AFIL), three ordinal (TENURE, AVAIL and HSTATUS).

iii- A relatively small sample (219 observations, one per each TAP).

iv- The possibility of applying controls per technology --a total of 38 categories--, or per area of activity --6 categories.

v- As a result of eliminating all those TAP's which were not homogeneous we have introduced sampling error. Therefore, our choice of method should be stochastic whenever possible. In other words, we should refer to our dependent variables as probable responses and to our independent variables as effects. [15]

vi- Because of the numerous levels of our categorical variables, we have a large number of populations (portions of the sample in which the independent variables have the same value).

The characteristics i and ii lead us to discard the use of discriminant analysis for our particular case.

The discriminant, or classification method (Morrison, 1976) is deterministic in its interpretation of the variation in the dependent variable. The stochastic nature of the phenomena under study leads us to select a qualitative, multiple choice method. In our case, we have decided to use the variety known as "logistic probability" model (logit) to estimate the effects of the independent variables.

15- Indeed, it may be argued that any process of individual choice requires a probabilistic interpretation of the levels of response. For a discussion see Pindyck and Rubinfeld, 1976).

This method, however, has some potential drawbacks because it requires estimation of the probability of choice for each group (what we call populations or cells) of individuals. In sparse problems (such as ours, because of characteristics iii and iv) the logit model can encounter difficulty due to the form of the "odds" formula:

the form of the standard response function is:

$$Zi = F(\alpha + \beta Xi)$$

with a probability function of the form:

$$Zi = \text{Log} \frac{Fi}{1 - Fi}$$

which becomes infinite or underdetermined whenever Fi is either 0 or 1.

where Zi = cumulative probability function.
α, β = vectors of parameters
Xi = matrix of independent "effects."
Fi = probability of response of the dependent variable in the population i.

It is a common practice to assign a very small, constant, probability to each cell to avoid the possibility of division by 0. Since this remedy introduces possible biases in the estimates, it is necessary to follow an iterative maximum-likelihood procedure. The only limitation of the iterative procedure is computational cost but, otherwise, it always converges (Pindyck and Rubinfeld, 1976: 251, 260). The routine FUNCAT, available within the Statistical Analysis

System package (SAS, 1982: 254-285), includes this generalized maximum-likelihood procedure.

The routine FUNCAT produces the following information:

- estimates of the parameters assuming a logit response.

- probabilities (associated within a chi-square-like test) that the parameters are zero.

- A likelihood ratio, which is to be interpreted similarly to the residual in a least-squares procedure. That is, it measures the remaining variation in the response across populations after the fitting all the other effects.

Hence, the FUNCAT procedure can be used to test the hypotheses of marginal homogeneity, e.g. that the true response probability is the same across different populations. The sign and magnitude of the response can be inferred from the parameters of the model. These parameters, we may add, are estimated for each level of the response variable.

Other decisions were made before the final implementation of FUNCAT. We aggregated variable values into classes to accommodate to the specifications of FUNCAT, and generated an additional dependent variable (TSOURCE) which does not differentiate between the various ex-concessionaires as sources for technical assistance, e.g. to show that Gulf, Exxon and Shell are different (explanation is available in appendix C). The final version of our response model is shown in table 9.

TABLE 9. FINAL TEST MODEL[a]

DEPENDENT RESPONSE VARIABLES		LEVELS
TSOURCE	:	1 = ex-concessionaire 2 = foreign independent firm 3 = domestic firm
TEVAL	:	1 = poor 2 = mediocre 3 = good 4 = excellent
NSOURCE	:	Exxon Shell Gulf Independent foreign firm Domestic firm
APSOURCE[b]	:	1 = ex-concessionaire 2 = foreign independent 3 = domestic
DELTA[b]	:	0 = (AP source=Tsource) 1 = (AP source≠Tsource)

INDEPENDENT EFFECT VARIABLES		LEVELS
TENURE[c]	:	1 = From 0 to 7 years 2 = 7 to 20 years 3 = more than 20 years
BGROUND	:	1 = Petroleum and related Engineers 2 = Electrical and Mechanical Engineers 3 = Chemical Engineers 4 = Scientists and others

TABLE 9 CONTINUES ON NEXT PAGE

TABLE 9 (continuation)

AFIL	:	2 = Lagoven 3 = Maraven 4 = Meneven
AVAIL	:	continuous
HSTATUS	:	1 = original 1+2 (categories) 2 = original 3+4 (from sub-) 3 = original 4+5 (sec.V-A-3)
AREA	:	E = exploration P = production R = refining SP = special projects T = transportation MS = miscelaneous
TECH	:	1 TO 40 generic technologies, see appendix A.

<u>CATEGORICAL VARIABLES</u>: TSOURCE, NSOURCE, APSOURCE, DELTA, BGROUND, AFIL, AREA

<u>NUMERICAL VARIABLES</u>: TEVAL (discrete), TENURE (interval), AVAIL , HSTATUS (INTERVAL)

NOTES:

a) in most variables the data has been aggregated into broader categories for test purposes.
b) these two variables are explained in the discussion section.
c) counted from the year 1982.

C. RESULTS

1. Influences on the Selection of Technical Assistance

Table 10 shows very significant results. The probability of selecting a given source of technical assistance is significantly related to the job tenure and professional background of the selector, to the identity of his affiliate, and to the availability of technical resources within the technology in question. Only hierarchical status provides an insignificant contribution. Note that the overall likelihood ratio (residual variance) is small 0.08, so our variables explain a good part of the variability of choice. Thus, hypotheses H1, H3, H4 and H5 are accepted while H2 is rejected.

Not all the parameters for each effect appear to be significant.[16] For those that are, we obtained the following results:

In the case of job tenure, the sign of the parameters, (-), reveals that the longer the job tenure, the more likely is the selector to choose the ex-concessionaire as a source for technical assistance. Thus, hypothesis H1' is accepted.

In the case of availability, the sign of the parameters,

16- Note that in these multi-choice probabilistic models there are more than one parameter per variable.

TABLE 10. INFLUENCES ON THE SELECTION OF SOURCES FOR TECHNICAL ASSISTANCE

DEPENDENT VARIABLE = TSOURCE (RESPONSE VARIABLE)

INDEPENDENT VARIABLES:	CHI-SQUARE/ Probability of homogeneous response	Significant parameters	Probability of being=0
TENURE (Degrees of freedom=4) H1, H1' accepted	44.6/0.0001	-1.79 -0.84 -0.87 -0.55	0.0001 0.007 0.0163 0.1140
AVAIL (Degrees of freedom=2) H5 accepted, H5' rejected	15.6/0.0003	3.24 1.70	0.0005 0.05
AFIL (Degrees of freedom=4) H4 accepted	12.8/0.012	-0.82 0.72	0.03 0.02
BGROUND (degrees of freedom=6 H3 accepted	33.4/.0001	1.22 1.52	0.004 0.0005
HSTATUS (degrees of freedom) H2, H2' rejected	3.04/.55		
AREA (degrees of freedom)	21.93/0.02	-2.62	0.0017 0.11

LIKELIHOOD RATIO= 181.01
(REMAINING VARIANCE)= 0.08

(+), reveals that the selection of the ex-concessionaires as sources for technical assistance is more likely to occur when the availability of technical assistance is low. Thus, hypothesis H5' is rejected.

In the case of identity of the affiliate, we must be careful to interpret the parameters because the variable is categorical (they also have mixed signs). However, the fact that there is only one traditional source for each affiliate (the former concessionaire), and that within each affiliate, long tenure is associated with a preference for that ex-concessionaire, reveals that the selection of the ex-concessionaire as a source for technical assistance is somehow caused by the previous affiliation within that source. Thus, hypothesis H4 is accepted.

In the case of professional background, we must be careful to interpret the parameters because this is a categorical variable (they have, however, a consistent + sign). However, the aid of a two by two table allows us to say that, in general, petroleum, geological, electrical and mechanical engineers are more likely to select the ex-concessionaires as sources for technical assistance than chemical and process engineers, and scientists. This result is beyond the hypotheses originally formulated, but is in agreement with Allen's (1977) findings about the differences among professionals in their information habits. We may expect, for example, scientists to obtain technical knowledge through technical literature.

The results also show that the probability of selecting a particular source is related to the area_of_activity. This result indicates that there is a relatively high degree of technological heterogeneity among the areas and that this variable should be included as a control. In other words, it suggests that preferences regarding sources of technical assistance are different within each area of activity. In practical terms, this result means that, in the view of the selectors of technical assistance, suppliers are specialized within each area.

2. Influences_on_the_Evaluation_of_Technical_Assistance.

It is important to note at the outset that while these results on evaluation of technical assistance stand on their own, it is not strictly correct to apply them to the discussion on selection. The reason for this is that the data we collected on evaluation correspond to an ex-post evaluation of the sample of TAPs for which we are making the study (thus, this evaluation was made after the sources for technical assistance were selected).

The validity of the results on evaluation must be qualified further for a different reason. Different from the case of technical assistance sources, the dependent variable "evaluation" is subjective and could be seriously biased by the format of the questionnaire, among other things. Table 14 of the Appendix A reveals that 57% of the responses are located within the category labeled as "good." Although, this type of result is common in this type of variables (Babbie, 1977), it is high enough to raise at least minor suspicions about the reliability of the evaluation data.

Our results (table 11) indicate that the evaluation of the technical assistance received is significantly related to the identity of the affiliate, to the area of activity where the evaluator is located and, to lesser extent, to the professional background of the evaluator. Thus, the hypotheses H1 and H8 are accepted, but the result on area of activity is beyond the set of hypotheses formulated earlier. On the other hand, the hypotheses H6 and H6' are rejected, as TENURE does not appear significant.

3. Discussion

It is appropriate to initiate this discussion with an explanation for the very good fit of our model to the sample (see tables 10 and 11). In our case, we believe that this high level of significance is traceable to the large number of variables used. As Bishop, Frienberg and Holland (1975:324) comment, this is a frequent result in multivariate models. In our case, the use of a model with a large number of parameters was decided after several bivariate (two by

TABLE 11. INFLUENCES ON THE EVALUATION OF TECHNICAL ASSISTANCE

1) Results of the general linear model

VARIABLE	degrees of freedom	F value	probability of being=0
AFIL	2	5.54	.004
HSTATUS	2	0.61	.54
BGROUND	3	1.88	0.13
AREA	5	4.50	0.0007
TENURE	2	0.37	0.69
AVAIL	1	0.46	0.49

MODEL'S F=2.94 ; R^2 =0.16
PR>.0007

2) Results of two by two Tables

BGROUND X TEVAL
(% OF PROJECTS)

TEVAL	BGROUND 1	2	3	4
1	1.8	.91	.46	.00
2	3.2	2.74	9.13	5.4
3	16.4	16.4	15.0	9.1
4	10.0	2.74	4.54	1.83

CHI-SQUARE (MAXIMUM LIKELIHOOD)=27
PROBABILITY OF HOMOGENEOUS RESPONSE= 0.0014

where:
BGROUND = 1-petroleum and geological engineers
2-mechanical engineers
3-chemical engineers
4-scientists

(continues on next page)

TABLE 11 (CONTINUES FROM THE PREVIOUS PAGE)

NSOURCE X TEVAL

(% OF PROJECTS)
(% ROW)

NSOURCE	TEVAL 1	2	3	4
EXXON	0.0	4.1	5.02	2.74
	0.0	34.6	42.3	23.0
SHELL	.91	2.74	10.05	5.02
	4.88	14.63	53.66	26.83
GULF	1.37	1.37	11.42	5.94
	6.82	6.82	56.82	29.55
INDEPENDENT	.46	2.74	15.53	3.65
	2.04	12.24	69.40	16.33
DOMESTIC	.46	9.59	15.07	1.83
	1.69	35.5	55.93	6.78

CHI-SQUARE (MAXIMUM LIKELIHOOD)=31.98
PROBABILITY OF HOMOGENEOUS RESPONSE=.0014

two tables) analyses. For instance we found that professional background alone produced an extremely good bi-variate fit to the evaluation data (probability of homogeneous response = 0.0014, within table 11-2), but a relatively low fit in the general linear model (probability of homogeneous response = 0.13 within table 11-1). In our view the bivariate result was just masking the strong effect of AREA because selectors that work within a given area of activity tend to have similar backgrounds, e.g., petroleum engineers tend to work in production while chemical engineers tend to work in refining. Thus, we concluded that the only way to obtain clean effects was to use a comprehensive model.

