PROCESS ENGINEERING

AND

PROCESS INDUSTRIES

IN

ARGENTINA AND MEXICO

Mario Kamenetzky
Buenos Aires, 1976.

ARGENTINA AND MEXICO (the author's feelings in his own words)

ARGENTINA

An industrious yang
hurls himself outside
down the river wide as a sea.

A bucolic yin longs
for retaining the energy inside

MEXICO

They are
like prickly pears
they are
like feathered snakes.

Their juicy hearts,
plenty of feelings,
steer their flights.

Someone else's reason
yields them crawling
and spines.

LATIN AMERICA (the author's feelings expressed in Kahlil Gibran's words, freely translated from a popular Spanish version).

Reciprocally fill up your goblets,
but never drink from only one.
Share your bread,
but never eat from the same loaf.
Sing and dance and enjoy together,
but remain independent.

The columns of the temple
are set apart
and neither the oak grows
under the cypress' shadow,
nor does the cypress
under the oak's.

I N D E X

PREFACE AND ACKNOWLEDGEMENTS

In a preceeding report, under the title "Engineering and Pre-Investment Work", I developed some concepts resulting from my previous experience and field research on process engineering in Argentina and Mexico conducted during 1974. This one will mainly assemble facts and figures arising from the same research work, performed thanks to a grant of the Canadian International Development Research Center.

Data was collected from the enterprises offering process engineering services, as well as from production enterprises demanding those services. I wanted to measure facts, but also and fundamentally to sense them. This is why I preferred personal interviews as the principal method for accomplishing my purposes, without questionaries previously known by the interviewed and without tape-recorders.

Within each enterprise, I tried to get in touch with somebody in the intermediate staff level and with the general manager or somebody close to him. In a few cases, I had to do with opinions from only one of those staff levels.

I had prepared my own guidelines for the interviews, but, as soon as conversations were started, those interviewed did always open new subjects and introduce supplementary information. The final results summed up to a bulk of information that was much broader than that obtainable if only the basic questions I had intended to make had been answered. Profound and sympathetic communication levels were often reached.

For all this, I thank:

-entrepreneurs, administrative personnel, engineers and technicians in the Mexican and Argentine chemical industries and in consulting and engineering firms, who have kindly cooperated with me.
-directors and managers of the Argentine entrepreneurial associations: Cámara de la Industria Química and Cámara de Industrias de Procesos de la República Argentina.

Although private enterprises are kept anonimous, those working in the corresponding branches of business will probably find it easy to identify some of the actors, specially among engineering firms. This is due to their being very few and to the fact that some of them have grown so much that they have overflown the microeconomic limits imposed by their capital structures and become entities of interest for the macroeconomics of their countries.

Since the time dedicated to field work in Mexico was much shorter than that in Argentina, the most thorough and exhaustive work in the former was carried out among engineering firms and the demand was just slightly viewed. Neither could contacts with the Mexican public sector be very extense and remained limited to short conversations with authorities and officials having worked or working for the National Council of Science and Technology, for the Register of Technology Transfers and for the Register of Foreign Investments.

On the contrary, the Argentine public sector was extensively used as a source of information, even on the private sector. Here, I was able to get statistical data specially processed for this work, as from the applications filed by both public and private enterprises with the National Register of License Agreements and Technology Transfers, for importing technologies or engineering services, and with the Secretary of State for Science and Technology, for tax reductions on their research and development expenses.

I am very grateful for the cooperation received from officials and administrators at that time in the Register, specially from Ing. José A. Valeiras (Head) and from Ing. Jorge Albertoni (President of the National Institute of Industrial Technology) to which the Register reports). I am also indebted with Francisco Sercovich for his collaboration and for his experience and ideas as applied to our work in the Register.

I am also thankful to the officials in the Secretary of State for Science and Technology operating the Department of Statistics and Information between April and August 1974, and, in the first place, to Dr. Julio H. G. Olivera, at that time the Secretary of State, who approved my guidelines for processing the data and authorized the above Department to perform the work.