Our results strongly indicate that non-economic criteria are used in the selection of sources for technical assistance by the Venezuelan petroleum industry. Otherwise, we should observe no significant variance in the selection of sources for technical assistance[17] in a research design which allows for only insignificant differences in the types of technology used among the units (here affiliates) being compared.

The roots for non-economic criteria appear to be cultural, <u>not</u> based on the structural characteristics of the the organization under study. In particular, it seems that cor-

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17- Note that we are accepting variance in the dependent variable, even in the event of an insignificant test. This is a consequence of our probabilistic model. In a deterministic model (innappropriate to our case) we would expect no variation, or very small variation, for an insignificant test.

porate culture, understood mainly as an individual/psychological attribute, is its main cause. The result about job tenure shows that the level of "acculturation," whatever its nature, increases with time of employment, as measured by the variable TENURE. Any other result for the variable TENURE (a low level of significance or a different sign for the parameters) would have indicated that the bases for the non-economic criteria are organizational, e.g. structural, in nature (for a list, see pages 214-15).

This conclusion is strengthened further by our finding that low availability of indigenous technical resources does not increase the likelihood of choosing the ex-concessionaire as supplier of technical assistance. In other words, those who select non-traditional sources do so by their own choosing, not because they cannot obtain the assistance from the technical assistance contracts (CATs). Alternatively, those who have used up all of what is available from the CATs want even more assistance from the same traditional source.[18]

Professional background constitutes another significant

18- There is an alternative explanation. Our variable on availability is also dependent on the size of the technical assistance project: it is low for large projects. Thus, the association between low availability and traditional sources may indicate that for large projects there is a greater propensity to choose the ex-concessionaire. Whether, this is due to a need for reliability, or is the outcome of an internal bargaining process (i.e. is a "transactional" decision), cannot be discerned at the present time.

influence upon the selection of sources for technical assistance. It appears that some professionals (electrical, mechanical, petroleum and geological engineers) tend to select the ex-concessionaires, while others (chemical engineers and scientists) tend to select other sources for technical assistance. This result is in superficial agreement with those of Wells (1975). In our case, however, we have no economists or administrators in the sample, and we do not deal with the capital-intensity of technologies. Still, our results suggest that one of the attitudinal models proposed by Wells, the "engineering man,"[19] has to be refined, as different branches of engineering reveal different technological preferences. Our results with the evaluation data, although weaker, confirm this assertion.

The preferences of the three cultures we have examined here are shown in table 12. In agreement with our results of the previous chapter, it appears that the affiliates follow different global patterns in the selection of sources for technical assistance.

An interesting issue, with important normative implications, concerns the influence of the culture-based factors thus far described upon the "appropriateness" of the choices

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19- The "engineering man," according to that author is an individual with engineering, or technical, background who tends to choose capital-intensive technologies.

TABLE 12. PREFERENCES_OF_AFFILIATES

TABLE TSOURCE X AFFILIATE

AFFILIATE	TSOURCE		
	ex-concessionaire	independent	domestic
LAGOVEN	39.4	22.7	37.9
MARAVEN	50.6	32.10	17.3
MENEVEN	61.1	11.1	27.8

of sources for technical assistance. Although not the subject of this research, we completed a very rough analysis of this issue. To this end, we defined "appropriate" class of source for each one of our generic technologies. For instance, we considered that technology 5 (field studies) should be serviced by the ex-concessionaires (TSOURCE=1) who developed a profound knowledge of Venezuelan oil fields.[20] The appropriate sources, labeled as APSOURCE, are shown in table 13 together with other results of this analysis. Then, we developed a new dichotomous dependent variable, DELTA, representing the difference between the actual source of technical assistance (TSOURCE) and the appropriate one (APSOURCE).

The results of applying a probabilistic model of dichotomous choice to DELTA are shown in table 13. Very interestingly, no affiliate appears to be consistently "wrong" or "right" in their choices. Tenure, on the other hand, appears as very significant, and with negative parameters, meaning that new employees tend to make the most appropriate choices. On possible explanation for this result is that junior employees are more knowledgeable of the last technologies and, therefore, more likely to make appropriate choices. It is important to indicate that these results are very rough because they depend on our almost-arbitrary choice of what is

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20- The categories of "appropriate" source of technology were developed through the application of standard engineering principles as well as from personal communications with members of INTEVEP, the R & D affiliate of PDVSA.

TABLE 13. APPROPRIATENESS OF SOURCES FOR TECHNICAL ASSISTANCE

VALUES FOR APSOURCE:

(TECH, APSOURCE)

1= 1,	2= 2,	3= 2,	4= 2,	5= 2,	7= 2,
8= 2,	9= 2,	10= 2,	11= 2,	14= 2,	16= 2,
17= 2,	18= 2,	21= 3,	22= 2,	23= 3,	24= 1,
26= 3,	27= 2	28= 1,	29 =3,	30= 1,	31= 1,
32=2,	33= 3,	34= 2,	35= 2,	36= 2,	37= 2,
38= 2,	39= 2,	40= 2,	41= 3,	42= 3,	43= 3,
44= 3,	45= 3,	46= 3.			

DICHOTOMOUS CHOICE MODEL

DEPENDENT VARIABLE= DELTA

0= TSOURCE=APSOURCE

1= TSOURCE≠APSOURCE

INDEPENDENT VARIABLES=

	CHI-SQUARE	PROBABILITY=0
AFIL	2.09	.35
TENURE	9.68	.04
HSTATUS	0.18	.91
BGROUND	4.31	.63
AVAIL	7.82	.02
AREA	6.35	.78

RESIDUAL= 50.6 %

BIVARIATE TABLES

DELTA X AFIL
(% COLUMN)

DELTA	AFFILIATE		
	LAGOVEN	MARAVEN	MENEVEN
0	39.4	44.4	20.8
1	60.6	55.6	79.2

an "appropriate" source of technology.

Summarizing, our results indicate that corporate culture does influence the pattern of selection of sources for technical assistance. Furthermore, our results show that the longer is the exposure to a given corporate culture, the stronger is the selection bias created in favor of the original holder of the corporate culture. In general, our results indicate that these cultural effects are at least semi-permanent. Chapter VII explores the implications of these results in the development of policies for the rational use of technology within the Venezuelan petroleum industry.

C. SUMMARY

With this chapter, we end our analysis of the selection of technical assistance within the Venezuelan petroleum industry. The study of the activity of technology development is forthcoming in the next chapter.

The results of this chapter reveal that non-economical factors can be major influences in the selection of technologies. Interestingly enough, our tests indicate that factors of individual nature are dominant. Other factors of structural nature do not seem to be as important because the tendency to select the ex-concessionaire, which is an individual decision, is proportional to the number of years of work in the industry before nationalization took place. Because of the types of technologies analyzed, we are reasonably certain that the choice of the ex-concessionaries is not the result of monopolistic control of these companies over the technologies being transferred.

In the context of the Venezuelan petroleum industry, a group of enterprises which were nationalized in 1975, the presence of these non-ecomical factors can be interpreted as an inheritance from the ex-concessionaires.

Our findings grant validity to our contention, depicted in chapter I, that it is necessary a managerial approach to international technology transfer. If non-economical factors --culture and organizational structure-- are, indeed, so important in the selection of technology, then governmental policies are intrinsically limited in controlling this process. New policy solutions, and new descriptive models, appear necessary both at the firm and government level.

At the firm level, it would appear necessary for managers to implement strong incentives in order to drive their subordinates toward making the appropriate choices of technology. At the government level, it appears necessary to design specific technological policies beyond the macroeconomical manipulation of the factors of production --capital and labor. In this sense, our results support the current practice of many countries which engage in technological policy making. However, our evidence calls for more powerful policies for directing the choice of technology, which are capable of counteracting the effects of corporate cultures.

From the perspective of economic theory, our findings indicate that isoquants (a curve which represents capital-labor combinations for a given level of output) are inadequate representations of the technological possibilities open to a firm. Besides the common argument that they are discontinuous (Streeten, 1978), our results suggest that these curves can very well intersect for different levels of output. Different corporate cultures, which are firm-specific, could show different "maximum" levels of output with the same combination of capital and labor. We have to admit that, in the aggregate, the response of firms to changes in capital-labor ratios could still follow a continuous pattern, as the effects of different cultures could cancel each other.

Our findings corroborate the contention, depicted in chapter I, that nationalized enterprises are, indeed, different from those firms originally created by the government. Inherited cultures appear to be strong determinants of the behavior of nationalized enterprises. Hence, nationalization does not appear to be a suitable instrument to change the conduct of firms, only the pattern of ownership. The same argument, although with some qualifications, can be extended to state-ownership in general.

APPENDIX A: DESCRIPTION OF THE SAMPLE

This appendix contains information about the sample used for our statistical analysis. The following tables are included here:

TABLE 14. SOME DESCRIPTIVE STATISTICS.

TABLE 15. CORRELATION COEFFICIENTS FOR THE NUMERICAL VALUES.

This appendix does not include information about - Internal flows of technical assistance. In manpower training alone, the industry involved a total of 26,200 employees during the year 1980. This corresponds to about 70% of the industry's manpower. The total number of man_hours occupied in this activity was 2.1 million during that same year. Of these, the Instituto Nacional de Capacitacion Petrolera (INAPET) provided 1.5 million, distributed across 1259 courses.

TABLE 14. SOME DESCRIPTIVE STATISTICS

1) Frequencies (Number of projects: Percentages)

AREA	E	29	13% [a]
	P	56	25%
	R	80	36.5%
	SP	23	10.5%
	T	16	7.3%
	MS	15	6.8%
TSOURCE	1	111	50%
	2	49	22%
	3	59	26%
TENURE	1	60	27.4%
	2	50	22.8%
	3	109	49.7%
BGROUND	1	69	31.5%
	2	50	22.8%
	3	64	29.2%
	4	36	16.4%
HSTATUS	1	7	3.2%
	2	85	38.8%
	3	123	56.1%
	4	4	1.8%
TEVAL	1	7	3.2%
	2	45	20.5%
	3	125	57.0%
	4	42	19.1%
NSOURCE	EXXON	26	11.8%
	SHELL	41	18.7%
	GULF	44	20.1%
	INDEPEND.	49	22.4%
	DOMESTIC	59	26.9%

(continues on next page)

2) Means and Standard Deviations for Continuous Variables

	Mean	Standard Deviation
TEVAL	2.92	0.72
TENURE	2.22	0.85
AVAIL	0.61	1.47
HSTATUS	2.54	0.56

NOTE: [a] These percentages add 100% for each variable (approximate).

TABLE 15. CORRELATION COEFFICIENTS FOR THE NUMERICAL VARIABLES

Key: R^2/probability

	TEVAL	TENURE	AVAIL	HSTATUS
TEVAL	1.0 0.0	0.095 0.159	0.029 0.662	0.015 0.826
TENURE	0.095 0.159	1.0 0.0	-0.025 0.711	0.483 0.0001
AVAIL	0.029 0.159	-0.025 0.711	1.0 0.0	0.035 0.606
HSTATUS	0.015 0.826	0.483 0.0001	0.035 0.606	1.0 0.0

APPENDIX B: INSTRUMENTS FOR DATA COLLECTION

This appendix includes the different questionnaries used for the collection of quantitative information during the course of this thesis. These include:

TABLE 16. GENERIC TECHNOLOGIES USED FOR SAMPLE SELECTION.

TABLE 17. CODES FOR DATA COLLECTION.

TABLE 18. SAMPLE OF QUESTIONNAIRE USED FOR EVALUATING HIERARCHICAL STATUS.

TABLE 19. SAMPLE OF QUESTIONNAIRE USED TO SUMMARIZE DATA ABOUT THE TAPs.

TABLE 16. GENERIC TECHNOLOGIES USED FOR SAMPLE SELECTION

APPENDIX No. 1 Generic technologies used for sample selection

Operational area	Generic technologies
Exploration	Sysmic data processing
	Nannoplankton studies
	Stratigraphic studies
	Polynostratigrphic studies
	Field studies/sysmic sampling
	Marginal fields analysis *
	Interpretation of geophysical data (quadrangles' interpretation)
Production	Production engineering and geology
	Stimulation procedures
	Core analysis
	Blow-ups/wells' control
	Compaction/subsidence studies *
	Lifting methods (gas-lift, for ex.) *
	Drilling engineering (casing, sour crude handling, piping inspection,etc.)
	Reserves' calculation *
	Toxic gases production
	Directional drilling
	Natural gas compression/inyection
	Heavy oil production techniques *
	Production platform engineering *
Refining	Energy-fuel balances
	Process control engineering
	Small/ancillary equipment design (design of drums, tanks, valves,etc.)
	Flowcharting, process engineering
	Ctalysts' characterization *
	Boilers' and steam equipment
	Flares
	Process design (proprietary)
	Small civil projects.

Operational area	Generic technologies
Refining	Industrial safety Lube-oil technology Rotative equipment Electrical systems
Special projects	Project management Procurement Enviromental/urbanistic projects
Crude and products' transport	Pipelines/gaslines Docks, shipping facilities Ships' inspection * Transport systems analysis (scheduling, etc.)
Domestic Marketing	Market studies Service station design
Civil engineering/architecture	
Computing	Package implementation Special consultations Personnel assignments

* - Generic technologies with this symbol were discarded from the sample because there were no projects in all four affiliates.

**- there are, of course, generic technologies with more than one project.

TABLE 17. CODES USED FOR DATA COLLECTION

APPENDIX 2. CODES FOR DATA COLLECTION

DEPENDENT VARIABLES	CODE
Y1 = Technical assistance source	01_0
Levels:	
same affiliate	0110
another operating affiliate	0120
INTEVEP	0130
ex-concessionary	0140
oil company distinct from ex-concessionary	0150
foreign engineering firm	0160
domestic engineering firm	0170
other	0180
Y2 = Evaluation of technical assistance received from Y1 during 1980.	
Levels:	
excelent ("excelente")	0111
good ("bueno")	0121
regular ("regular")	0131
deficient ("deficiente")	0141
Y3 = Evaluation of the projects performed by INTEVEP during 1980.	
Levels:	
excelent	0111
good	0121
regular	0131
deficient	0141

INDEPENDENT VARIABLES	CODE
X1 = Job tenure (within the oil industry)	
Levels:	
more than 30 years	0210
between 20 and 30 years	0220
between 10 and 20 years	0230
between 7 and 10 years	0240
between 1 and 7 years	0250
less than a year	0260
when coming from another affiliate, add:	
less than 2 years in new job	XXX1
between 2 and 4 years in new job	XXX2
more than 4 years in new job	XXX3

APPENDIX 2 (continuation)

X2 = professional background

Levels:

Engineer:	chemical	0310
	petroleum	0311
	mechanical	0312
	electrical	0313
	geological	0314
	other	0315
Scientists:	chemist	0320
	physicist	0321
	matematician	0322
	biologist	0323
	other	0324
Legal:	lawyer	0330
	political scientist	0331
	other	0332
Administrative:	administrator	0340
	industrial engineer	0341
	statistician	0342
	accountant	0343
Social science:	economist	0350
	sociologist	0351
	journalist	0352
	antropologist	0353
	international studies	0354
	other	0355
Technician	: petroleum	0360
	chemical	0361
	mechanical	0362
	electrical	0363
	other	0364

X3 = Affiliate

Levels:

CORPOVEN	0410
LAGOVEN	0420
MARAVEN	0430
MENEVEN	0440
INTEVEP	0450

X4 = Index of availability of technical resources; defined as:

$$\left\{ \frac{\left[\begin{array}{l}\text{man-hours used by operational area (exploration,} \\ \text{production, refining, etc.), cumulative by june 1980.}\end{array}\right]}{\left[\begin{array}{l}\text{maximun available from the contract} \\ \text{(man-hours per area)}\end{array}\right]} \times \frac{\left[\begin{array}{l}\text{man-hours per} \\ \text{technical as-} \\ \text{sistance project}\end{array}\right]}{100} \right\}^{-1}$$

APPENDIX 2 (continuation)

X4; LEVELS:

less than 0.5	0510
X4 between 0.5 and 1.0	0520
X4 between 1.0 and 1.5	0530
X4 between 1.5 and 2.0	0540
X4 larger than 2.0	0550

X5 = Hierarchical position (this category was def[illegible] in an appendix to a)
note sent to each [illegible] PDVSA's affiliates

Levels:

new technical personnel (junior)	0610
senior technical personnel	0620
middle management 1	0630
middle management 2	0640
middle management 3	0650
top management	0660
administrative personnel (clerks, etc.)	0670

TABLE 18. SAMPLE OF QUESTIONNAIRE USED FOR HIERARCHICAL STATUS

APENDICE 3: Planilla para establecer el "Rango Jerárquico" de los solicitantes de asistencia técnica

Definiciones (aproximadas):

Personal técnico nuevo: Persona contratada para funciones técnicas que tiene poco tiempo en el ejercicio de sus funciones. (0610)

Personal técnico con experiencia: mismo anterior, pero con mayor tiempo en el ejercicio de sus funciones. Generalmente tiene bajo su cargo la supervision de varios empleados en la categoría 0610. (0620)

Gerente medio 1: Personal que tiene bajo su cargo varios miembros de staff administrativo; poco tiempo (aprox. 5 años) en funciones. (0630)

Gerente medio 2: igual que 0630, pero con más tiempo en sus funciones. (0640)

Gerente medio 3: supervisa varias personas colocadas en 0640, llegando hasta el cargo de gerente funcional de división (gerente de finanzas de la división de mercadeo interno, por ejemplo). (0650)

Alto gerente: Todos aquellos por encima de 0650. Esto es. rango igual ó superior a gerente general de división, directores de filial incluídos.

Staff: personal ocupado en funciones administrativas bajo la supervisión de gerentes medios 1,2 y 3. Generalmente en nómina menor. (0670)

Nota: esta clasificación es, naturalmente, bastante ambigua. De todos modos lo que interesa es obtener una idea de cuál es la apreciación de otros, ó de la misma persona, de cuál es su posición en la jerarquí de la empresa.

POR FAVOR, CONTESTE A SU DISCRECION CUAL ES SU APRECIACIÔN DE LA JERARQUÎA DE LOS SIGUIENTES EMPLEADOS . (Próxima página).

Esta planilla es para su uso, no tiene que ser entregada al responsable del proyecto.

Appendix 5:

Sample of questionaire used for evaluating hierarchical rank (variable X5).

Page 1: description of the categories used for hierarchical rank.
Pages 2-4: form for filling apparent rank

APENDICE 3: continuación.

FAVOR MARCAR CON UNA X

Proyecto: Nombre

posición jerarquica, apreciación personal

a) personal tecnico nuevo
b) personal técnico con exp.
c) gerente medio 1
d) gerente medio 2
e) gerente medio 3
f) gerente ,alto
g) staff

		a	b	c	d	e	f	g
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
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28								
29								

		a	b	c	d	e	f	g
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61								
62								
63								
64								
65								
66								
67								

		a	b	c	d	e	f	g
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69								
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85								
86								
87								
88								
89								
90								

TABLE 19. SAMPLE OF QUESTIONNAIRE USED FOR SUMMARIZING INFORMATION ABOUT THE TAPs

Appendix 4.
Sample of questionaire used for collecting TAP's (technical assistance project's) data.

APENDICE HOJA PARA LLENADO DE DATOS (sección a, ref. nota informativa)

FILIAL:

			DATOS SOBRE EL SOLICITANTE:				
proyecto: #	Descripción del proyecto	unidad solicitante	Profesión	tiempo en la industria	viene de otra filial ?	posición jerárquica (ap. 3)	Evaluación asistencia

APPENDIX C ALTERNATIVE TEST MODELS

This appendix reports the reasoning followed to develop our test model. It includes a discussion of the alternative formulations for our research problem and a test for the goodness of the approximations made for the model we actually use in this thesis.

Development of the Test Model

The "ideal" model to analyze choice of sources for technical assistance, including all the effects, and controlling for the type of technology, would be a log-linear model as:

```
                (Probability )
                (of selecting)
F=F(NSOURCE)=(  a class of  ) = F(TENURE, BGROUND, AVAIL,
                ( source of   )              HSTATUS, TECH)
                ( Technical   )
                ( assistance  )
```

where:

TECH is a categorical variable with a value for each generic technology, and

NSOURCE is a categorical variable with 5 levels (1=Exxon, 2=Shell, 3=Gulf, 4=independent foreign firm, 5=domestic firm)

This model is referred to as "ideal," because it includes all the possible independent variables (or "effects"). Because of the inclusion of the variable TECH, this model can provide very strong tests for marginal homogeneity: the presence of even one significant relationship is enough to reject the hypothesis that the selection of sources for technical assistance is made in response to economical criteria only. However convenient the ideal model may be, it is impossible to calculate. The variable TECH, which is categorical, comes in 39 levels (one for each generic technology). Moreover, the dependent variable (or "response") should have 5 levels: one for each of the 3 concessionaires, one for independent firms, and one for domestic firms. In short, the number of populations to analyze is immense.

A "second-best" model is:

```
               (Probability of )
               ( selecting a    )
F=F(NSOURCE)=(class of source) = F( TENURE,..., AREA)
               ( for technical )
               (  assistance    )
```

In this "second-best" model we attempt to control for technologies by grouping the data in areas of activity: exploration, production, etc. This guarantees at least some "technological homogeneity" within the populations because generic technologies within a particular area of activity tend to be related. Nevertheless, there could be substantial "technological heterogeneity" left within each area of activity, and some overlap within different areas (for example, rotative equipment --pumps-- being used in production and refining). Note, also, that AVAIL still should be calculated as in the "ideal model", that is, as availability within each technology and not within area of activity. After all, requests for technical assistance within the technologies draw from a small pool of scarce, specialized resources.