Both in Argentina and in Mexico, I was able to exchange information with the national teams working on the Science and Technology Policy Instruments project of the I.D.R.C. I highly appreciate the cooperation obtained from their members and, specially, from their Directors, Eduardo Amadeo and Alejandro Nadal, respectively.

As in my previous report, I feel obliged to acknowledge the cooperation of the Directors in the Social Sciences and Human Resources Division of the I.D.R.C.

Also, again, I appreciate my son Eduardo's help in gathering data from indirect sources and Floreal Martínez's efforts in grasping my ideas and in getting them translated into English.

As work progressed, the scope of some objectives had to be reduced, while that of other was expanded. For instance, I had to circumscribe the analysis of the demand to only the chemical and petrochemical subsectors, within the process industries sector. The food industries, also classified under this sector, would deserve an individual analysis in each one of those countries, both because of their importance and of the complexity of their technological evolution.

On the contrary, I went well beyond a research work on the evolution of Argentine and Mexican process engineering, when the information gathered supported further development of prior ideas on a *technology to scale* approach for the selection, design and evaluation of technologies while performing pre-investment studies. The same applies to the analysis of the various factors influencing the disaggregation of imported technological knowledge by local teams in developing countries. These two subjects were treated in the aforementioned preceeding report.

The present report may be outlined as follows:

a) In the first Chapter, I am describing the activities encompassed by process engineering and process industries, detailing the characteristics of the chemical subsector within the latter.

b) I felt it was hard to grasp the differences in the evolution of chemical industries and of process engineering between Argentina and Mexico, unless socio-cultural factors in each country were considered. That is why, in Chapter II, I am attempting to summarize the historical evolution of both countries, on the basis of more amateurism than expertise.

c) From the detailed analysis on Argentine and Mexican chemical industries and process engineering carried out in Chapters III through VIII, the following points may be made:

(i) Both in Mexico and in Argentina, local and foreign investments in the chemical industries are sustained by imported basic knowledge and preliminary engineering.

(ii) These investments are preferentially applied to the production of chemicals aimed for mass consumption or reaching this market through very few additional manufacturing steps performed by other than chemical industries.

(iii) Local process engineering services in both countries are offered for much lower prices than those from industrialized countries and are being mainly used for locally performing the detailed engineering of imported technologies. Nevertheless, process engineering in Mexico has attained a higher development level than in Argentina, supported by particular socio-cultural conditions in the former.

(iv) The fact that in Mexico it was preferred to build independent engineering firms, rather than engineering departments within the production enterprises as in Argentina, has allowed the former to benefit in a greater extent from the economies gained through repetitive work and from experience and skills acquired in the execution of many different projects.

d) Since I have been living the problems in Argentina all along my life, it is only for this country that I have dared to propose instruments for the promotion of local process engineering services and for their orientation towards the accomplishment of social objectives. This proposal, in Chapter IX, is somehow based on a similar idea that Jorge A. Sabato tried to implement on 1971 in the field of electrical industries and engineering. I thank him for letting me share the experience he gained while developing and implementing the idea.

I also appreciate Francisco A. Sabato's efforts towards having my proposal discussed at the Secretary of State for Energy, between May and August 1974. The State monopoles on petroleum and natural gas, with their large petrochemical undertakings, report to this Secretary of State. Regrettably, the final period of my research work coincided with deep political and economic crisis in Argentina and, consequently, a fast turnover of governmental teams vanished the possibilities of implementing the idea.

e) The feasibility of a multinational Latin American engineering and consulting firm did frequently arise during my conversations in Mexico and Argentina. The interesting comments and ideas I gathered lead me to briefly consider the situation of the Latin American market, as regards to this type of services, stating my own ideas on cooperation among Latin American countries in the consulting and engineering field (Chapter X).