One unwanted consequence of having heterogeneity within groups of technologies is that variance in the response variable can arise even if the selection of sources for technical assistance is based exclusively on techno-economical criteria. This is because is logical to select different types of suppliers for different technologies. Note that, for comparative purposes, the model still can be useful because this problem of data aggregation would arise within each of the three affiliates. Furthermore, we can devise a simple test for homogeneity: calculate the chi-square for bi-dimensional tables between TECH and AFIL (affiliate), within each area of activity. If the chi-square coefficient is small, we confirm the hypothesis of marginal homogeneity for the sample of technologies used by the affiliates within each area of activity. In other words, we would say that the affiliates used the same group of technologies for exploration, refining, etc. This test is included later in this appendix.

Unfortunately, this model is still too complex to be properly handled. The computer-based procedure which was used to calculate the parameters of this "second-best" equation (maximum-likelihood logit procedure) consistently aborted during execution time. It appears that any model with more than 3 levels in the response variable is unworkable within our data set.*

Consequently, we decided to rely on a simpler, yet still useful model:

F= F(TSOURCE)= F(TENURE, BGROUND, AFIL, AVAIL, AREA)

where: TSOURCE= class of technical assistance source, classified in three levels: ex-concessionaire, independent firm, and domestic firm.

The response of the dependent variable in this last model does not differentiate between the affiliates. In other words, it considers that the level of response for TSORCE (=1) is the same for Shell than for Exxon, and for Gulf. Nevertheless, this model allows us to test all our hypotheses. However, these tests are likely to be weaker than those conducted within the "ideal" model. How much weaker are these tests can be inferred from the same test for homogeneity described for the second-best model. The results of this test are presented next in this appendix.

From a different perspective, it can be argued that the "last" model is better than the "ideal" because it is not so strongly biased in some responses (we know, for instance that there is no choice for Shell in either LAGOVEN or

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*- In fact, an attempt to run this second-best model with a modified dependent variable with four levels (1=Exxon, 2=Shell, 3=Gulf and 4=all others) was aborted on execution time.

MENEVEN). This bias may have been the cause of our computational problems with the first two models.

The model used to analyze the evaluation of sources for technical assistance is also a general linear model:

TEVAL = F(TENURE, BGROUND, AFIL, AVAIL, AREA)

(The symbols have the same meaning as in previous models)

The model is not probabilistic in the same sense described earlier.

Test of Homogeneity

Table 20 shows that our sample is indeed, quite homogeneous regarding the use of technologies within each area. In all three areas examined, exploration, production and refining, the probability of homogeneous response is almost one, meaning that there is no significant difference in the decision patterns made by the affiliates within the different areas of activity.

Thus, we can say very confidently that the aggregation of generic technologies within areas of activity, i.e., the use of the "second-best" or "last" model should not introduce significant errors in our incoming analysis. Still, parts of the "ideal" model seem necessary. We refer to the need to calculate availability (AVAIL) on the basis of technologies (of which there are 40) instead of areas (of which there are 6).

TABLE 20. <u>TECHNOLOGICAL HOMOGENEITY WITHIN AREAS OF ACTIVITY</u>

Key: Number of TAP's within each technology.

AREA	TECHNOLOGY	AFFILIATE		
		LAGOVEN	MARAVEN	MENEVEN
EXPLORATION	1	1	1	3
	2	2	2	1
	3	1	1	1
	4	1	1	1
	5	1	4	1
	7	2	2	4

CHI-SQUARE = 5.6; PROBABILITY = 0.84

AREA	TECHNOLOGY	LAGOVEN	MARAVEN	MENEVEN
PRODUCTION	10	1	1	2
	11	2	1	2
	14	3	2	5
	16	1	1	2
	17	1	1	1
	18	3	4	5
	8	1	4	4
	9	2	3	3

CHI-SQUARE = 4.3; PROBABILITY = 0.99

AREA	TECHNOLOGY	LAGOVEN	MARAVEN	MENEVEN
REFINING	21	2	1	1
	22	3	4	2
	23	1	5	3
	24	1	1	1
	26	1	2	2
	27	1	1	1
	28	6	8	5
	29	2	2	1
	30	2	1	1
	31	1	2	1
	32	2	2	2
	33	2	4	5

CHI-SQUARE = 8.8; PROBABILITY = 0.99
CHI-SQUARE = MAXIMUN-likelihood ratio

PROBABILITY = PROBABILITY OF HOMOGENEOUS RESPONSE

CHAPTER VI

DEVELOPMENT OF INDIGENOUS TECHNOLOGY

A. ORGANIZING R&D: INFORMATION PROCESSING

Research on the management of technology (hereinafter MOT) has grown in amount and significance during the last decade. The literature in this field now provides important practical lessons in a wide variety of issues, from aspects of physical location and architectural design of laboratories to problems in the creation of research teams. In this section we conduct a brief, and necessarily partial, review of the literature on technology management. The purpose of this revision is two fold, first, to support the empirical investigation conducted within INTEVEP and, second, to integrate this chapter into the general framework of information processing developed earlier.

1. The Relationship between Technology and Strategy.

The problem of incorporating technological considerations into strategy represents perhaps the weakest area in the MOT field.[1] Essentially, the research in this area has evolved in two directions: direct incorporation of technological questions into the process of strategic planning, and the categorization of some strategies such as licensing, technology-based divestment, internal venturing, etc. Another distinguishing characteristic of the research in this area is that it tends to be concerned with corporate-level strategy. That is, with questions of concern to top management. In

1- A recent review of this topic was made by Kantrow (1980).

general, issues such as the development of divisional and functional objectives, action plans, etc., with specific implications for R&D, tend to be neglected in this line of research.

Working within the first orientation, Ansoff (1967) pioneered the introduction of technological variables into the diagnostic phase of startegic planning. In his view, the position of a firm with regard to five dimensions[2] determines the characteristics of the most appropriate strategy (some of these characteristics include R&D, product shape and time of market introduction, etc). This particular type of deterministic analysis has not been repeated in the literature of the MOT field.

Of course, different approaches to this problem have been proposed more recently. Fusfeld (1978), for example, has emphasized the importance of having the appropriate portfolio of technologies in securing the long term viability of firms. According to this author, the involvement in many different products is only justified if there is a degree of sinergy among the technologies used in the manufacturing of these products.[3]

2- These dimensions are: 1) the mix between research and development, 2) the coupling between marketing and R&D, 3) life cycle of its product, 4) rate of investment into R&D and, 5) distance to the state-of-art technology.

3- Another line of research in MOT with some normative strategic implications is that developed by Abbernathy and Utterback (1974). In the discussion (continues on next page)

Working within the second line of research, Roberts (1980) has analyzed the merits of the so-called internal venture strategies, i.e. the creation of organizational units in which working conditions resemble those present in independent entrepreneurial firms. This author analyzes a set of five venture strategies[4] which require varying degrees of involvement of the parent firm. Some of these venture strategies, particularly those which require a low level of involvement by the parent, may be appealling to firms with a rigid structure which have a willingness to try new lines of business or apply their expertise in new markets.

We can summarize this review of the literature on the connection between strategy and technology by pointing at two of its characteristics. First, it assumes certain degree (some may say excessive) of flexibility in the selection of the business portafolio, i.e. that it is feasible to write-off entire divisions with ease.[5] Second, as we mentioned, it

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3- (continues from former page) of their concept of "technology life cycle," these two authors, contend that there are some responses more appropriate than others to counteract market invasion by innovators.

4- These 5 types of venture strategies are: 1) risk capital (self-explanatory), 2) venture nurturing (risk capital but with some involvement in the mangement and technology of the new venture), 3)venture spin-off (requires setting a separate firm), 4)venture merging & melding (involves setting up a separate conglomerate of small ventures to achieve the critical mass required for success) and, 5) new-style joint venture (two separate firms set-up a joint venture to pool expertise).

5- Hamermersh (1981) considers to this characteristic as a drawback of most formal planning methods.

does not emphasize the details of developing specific R&D strategies and plans of action from division-level objectives, ignoring that this may be the only alternative left to many firms. By virtue of their rigid structure, most SOEs --PDVSA included-- cannot benefit much from the results of this research. Still, the propositions on internal venturing appear as an intersting, and perhaps viable, set of alternatives.

2. The Management of R&D.

Most of the research on the management of R&D has evolved out of studies on organizational communication. Of particular significance appears to be the view of organizations as constituted by partially open networks of relationships. As we describe in this review, the structural characteristics of these networks, as measured from the interpersonal communication patterns are strongly related to the performance of R&D organizations.

Although network anlysis has been known since the 1930's (Moreno, 1937), it was Allen (1964) the first to use this methodology for the systematic analysis of R&D organizations.[6] More recently, one of Allen's students,

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6- Outside R&D, a very considerable amount of network analyses have been reported. Within organizations, the work of Rogers and Agarwala-Rogers (1976) is well established. Outside organizations, the network "approach" has proven its usefulness in the study of birth control methods (Rogers and Kincaid, 1981) and new energy technologies (Leonard-Barton, 1981), to cite just two examples.

Tushman (1979) has integrated this line of research into the more general framework of information processing (see chapter I for details).

In his original work, Allen (1977) was concerned with the study of how information flows, in particular verbal communications, are related to demographic characteristics of researchers (profession) and how these flows to affect performance of research groups. Gradually, this interest was broadened to include statements about how the physical layout and location of laboratories affected information flows (Fusfeld and Allen, 1974) and, most important, how do networks maintain contacts with the external environment.

Perhaps the most popular concept developed within this line of research is the one known as "the gatekeeper." This term is used to denote individuals who show a notorious capacity to transfer information from the outside into the network. Later, the idea of a gatekeeper was found to be relevant to international technology transfer[7] (Allen, Piepmeier and Cooney, 1971). In most cases, the presence of gatekeepers was found to be significantly related to

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7- Parallel research has been conducted about personal attributes of these individuals (Katz, 1980). In general, they enjoy excellent technical repuatation, good relationships with both the the outside and inside of research groups, and maintain continuous interest in professional meetings and publications.

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successful performance in R&D.

The framework of information processing provided long needed integration within this line of research. It was found, for example (Allen, Lee and Tushman, 1978), that the effects of gatekeepers were dependent on the nature of the activity (referred to as task) being conducted. For universally defined tasks such as as basic research, the presence of gatekeepers is not significantly related to performance. In developemnt, on the other hand, the presence of these individuals appear critically related to performance. In technical assistance, the incidence of the whole communication network is not that important.

The basic conclusions of the information processing view of R&D can be summarized as:

1) In the case of research, and other universally defined tasks where information is well codified, the presence of gatekeepers is not necessary to ensure performance.

2) In development, where a considerable amount of organization-specific information is required, the presence of gatekeepers is critical for success.

3) In technical services, the formal structure appears sufficient to supply the information required by this task.

8- The concept of gatekeeper has been incorporated into the area of strategy through the so-called "critical functions analysis" (Roberts and Fusfeld, 1977). This analysis consist, basically, in a diagnosis of the balance of gatekeepers, and four more roles (idea generating, championing or entrepreneuring, project leading and sponsoring), which are present in a given organization. Then, on the basis of the deficiencies and/or excesses, stafing strategies are proposed.

4- The appropriate organization of a given unit is contingent upon the nature of work. Succesful units with different work requirements will have different communication structures.

4'- In consequence, succesful research groups will show different communication structures from succesful development, or technical service groups. These required differences in structure will have to be more notorious if other elements which contribute to uncertainty are fixed, as is the case when both units are located within the same R&D organization.

5) The effects of the integration of new personal to a given unit will depend on the nature of the work being performed. In the case of development, the effect may very well be negative if the newcomer disrupts the delicate flow of information of that unit.

Recent research has pointed out at the need to examine other characteristics of communication networks besides their structure. Delehanty, Sullo and Wallace (1982), for instance, have explored the aspects of reliability of these networks. In particular, these authors are interested in the probability that a given individual will receive a particular message.

Other authors (Burt, 1980) have criticized all relational (communication) methods of network analysis. In building their case, they argue that missing links are as important as existing links in characterizing networks, and that the only way to properly account for the overall effects of networks is to adopt this "structural" view. The mathematics, we may add, are different in the two approaches.[9]

9- Algoritms used in two approaches are different. Negopy (Richards, 1975) is one example of a relational method. SOCK, on the other hand, is employed in "structural" network analysis. We may comment that, although Allen's work is based on a relational considerations, it has never relied on the use of computer algoritms.

B. INTEVEP

1. Some Basic Facts

Most of PDVSA's formal activities for the in-house generation of technology are conducted within INTEVEP. As said before, this affiliate was created shortly after nationalization with the status of fundation, but was converted into a subsidiary on May, 1979. Its "mission" is to:

> "(1) to perform basic and applied research and development in the field of hydrocarbons and petrochemicals; (2) to provide technical support, specialized technical services and information in these areas to Petroleos de Venezuela S.A., its affiliated companies, private and public enterprises; and (3) to advise the government, state companies, and other private and public bodies in all scientific and technical aspects related to hydrocarbons and petrochemicals." [10]

From this mission INTEVEP has developed the following set of 6 "corporate objectives:"

1- To coordinate the formulation of the research and development plans of the industry.

2- To participate in the research and development programs related to priority areas of the industry.

3- To reduce the industry's dependence on traditional sources of technology to acceptable strategic and economic levels.

4- To provide the specialized technical services and technical support that the industry requires, and to centralize such services and support functions when justified by economic and/or strategic reasons.

5- To advise the government, state companies and other public and private organizations on scientific and technological aspects of hydrocarbons and petrochemical affairs.

10- INTEVEP, annual bulletin, p.1, 1980.

6- To assure continuity of effort in technological matters carried out in the industry and to stimulate the formation of an infrastructure suitable for basic research in the country, which will support applied research in the areas of petroleum and petrochemicals. [11]

Originally, the funding of INTEVEP's activities was in the sole hands of PDVSA (that is, the corporate direction of the industry). The budgetary appropriations of this affiliate initially accounted for 0.1% of the industry's revenues; this amount, however, has been growing to the point that it now accounts for about 0.44% of the total revenues of the industry. Recent changes call for INTEVEP to charge the other affiliates for some technical services at cost, plus a fixed surcharge. This measure, it was argued, would contribute to the establishment of more intense links between this affiliate and the operating subsidiaries.

The creation of INTEVEP was accompanied by a debate about convenience of setting up a centralized research facility or delegating R&D activities to the affiliates. The proponents of the first alternative, which was the one adopted, argued that the realization of gains from economies of scale in a separate, unique research facility would more than compensate for existence of communication barriers between research and operations. In building their case, they alledged that most similar oil companies had adopted similar structures,[12] and

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11- INTEVEP, ibid, p.2.

12- Internal documents show that INTEVEP as modeled after Exxon and Shell. Exxon, for instance, (continues next page) that the communication links between INTEVEP and the operating affiliates would eventually evolve as a result of the performance of technical services, or the creation of specialized structures (committees, task forces, etc.). The proponents of the second alternative, on the other hand, stressed the negative consequences of having a centralized, academicist research facility.

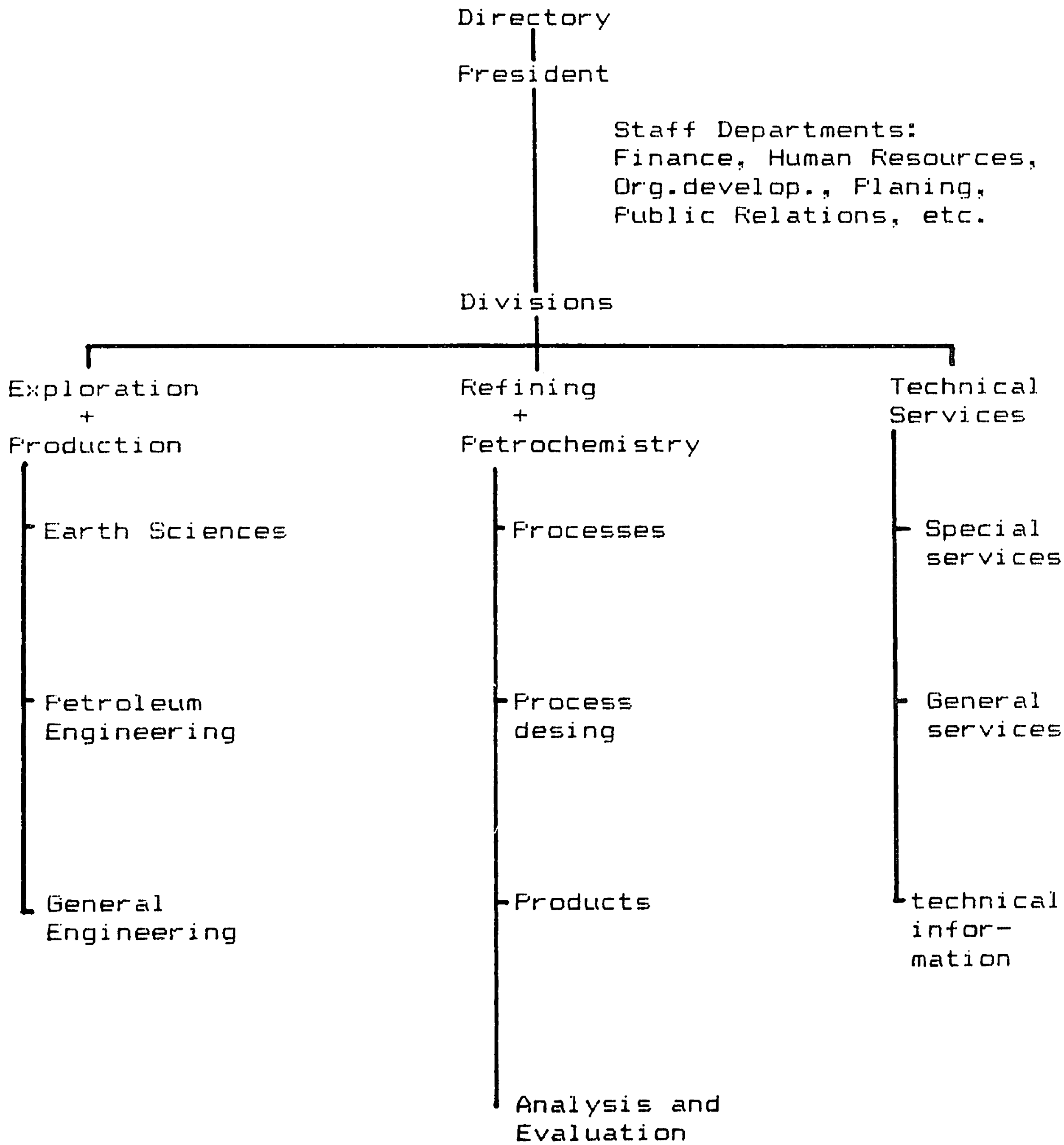
In its current form, INTEVEP has a functional organization (exploration-production, refining-petrochemistry, and technical services) which is complemented with a second tier of disciplinary departments (Figure 9 shows an organizational chart). Superseeding the functional structure, there is set of "coordinations": planning, organizational development, institutional relations, Orinoco Tar Belt, etc. This structure has attempted the separation of R&D from the performance of technical services because some of laboratories thus defined are quite specialized. The bulk of researchers remains committed to research projects that, in some instances, are quite separate from the current needs of the industry.

The strengthening of the links with the operating affil-

12- (continues from former page) has two R & D centers: EPRCO in the area of exploration and production, and ERDL in the area of refining. Shell has several labs: those occupied in research are organized by disciplines, and those occupied in development are organized by products. In the two cases R&D activities are separated from operations but, different from our case, there are numerous and permanent links between the two (the so called "focal points" in Shell) functions. Other companies analyzed by INTEVEP included PEMEX, IBM, SIEMENS and G.M.

FIGURE 9. INTEVEP's ORGANIZATIONAL CHART

(up to section level)



iates has been a major preocupation, and problem, for INTEVEP. In attempting to correct what it perceives as a situation of isolation, INTEVEP has not only started creating financial charges to the other affiliates, it has also created an office for institutional relations, actively promoted "information exchange" meetings, participated in courses sponsored by the other subsidiaries (some of them under the CATs) and offered other courses to them, volunteered participation in the negotiations of some of the clauses of the CATs (mainly research clauses), temporarily transferred some of its personnel to other affiliates, and circulated abundant information of its activities and plans. However, the image of INTEVEP within the industry remains ambiguous. Several factors contribute to this situation:

First, INTEVEP is a very young institution (table 21 shows some facts about INTEVEP). It was created in 1976 with the name VEPET as a foundation as a foundation under the tutelage of the Ministry of Mines and Hydrocarbons. This meant that its original management team did not belong, for the most part, to the active ranks of the industry.[13] Instead, much of the personnel of INTEVEP was drawn from R&D centers located outside the industry, such as the Venezuelan Institute for Scientific Research (IVIC) and local universities. This personnel had very little or no experience

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13-Furthermore, this early association with the Ministry could have put INTEVEP in the middle of the long-standing rivalry between the Ministry and the oil industry.

in applied research, a large percentage having been trained in the so called pure science (physics, chemistry, biology, etc.). The addition of a core of personnel from the affiliates to the key posts of INTEVEP has not succeded, according to our interviews in the affiliates,[14] in changing the academicist image borne by this affiliate. Building on our results from chapter V, we may expect "cultural" differences to play an important role in creating differences between INTEVEP and the rest of the oil industry. Nevertheless, it should be stated that, given the scarcity of people with R&D training, there was no alternative but to draw people from academic institutions.[15]

Second, the <u>organizational and geographical position</u> of INTEVEP within PDVSA separates this affiliate from others. This situation was, to some extent, to be expected (and predicted) from the creation of a centralized R&D facility

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14- We refer here to a series of interviews conducted with officials of the operative affiliates during the course of our research on technical assistance.

15- It should be noted that INTEVEP seems to be reaching a limit in its capacity to grow by drawing personnel from other institutions. Several of the affected institutions, depleted from large numbers of some of its most valuable employees, have exerted various forms of pressure to modify INTEVEP's hiring practices. This trend seems to be confirmed by the spectacular decline in INTEVEP's growth rate: from a 60% in 1978 to a 28% in 1980, and projected to be 9% by 1985 (INTEVEP, 1980). This last figure is close to the demographic growht rate for technical professionals in Venezuela. Therefore, INTEVEP will increasingly have to rely on some scholarship programs sponsored by the Venezuelan government and in its own programs to satisfy its future needs.

TABLE 21. SOME STATISTICS ABOUT INTEVEP.