I am proposing that engineering and consulting services be organized and developed in such a way that each country acts independently from and intimately related with the rest. When developing this model, based on independence with interrelation, I tried to keep as far from dreams about autarchy as from reveries about integrating markets still inefficiently managed at the national levels and whose physical spaces are not yet entirely dominated by the local societies.

The research work performed has reinforced my ideas about education being the key instrument for promoting a progressive social change. However, for this to happen, great efforts must be made in Latin America towards imaginatively re-thinking education from the top down.

Latin American universities, and particularly their engineering schools, are to play a leading role in the promotion of national consulting and engineering services. The human resources they form should be capable of selecting, developing and using technologies, without blinders that may obstruct their discernment of the different biological, psychological, environmental, social and cultural impacts that alternative technologies may exert on each nation and specially on their rural poor. The latter are still a majority in Latin America and the way in which their daily-living problems are treated may lead either to a peaceful development, with a human face, or to violence, repression and the destruction of men, Nature and economies.

CHAPTER I

PROCESS ENGINEERING,

PROCESS INDUSTRIES

AND

THE CHEMICAL SUBSECTOR

A. SOME DEFINITIONS

The overall field of technology and engineering as applied to industries could be divided into five large sectors:

- *electro-mechanic:* covering all the shape transformations, with or without physico-chemical modifications, performed on materials so as to make equipment parts and assemble them into capital or durable consumer goods.
- *electronic:* profiting from the transformations that take place at the level of atoms, so as to pick up, transmit and issue signals and build the corresponding apparatus for the storage, transport and transfer of messages and information.
- *construction:* combining materials, that may or may not have been previously shaped by the electro-mechanic sector, into structures and use them for constructing buildings, roads, bridges, dams, ports, etc.
- *nuclear:* employing the transformation phenomena taking place at the level of the nucleous of atoms so as to convert mass into energy and make a practical use of the freed energy.
- *process:* transforming one substance into another by changes at the level of molecules and/or their aggregates.

In the last case, when the change is produced only at the molecular level, we have a chemical transformation and those industries whose products result from such a change are known as chemical industries.

The concept of process industries is much broader than that of chemical industries and encompasses the latter. Process industries do not only include those changing the composition at the molecular level, but also those introducing composition or phase modifications connected with molecular aggregates (physico-chemical transformations).

Therefore, process industries are also those utilizing various substances in order to obtain certain preparations (pharmaceuticals, cosmetics, domestic chemical specialties) and those extracting substances contained in vegetals and animals and conditioning them for human consumption (food and paper industries, for instance).

Two distinctive traits of the chemical sub-sector are the following:

a) Its products are very seldom aimed to direct massive consumption. They get to the final users through formulations or through mechanical transformations in shape and structure that do not imply chemical changes. Thus, for instance, fine drugs reach the market as formulated pharmaceutical products. Polyethylene reaches it in the form of pails, dolls, hoses, bags, etc.

b) Diverse molecular structures may be produced from the same initial molecule by submitting it to different processes of chemical change. This gives way to a large number of products that may be prepared as from the substances contained in the air, in water and in mineral, vegetal and animal resources.

When studying the chemical sub-sector, it is useful to order its products as per the number of steps of transformation to which the initial molecule is submitted after it is extracted or obtained from the raw materials. Thus, we may have:

-*Basic products:* these are the acids, the inorganic bases, the hydrocarbons that may be separated from petroleum, coal or natural gas, and all the metals.