1. INTEVEP's BUDGET IN RELATION TO PDVSA's.

(billions of Bolivares) [a]

Year	1980	1981	1982 [b]	1983	1984	1985
PDVSA	80	100	110	121	133	146
INTEVEP	0.026	0.039	0.482	0.610	0.685	0.756
%	0.2	0.4	0.44	0.5	0.5	0.5

2. PERSONNEL: INTEVEP IN RELATION TO PDVSA

Total Number = 716 (1980)

By job tenure (% by year 1980)

	less than 5 years	5-10	10-20	more than 20 years
PDVSA	51	14	11	24
INTEVEP	46	25	29	

By Highest degree (% by years 1980)

	secondary	technician	university	post-graduate
PDVSA	73	9	14	2
INTEVEP		54.6 [c]	25.9	19.44

TABLE 21. (CONTINUATION)

3. R&D EFFORT IN SELECTED AREAS: [d]	
	%
-Heavy and Extra-heavy crudes	29.3
-Enhanced recovery	11.05
-Continental Shelf	9.1
-Materials' engineering	5.9
-Gas technology	.65
-Complementary programs	9.1
TOTAL R & D	65.0

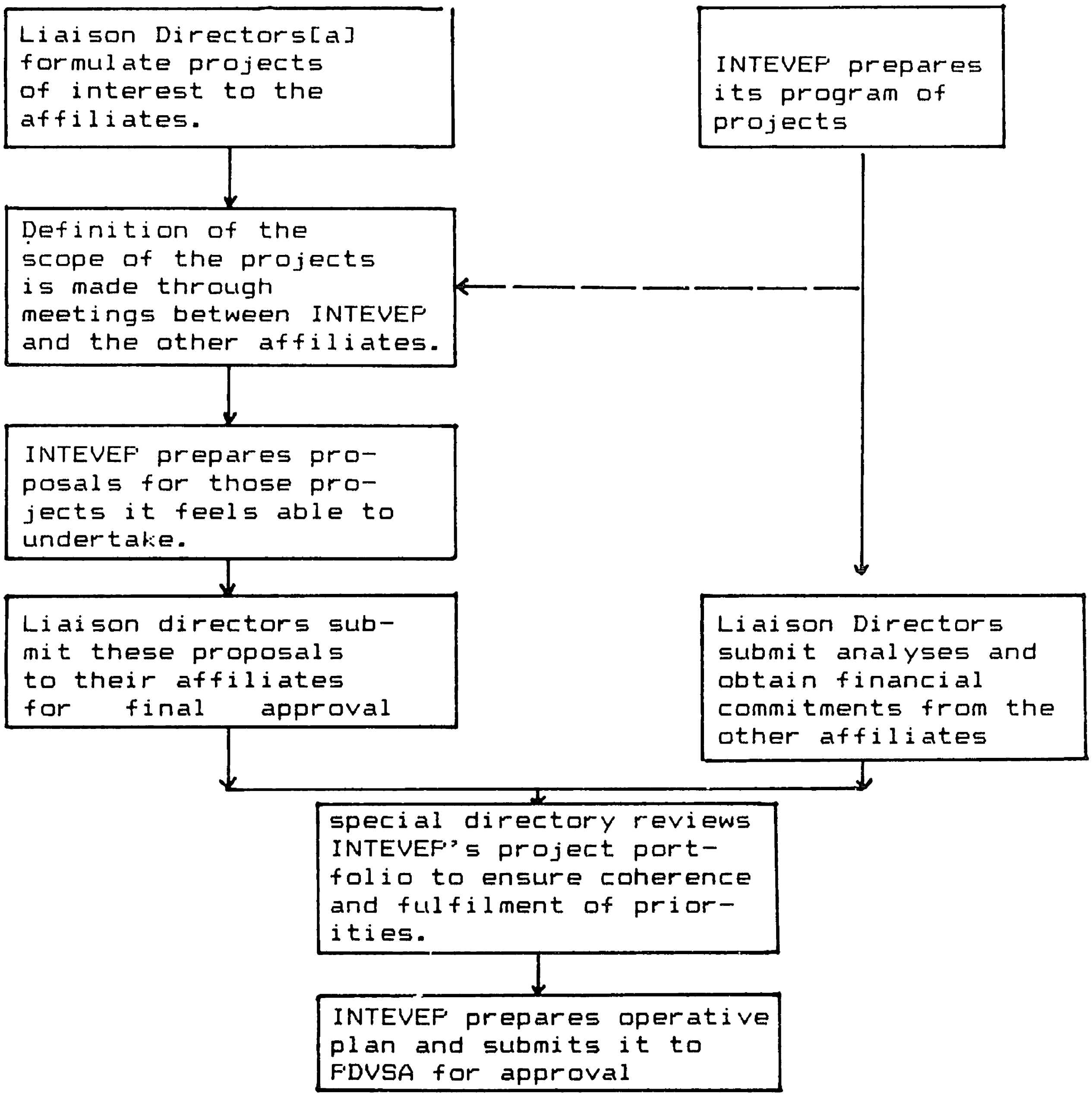
4. TECHNICAL ASSISTANCE TO THE OTHER AFFILIATES; AS % OF THE OVERALL EFFORT.	
35	consulting, troubleshooting (28.3)
	specialized technical services (6.7)

NOTES: [a]- exchange rate = 4.30 bolivares per US $ dollar
[b]- figures for 1982 and beyond are predicted. These are expected to decline as a consequence of the current Oil Glut.
[c]- includes secondary education.
[d]- percentages for 1981.

but, in this case, it is exacerbated by two elements. The first is that this geographical separation has not been counteracted in a truly assertive manner by the Corporate (PDVSA) management. So far, the main mechanism to link INTEVEP's activities with the industry is a series of unstructured yearly meetings held between officials of the affiliates and INTEVEP ("Reuniones de Enlace"). This mechanism, depicted in figure 10, has not resulted in a balanced portafolio of R&D projects. According to our data, only 20% of INTEVEP's projects have been originated within the affiliates. The rest is INTEVEP's own doing. The second is that some of the consequences of INTEVEP's high growth (high turnover and recycling of executives, frequent reorganizations, etc.) tend to destroy any individual links which may have been created as a result of giving technical assistance to the operative affiliates.

Third, there is a basic, structural, conflict between R&D and the activities related to the provision of technical assistance to the industry, because scarcity of qualified personnel forces dual involvement of researchers in technical assistances. R&D requires of long-term, unstructured, thinking that does not fit well into rutinary technical assistance. Users of technology, on the other hand, are concerned with reliability and continuous assistance. This situation generates confusion among scientists between short and long-term goals. Thus, occupying highly trained scientists in technical assistance has a very high opportunity

FIGURE 10. LIAISON MECHANISM AMONG INTEVEP, PDVSA AND THE OPERATING AFFILIATES



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[a] Liaison directors belong to the operating affiliates.

costs that goes beyond the time and training lost, because it carries the risk of having negative interactions with the research projects. To this dilemma we can add the fact discussed earlier, that the interpersonal communication network suitable for research differs from that suitable for development which, in turn, differs from that which is suitable for technical assistance. The organizational structure of INTEVEP (technical services separate from the research departments) reflects a concern for avoiding such a cost. This issue will be investigated empirically later in this chapter.

2. Formal Influences Upon Project Performance

As part of our study on INTEVEP, we completed a multivariate analysis of the organizational determinants of project performance. The dependent variable selected was the rating given to the projects by the sponsoring affiliates. Our original group of analysis was the whole universe of active R&D projects for the year 1980. The final analysis, nevertheless, was confined to 91 projects out of a total number of 105. The rest was dropped because they lacked evaluation ratings. In all cases, at least two evaluations were available per project, and the average used as value for the dependent variable.

The independent variables used in this analysis included demographic and organizational data about the individuals who "originated" the projects, and a variable indicative of project size in terms of monetary amount committed. The term "originators" refers, in this context to those individuals who are believed to be responsible for the idea of a given project.16

The experiment thus defined permits us to analyze performance as a function of demand conditions. In other words, we are interested in finding out whether the performance of a given project depends on the characteristics of those who perceived the need for it.

The variables we use in this analysis, together with their values, are shown in Table 22. The characteristics of the sample are shown in Table 23.

A general linear model was applied to this sample. This model is simply:

TEVAL = F(HSTATUS, TENURE, SIZEPRO, DEGREE)

The results of this model, shown in Table 24, indicate that the only significant variable correlated to performance is BGROUND (PR>F=0.001). This equation shows a relatively high explanatory power (R-SQUARE = 0.31) for this type of model. Nevertheless, we considered interesting to explore the use of a multiple choice probabilistic model. We believe that that this last formulation may be more appropriate for a

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16- The identity of the originator was obtained in the following manner. First, a list of all project chiefs was prepared. Second, each chief was contacted personnally and asked for the identity of the originator. Third, this identity was confirmed/disproved by follow-up calls to other members of the same section.

TABLE 22. VARIABLES USED IN INTEVEP's ANALYSIS

Variable		Values
TEVAL (Project's rating):		1= poor 2= mediocre 3= good 4= excellent
TENURE (within the industry)	:	1= 2 years maximun 2= between 2 and 7 years 3= between 7 and 10 years 4= above 10 years
BGROUUND	:	1= Petroleum related Engineers 2= Mechanical, electrical, chemical engineers. 3= Scientists.
DEGREE (highest degree)	:	1= B.S. 2= M.S. 3= Ph.D.
AFFILIATE	:	1= CORPOVEN 2= LAGOVEN 3= MARAVEN 4= MENEVEN 5= PDVSA 6= INTEVEP
SIZEPRO (amount committed to the project, range in bolivares)	:	1= below 100,000 2= from 0.1 to 1 million 3= from 1 to 10 millions 4= above 10 million
HSTATUS (hierarchical status)	:	1= below 2 2= section chief 3= Department chief 4= Division chief or above

TABLE 23. CHARACTERISTICS_OF_THE_SAMPLE

1) NUMBER OF OBSERVATIONS = 91

2) VARIABLES; DISTRIBUTION OF VALUES

	VALUES	%	FREQUENCY
TEVAL (Mean=2.49)	1	8.8	8
	2	38.5	35
	3	57.2	43
	4	5.4	5
TENURE (Mean=2.89)	1	14.2	13
	2	30.7	28
	3	6.6	6
	4	48.3	44
BGROUND	1	25.2	23
	2	49.4	45
	3	25.3	23
DEGREE	1	17.1	16
	2	41.7	38
	3	40.6	37
AFIL	1	1.0	1
	2	6.5	6
	3	6.5	6
	4	2.1	2
	5	4.3	4
	6	79.1	72
SIZEPRO (Mean=2.70)	1	4.4	4
	2	32.9	30
	3	50.5	46
	4	12.1	11
HSTATUS (Mean=2.65)	1	10.9	23.1
	2	23.1	21
	3	54.9	50
	4	10.9	10

continues on next page

TABLE 23 (Continuation)

CORRELATION COEFFICIENTS

key:
Correlation coefficient
Probability > |R|

	TEVAL	TENURE	DEGREE	SIZEPRO	HSTATUS
TEVAL	1.000	-0.207	-0.090	0.027	-0.215
TENURE	-0.207	1.000	-0.009	-0.180	0.645
DEGREE	-0.090	-0.009	1.000	0.107	0.317
SIZEPRO	-0.027	-0.180	0.107	1.000	-0.022
HSTATUS	-0.215	0.645	0.317	-0.022	1.000

TABLE 24. FORMAL_INFLUENCES_ON_PROJECT_PERFORMANCE

N=91

1) GENERAL_LINEAR_MODEL

DEPENDENT VARIABLE= TEVAL

MODEL F= 3.28 PROBABILITY >F= 0.001

R-SQUARE=0.313

INDEPENDENT VARIABLES:

	F VALUE	PR>F
BGROUND	10.95	.0001
DEGREE	1.75	.1813
TENURE	3.01	.0868
AFIL	1.52	.1934
SIZEPRO	.12	.7300

2) MULTIPLE_CHOICE_MODEL

INDEPENDENT VARIABLES:

INTERCEPT	0.39	.941
BGROUND	12.39	.053
TENURE	1.05	.789
SIZEPRO	0.43	.934
DEGREE	2.20	.531
HSTATUS	2.26	.521

LIKELIHOOD RATIO=109

highly subjective dependent variable such as project ranking. The format of this model is similar to that used in chapter V, with the relevant variable changes.

The result of the multiple choice probabilistic model are shown in Table 24. Again, BGROUND appears as the only variable with some significance, although less than obtained with the deterministic linear model.

C. DISCUSSION

In terms of its organization, INTEVEP does not seem to be different from other research facilities within the oil industry. The use of centralized R&D subsidiaries is a common practice in the oil industry. Shell, Exxon, Occidental, Mobil, to cite just a few companies, have followed this alternative (Teece, 1978).

In terms of its billing structure, INTEVEP resembles other R&D subsidiaries. In the case of Occidental and Shell Oil (US), operating divisions are charged for services and other projects related to their inmmediate operations. In the case of projects of general interest, all divisions, or corporate headquarters, bears the expences. This pattern is, exactly, the one followed within INTEVEP.

In terms of the content of the research, there are significant differences between INTEVEP and other oil R & D facilities. In
our case, it is noticeable the large percentage of the effort devoted to extra-heavy oil production and refining (about 50%). The average effort devoted to the items oil & gas, plus shale and other fosil fuels is about 62% for the largest 22 oil companies in the US (Teece, 1978: 73). The balance, however, goes to coal, solar, nuclear and pollution control. In the case of INTEVEP, these items occupied a negligible amount

of R&D effort during 1980.[17] Important enough, studies on the R&D practices of the oil industry reveal that cross-fertilization among research on alternative energy sources and conventional oil technology does occur: the most innovative companies in basic/applied petroleum technology are the ones most involved in non-oil energy research.

The results shown in this chapter appear as quite revealing. Most of the demand for INTEVEP's activities, including technical support, is generated within INTEVEP itself.

The only attribute of project originators which appears to influence the performance is professional background. This result corroborates that those obtained in chapter V (Table 12), were background was found to be asignificant influence upon the evaluation of technical assistance. Moreover, it suggests that professional background should be taken into consideration in the constitution of research teams. This result brings us back to the concept of clan described in chapter I. As we mentioned, the performance of tasks of a high level of uncertainty, research being a good example, depends on the existence of a substantial degree of goal

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17- We may add, however, that several new projects on the utilization of coke (obtained as a byproduct of the exploitation of the extra-heavy crudes) were started during 1981 and 1982.

[18] congruency Professional background, and the process of socialization associated with college-level training, provides an excellent (although not the only one) basis for the constitution of "clans".

As it may seem, this result has powerful implications for strategy, but these will be articulated in the next chapter.

18- Of course, this argument can be put in the terms of the information processing framework by saying that professionals of the same kind have the same habits regarding the acquisition of technological information and speak the same type of language. Therefore, background homogeneity is necessary to avoid disruptions in the type of information network which is necessary to achieve success.

CHAPTER VII

CONCLUSIONS
POLICY RECOMMENDATIONS
AND
SUGESTIONS FOR FUTURE RESEARCH

A. CONCLUSIONS

In general, our results advance the theory of technology choice by showing that cultural factors are, or can be, major influences in the selection of sources for technical assistance. In particular, we conclude that, in the case of the Venezuelan petroleum industry, the process of technology transfer is dominated by the step of selecting the sources for technical assistance. This selection of sources for technical assistance, in turn, appears to be dictated by personal characteristics of the individuals making the choices.

The strength of our results calls for the inclusion of culture-related variables into research on international technology transfer. Similarly, these same type of variables should be taken into account in the design of government policy in the area of technology transfer. Our results suggest, for instance, that policy makers should consider that foreign investment may involve a "transfer of culture," not just a mere transfer of techniques.* This concern appears even more justified as this "cultural transfer" seems to have long-lasting consequences and may conceivably affect a whole

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*- This point has long been contended by the dependency theory "school," but with a general socioeconomical emphasis, for example, regarding the change in consumption patterns related to foreign direct investment. In our case, we study this phenomenon at the enterprise level, document its effects for a given type of decision and, most important, examine its permanence after a nationalization process.

range of decisions, not just those related to technology choice.

Although "cultural transfer" _can_ be associated with the selection of inappropriate sources of technology, it is comforting to observe that, also, it can involve the transfer of highly desirable aspects of the original cultures, such as corporate-wide norms and standards of efficiency. Given its high performance, we are led to think that this has been the case for the Venezuelan petroleum industry. In conclusion, foreign direct investment appears to be associated with a trade-off between technological dependency and administrative efficiency. We have to point out, however, that this dependency does not necessarily imply inappropriate choices of technology, as the former parent corporation may be the only supplier of operational know-how.

Our findings support our contention, depicted in chapter I, that it is necessary to adopt a managerial approach to international technology transfer. If non-economical factors --culture and organizational structure-- are, indeed, so important in the selection of technology, then governmental policies with an economic orientation are intrinsically limited in controlling this process. New policy solutions, and new descriptive models, appear necessary both at the firm and government level.

At the firm level, it would appear necessary for managers to implement strong incentives inorder to drive their subordinates toward making the appropriate choices of technology. At the government level, it appears necessary to design specific technological policies which go beyond the macroeconomical manipulation of the factors of production -- capital and labor (such as fiscal policy). In this sense, our results support the current practice of many countries which engage in the implementation of specific technological policies, such as R & D funding and technology transfer regulations. However, our evidence calls for more powerful policies, which are capable of counteracting the effects of corporate cultures.

Our findings corroborate the contention, depicted in chapter I, that nationalized firms are, indeed, different from state-owned enterprises originally created by the government. Inherited cultures appear to be strong determinants of the behavior of nationalized enterprises. Hence, nationalization does not appear to a sufficient instrument to change the conduct of firms, only the pattern of ownership. The same argument, although with proper qualifications, can be extended to other topics, such as state-ownership in general (this last topic in reference to the practice "statization" of ailing private firms).

From the perspective of organizational design, our research suggests that it is necessary to look seriously at the trade-off between operational efficiency and motivational gains associated with the choice of organizational forms. In this regard, our results indicate that subcultures with a divisional scope, and of noticeable strength, can coexist within a single corporate umbrella for long periods of time. For practitioners of the field of organizational design, this means that there are limits to the extent in which integration among divisions can be accomplished. Beyond certain point, conflict among subcultures is likely to arise.

In the case of PDVSA, it would seem that further reduction of the number of affiliates could reach this conflict point. At the level of the functions, our results suggest that the sharing of technical resources among the divisions, or affiliates, would require forceful mechanisms in order to be successful.

From the perspective of transaction-cost economics, our results indicate that non-economical factors, not just improved cash flow allocation, may account for the superiority some researchers claim for the multidivisional enterprise over functionally organized firms. While the divisional subcultures we describe here may not be present at the moment a multi-divisional structure is adopted, they are likely to develop with time. Since strong cultures seem related to high levels of corporate performance, we may expect the consolidation of these of these sub-cultures to be related to higher performance levels in the divisions and, thus, in the corporation as a whole.

Finally, our results indicate that the evaluators of corporate-wide projects should be aware of possible divisional biases. These biases can conceivably affect many aspects of the information provided by the divisions. Expected cash flows for a given project, for instance, can be affected by the preferences of the divisions. Seemingly minor aspects such as measurement units and the specifications of some equipment can force the selection of high-cost suppliers with whom the divisions have a special affinity. Another complication arising from this segmentation into subcultures which is relevant to corporate finance includes the possible use of multiple discount rates in capital budgeting. However, further discussion of these aspects is beyond the scope of this research.

B. POLICY RECOMMENDATIONS

1. The Acquisition of Technology by PDVSA

The policy recommendations presented in this section are aimed toward the rationalization of the process of acquisition of technology by the Venezuelan petroleum industry. Rationalization, in this context, refers to the acquisition of those technologies providing the best combination of cost, quality and, most important, learning opportunities.

This research concluded that the acquisition of technology by PDVSA is dominated by the process of selection of suppliers of technical assistance. Furthermore, our findings indicate that this selection is determined, to a large extent, by cultural factors. Thus, the current pattern of selection of sources of technical assistance may be irrational (from the global viewpoint of PDVSA) due to several reasons:

1- the criteria used in the selection is strongly influenced by cultural ties with some suppliers, particulary the ex-concessionaries,

2- information about alternative suppliers, although available, could be dismissed for the same cultural reasons,

3- information about alternative sources is unavailable.

It is important to note that it is impossible to differentiate between the first two reasons. At the same time, the remedies are equivalent for both.

Since these cultural influences are different from one affiliate to another, it is necessary to implement strong incentives and policies to counteract any negative effects they may cause upon the selection of sources of technical sources for assistance. Hence, it is necessary to follow three courses of action.

> First, we have to design a set of policies at the affiliate level to drive their employees toward making the most rational choices (again, from the global view of PDVSA).
>
> Second, we have to provide incentives at the corporate level to promote the sharing of technical resources and information, whenever this is necessary to rationalize the selection of sources of technology.
>
> Third, we have to provide the means for making rational choices within the affiliates by putting enough information in their hands (although this last action does not follow directly from our research, recommendations to this effect are included because they are deemed absolutely necessary to implement the other two steps).

On the other hand, our observation of the performance of the industry leads us to believe that the existence of sub-cultures is, for the most part, a positive feature of PDVSA. Therefore, our proposed solutions to the problem of rationalizing the acquisition of technology should avoid affecting the cultural identity of the affiliates. In practical terms, this means that our proposed actions should be neutral regarding culture and that, whenever they deal with cultural aspects, they should be limited in scope, i.e. affecting few individuals and few functions.

The above considerations notwithstanding, our recommendations are the following:

1) On the Creation of Incentives for Making Rational Choices Within the Affiliates.

a) PDVSA's employees should be required to conduct searches for alternative sources of technology whenever they need technical assistance (we acknowledge that this requirement exists in MARAVEN). Thus, means should be provided to document this activity. These may include specific questionnaires about alternative sources or computer-based records for these searches (later in --3-- we elaborate on this possibility).

b) The technological units of the affiliates should shift their current emphasis in computing "utilization" toward the collection of information about alternative sources of technical assistance and making it available to the employees of their respective affiliates. As we describe later --3--, "utilization" reporting could be automatized.

c) The technological units should collect data about the individuals who select the different sources for technical assistance, e.g. the "selectors," as part of their regular duties. These data should include, at least, the same variables we have collected here (job tenure, hierarchical status, professional background, number of man-hours provided, evaluation of the assistance received, etc.). The aggregated data currently being collected only serves accounting purposes. If collected on a regular basis, data about the selectors will permit the detection of the cultural influences studied here not only upon selection but, also, upon long-term use and learning.

d) The technological units of the affiliates should compile historical data about the nature and quality of the suppliers of technical assistance. Historical data, in this context, refers to past evaluations and other characteristics of the services received. This practice would allow them to check whether a request for technical assistance from a given source is made on the basis of sound criteria.

e) The technological units should not be directly involved in activities which are only marginally related to technology, or that can be covered by existing departments. We found that some units were overwhelmed with work out of their area, such as personnel training. On the other hand, the units should be keep track of the acquisition of technology from all external sources, not just those under the CATs (the case of CORPOVEN and MENEVEN).

f) Rewards should be given to those individuals who consistently select sources of assistance matching those considered best by the technological unit. The specific form of these rewards cannot be given here, as this would require a detailed knowledge of the promotion policies of PDVSA.

g) The technological units should make available their data banks to the other affiliates. This information should be organized according to the criteria provided by the "coordination of technology," or equivalent office from the corporate headquarters.

h) One individual from each operative function of the affiliates (exploration, production, etc.) should be appointed as technological liaison. This person should be assigned the task of dealing with all the matters of the technological unit (within the same affiliate) and the "coordination of technology." This liaison should preferably have line authority, capable of active enforcement of the policies derived from the technological unit and the "coordination." These individuals should be formally rewarded by their participation in the activities of the "coordination of technology" (see --2--) and by the contributions and relative use of their respective departments to the "network of technological information" (see --3--).