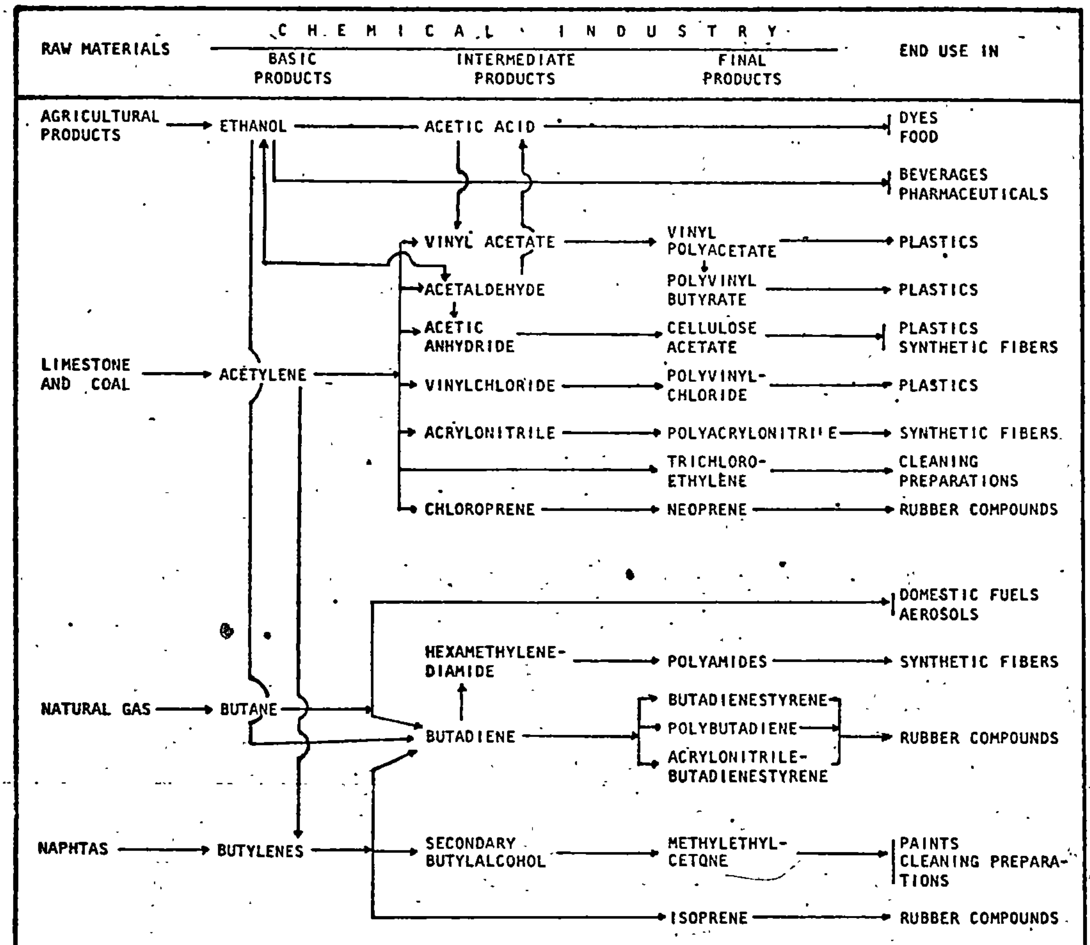
-*Intermediate products:* these result from transformations and combinations of the above basic products and are still rarely usable by the terminal industries.

-*Final products:* these are the last links in the chains of chemical transformation and may be utilized, without any further changes in their composition, by the producers of consumer or capital goods or services.

The chemical industry is, therefore, an intermediary between the raw material and the consumer markets. An industry for industries, as it has been called by many advertising slogans.

The above categories should not be rigidly considered. A given product may serve as a foundation for a long and ramified chain of transformations and may, simultaneously, be a direct input for an industry using it in producing goods or services without changing its molecular structure. The examples shown in Fig. 1.1. may better illustrate this concept.

FIGURE 1.1.



THE ABOVE REACTIONS ARE TECHNICALLY FEASIBLE, REGARDLESS OF THEIR ECONOMY, WHICH DEPENDS ON LOCAL CONDITIONS.

The chemical subsector is one of the most dynamic among the process industries, due to its dragging effect, both upwards, utilizing various raw materials, and downwards and alongside, serving or inducing the formation of other process, electromechanic, electronic, construction and nuclear industries.