2) <u>On the Strengthening of the Corporate Infrastructure in Charge of Technology</u>

a) The "coordination of tecnology should be created with the addition of the personnel currently attached to the "coordination of planning." This change in status should be accompanied, of course, with an increase in the amount of resources assigned to technology within PDVSA. This change would allow a more forceful enforcement of corporate technological policies and a more direct access to the corporate management.

b) The newly created "coordination of technology,"or its equivalent, should have personnel from all the affiliates. In this manner, the "coordination" could adopt a neutral approach in regard to the affiliates. As implied by our results, the predominance of personnel from any affiliate would result in the creation of cultural biasses.

c) The "coordination of technology" would have, among others, the following functions; first, the creation and enforcement of negotiation standards (currently being done); second, the creation and enforcement of standards about the reporting of information; three, the preparation of periodical reports on the selection and use of technology by the affiliates; fourth, all the other duties related to negotiation which are currently under the responsibility of PDVSA; and, fifth, conduct a comparative study of selection and usa of technology similar to the one presented in this study. This last task would be automatic if the information received from the affiliates is standarized (discussed in --3--).

d) The "coordination of technology" should establish a liaison network within the affiliates. This network should be composed by the functional managers mentioned in --2--. This network would provide PDVSA direct access to the issues related to the use of technology within the affiliates.

3) <u>On the Provision of Information for Making Rational Choices of Sources of Technical Assistance</u>

a) The normalization of the different data banks used by the affiliates to store information about technical assistance is required. In this regard, it is important to examine the important efforts made at INTEVEP's center for technical information towards the normalization of the technical reports produced within the industry. Once this step is completed, the design and implementation of a corporate network of technological information (NTI) is necessary.

b) The NTI would consist of i) a central data bank updated periodically, ii) a distributed system of computer hardware (with intelligent terminals in each of the affiliates) tied to a central computer, iii) a network of access facilities, located at the operating sites (refineries, oil producing areas, etc.) and, iv) a set of normalized data banks in the technological units of the affiliates. Much of what is required to set up the NTI is already installed. The centralized computer facility is certainly available. The data banks in the affiliates exist, although they have not been normalized and, in most of them, computer facilities are being used. The network of access facilities (a network of dumb terminals) is being installed as part of the "red de información petrolera" (network of petroleum information). Thus, most of the effort in the creation of the NTI would go to normalizing the affiliates' data banks and designing application software (filling and searching programs).

c) A detailed prescription of NTI's characteristics would require further study. However, this network should include features to identify users, so that they can be rewarded. Moreover, It does not seem necessary to make the system continuous, a periodic updating of the system would be enough. This last characteristic would make it much easier to attach NTI to the centralized computer facilities of the industry, because it would not tie too much computational capacity.

d) The information contained in the NTI should include, among other things, information about INTEVEP's technological offerings (organized in the same manner as the rest of the information contained in the data banks), information about the selectors (the same variables collected in this study), and information about the affiliate (about availability and endogenous technological capacity); only in this way it is possible to examine the cultural effects described here and to detect the evolution of learning processes.

e) The periodic questionaires collected by the affiliates, i.e. the "utilization" questionaires, would still constitute the primary source of information for the network. However, these questionaires should be modified to include the information described in (d).

f) the data included in the information banks should be organized at least in technological categories (our 40 generic technologies provide a starting point) because this could allow easy relation with the R & D activity. Further, this organization reduces the duplication of records as similar technologies are used in different areas of activity (exploration, production, refining, etc.) and different geographical locations. Nevertheless, some hierachization of the information may be necessary to locate and reward users.

g) The administrative support for the NTI should be as neutral as possible to avoid interference with the cultures of the affiliates. This means that it should be located outside any particular operating affiliate. The two remaining possibilities include INTEVEP and PDVSA. The advantage of setting up the system at INTEVEP is that it would easily mesh with R & D and use the experience and facilities of this affiliate's information center. PDVSA, on the other hand, keeps a close relationship with the affiliates, which are, after all, the ultimate users. Thus, we believe that PDVSA has the legitimate right to administer a system which is oriented, for the most part, to technical assistance. However, as we show in --2--, there are many other pending tasks for PDVSA. Therefore, it does not seem appropriate to divert PDVSA's in setting up and supporting the NTI. For this reason, we recommend INTEVEP for these tasks.

h) The NTI can be costly, but it is likely to yield important side benefits. For instance, the preparation of "utilization reports," a task which consumes a lot of the time of the technological units of the affiliates, would be automatized; and the same can be said at the corporate level.

The set of recommendations included here are certainly costly but, in our view, necessary to achieve a better utilization of technological resources available to PDVSA.

2. The Development of Technology by PDVSA

The policy recommendations presented in this section are aimed toward increasing the long-term effectiveness of the activities of research and development within PDVSA. Effectiveness, in this context, refers to the efficiency of the research activity and to its use by the operational branches of PDVSA.

These recommendations are based on the results of our research as well as on the application of well established principles about the management of R & D. Our findings indicate that:

- under its current organization, the major determinants of INTEVEP's research performance are related to its personnel, not to its structure,

- professional background of the researcher is the characteristic most related to their research performance,

- the performance ratings received by INTEVEP's R & D projects, although not critically low, deserve some attention,

- most of INTEVEP's managers have been formed within the research ranks, thus have not had professional training in managerial disciplines,

- INTEVEP has sustained a very high growth rate since its creation, causing strain on its resources.

Thus, our recommendations address three issues, 1) increasing short -term R & D performance, 2) preventing the occurrence of communication and, personnel problems arising from a high growth rate, and, 3) increasing the profesionalism of INTEVEP's management.

We have not proposed changes in the substance of research projects, as we believe that INTEVEP is strongly committed to its current portfolio of projects. Nevertheless, it is clear that in the future it will be necessary to receive more input from the operating affiliates. Only in this way it will be realistic to expect them to use INTEVEP's research input.

Our recommendations are the following:

a) INTEVEP should moderate its growth rate. The maintenance of annual growth rates above 20 % in the tight Venezuelan labor market would eventually lead to the creation of highly heterogeneous research teams, with a concomitant drop in research performance (not to mention the the hiring of unqualified people). According to our results, research teams should be carefully structured emphsizing those professionals coming from those disciplines shown to be more successful in research.

b) At the same time, the mobility of research personnel among groups should be encouraged. As we mention in section VI-A, excessive longevity of R & D groups leads to low performance.

c) INTEVEP's hiring policies should emphasize the acquisition of junior rather than senior personnel. Young professionals are less likely to cause disturbance in research groups.

d) Those departments which are actively involved in technical assistance should consider adopting the structure of the "Analysis and Evaluation" department. In particular, we refer to the creation of an office to handle the requests for technical assistance. As mentioned in section VI-A, the task of providing technical assistance can be handled through a formal unit. This organization, besides freeing research resources, permits the administrative specialization and easy monitoring of the volume and quality of technical assistance.

e) INTEVEP should stop the proliferation of research projects which, in some years, have increased by more than 30 %. These large increases in the number of active R & D projects, at a rate which equals or exceeds personnel growth, have reduced the number of researchers per project, thus increasing chances of low performance. A combination of measures can be proposed to lessen this effect: i) elimination of any existing reward associated with being project director, ii) rewarding performance more effectively (note that this reward can be negative, i.e. punishing low performing groups), iii) strengthening the requirements for project approval. A recommendation of the appropriate combination of these measures, as well as their specific format, would require further knowledge of INTEVEP's existing procedures for project evaluation and personnel promotion. We may say, however, that ii is the easiest to implement.

f) INTEVEP should avoid increasing the volume of technical assistance it currently provides to the other affiliates, as this would put further strain upon its already thin resources. In this area, we believe, energies shall be spent in setting up the network of technological information (NTI) described in the previous sub-section, VII-B-1.

g) In the course of its aggressive growth, INTEVEP should avoid increasing the physical distance among researchers. This means that any future developments its physical layout should try to maintain related groups at the closest distance possible. Observation of the patterns of physical growth indicates that, so far, this factor has not been considered within INTEVEP. As mentioned in section VI-A, the intensity of communication among researchers, which is strongly related to their performance, decreases exponentially with their physical separation.

h) Management education programs, some of which are currently underway, should stress the application of the material contained in the courses. Upon the participation in such programs, INTEVEP managers should be reviewed on the basis of the application of the concepts presented during the program. While this point may seem obvious, our observation of INTEVEP's practices indicates that this has not been the case.

In sum, the emphasis of our recommendations is the consolidation, rather than the expansion of INTEVEP's activities.

C. SUGGESTIONS FOR FUTURE RESEARCH

This thesis has opened several research questions. Among these, some of the most obvious are the following:

a) It would be very interesting to study the effects of the "acculturation" process described here upon the process of learning. That study would require carrying out a longitudinal study involving the collection of data from several years.

b) It would be interesting, also, to study the effect of "acculturation" upon the overall technological dependence of PDVSA's affiliates. This study would require the collection of data about the technical assistance provided by the affiliates themselves.

c) It seems equally important to explore other dimensions of the process of "acculturation" described in this thesis. Besides financial decisions, already mentioned as a possibility, there are other types of decision which are tractable enough to allow research of the type performed here. In particular, we can mention the areas of industrial relations (unions and personnel policies) and operations management (manufacturing practices) as two good candidates.

d) It would be of great interest to conduct a study of the specific ways in which biases can be introduced in the selection of sources for technology and in project evaluation generally. This "anatomic" type of study would be useful to managers, as it could help them know where to focus their attention when managing technology transfer processes and evaluating investment proposals from the divisions.

e) In view of the significance of our results, it seems important to attempt their validation in other countries and other imdustries. Perhaps it is easier to start in other countries which have nationalized their oil industries recently. Of these, Libya and Nigeria seem to offer the best possibilities because their oil industries were not structured in the form of consortia, as was the case of middle eastern oil producers.

f) It seems interesting to explore further the implications of our findings for the design of government policies. In particular, we would want to know whether the process of "acculturation" described here deserves regulation or any other form of government intervention.

g) Similarly, it appears interesting to explore the significance of our findings within the context of the general problem of economic development. An obvious area for research would be to address the implications of our results for the radical and conservative positions described in early chapters of this thesis.

h) Finally, this study raises a series of important questions of national strategy. It would interesting to explore the consequences of the "acculturation" process described here upon the national sovereignty of countries depending on the export of a single commodity by a foreign-owned company for major portions of their foreign revenue. Moreover, it appears interesting to study mechanisms to break the self-enforcing character of situations similar to the one studied here: an state-owned which industry maintains attitudes and goals inherited from the ex-concessionaires, leading newcomers to the industry to acquire those same goals. These questions are, at least for Venezuela, important enough to deserve further study.

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