In addition to the examples shown in Fig. 1.1., we may quote the case of aluminum, mostly extracted from bauxites, although allowing for other alternative raw materials such as alunites and laterites. In turn, aluminum sheets and profiles are used by several electromechanic industries and its powder is employed in formulating paints. Besides, new aluminum alloys are continually developed, allowing for its application to the manufacture of new objects or for substituting other substances in the manufacture of already known objects.

Other examples of interaction are the following:

- the extraction of uranium from minerals (chemical industry), as a response to the requirements of the nuclear industry.
- the purification of certain oxides or metals (chemical industry) for the production of semi-conductors to be used in electronic industries.

Among the groups classified by the International Standard Industrial classification of the United Nations, the following may be categorized as pertaining to the process industry sector:

3111 - Slaughtering, preparing and preserving meat.
3112 - Manufacture of dairy products.
3113 - Canning and preserving fruits and vegetables.
3114 - Canning, preserving and processing of fish, crustacea and similar foods.
3115 - Manufacture of vegetable and animal oils and fats.
3116 - Grain mill products.
3117 - Manufacture of bakery products.
3118 - Sugar factories and refineries.
3119 - Manufacture of cocoa, chocolate and sugar confectionary.
3121 - Manufacture of foods products not elsewhere classified.
3122 - Manufacture of prepared animal feeds.
3131 - Distilling, rectifying and blending spirits.
3132 - Wine industries.
3133 - Malt and malt liquors.
3134 - Soft drinks and carbonated water industries.
3140 - Tobacco manufactures.

3211 - Spinning, weaving and finishing textiles.
3219 - Manufacture of textiles, not elsewhere classified.
3231 - Tanneries and leather finishing.
3232 - Fur dressing and dyeing industries.
3411 - Manufacture of pulp, paper and paperboard.
3511 - Manufacture of basic industrial chemicals except fertilizers.
3512 - Manufacture of fertilizers and pesticides.
3513 - Manufacture of synthetic resines, plastic materials and man-made fibers, except glass.
3521 - Manufacture of paints, varnishes and lacquers.
3522 - Manufacture of drugs and medicines.
3523 - Manufacture of soap and cleaning preparations, perfumes, cosmetics, and other toilet preparations.
3529 - Manufacture of chemical products, not elsewhere classified.
3530 - Petroleum refineries.
3540 - Manufacture of miscellaneous products of petroleum and coal.
3620 - Manufacture of glass and glass products.
3692 - Manufacture of cement, lime and plaster.
3710 - Iron and steel basic industries.
3720 - Non ferrous metals basic industries.

Processes in groups 3511, 3512 and 3513 are mostly based on chemical changes. Instead, the groups in division 31 (food industries) largely involve physico-chemical transformations for separating food substances from vegetals and animals and conditioning them for human consumption, although a few strictly chemical processes, such as the fermentation of agricultural residues, may also be found.

Among the remaining groups, process involving composition changes, both at the molecular and at the aggregate level, are mixed up. For instance, groups 3710 and 3720 include the recovery of metals from ores (chemical processes), the manufacture of alloys (physico-chemical processes) and lamination (electromechanical transformation). The same happens within group 3620, in which, together with the manufacture of glass, its further electro-mechanic transformation is included.

Any industrial project involving chemical or physico-chemical processes calls for:

a) *Basic knowledge:* involving the systematization of results obtained from research work at a laboratory scale or from empirically operating an already existing production process and comprehending:
-the fundamental physical and chemical kinetics of the transformation that will lead to obtaining the product;

-a block diagram indicating the necessary operations for attaining the desired transformation and the intensive and extensive parameters affecting such transformation; and

-a manual with the procedures suggested to be followed for performing the operations.

The basic knowledge of the process allows for the preparation of a pre-feasibility study, assessing the probable investment and plant operation costs through quickies or order-of-magnitude estimates.*

b) *Preliminary engineering:* It is a preliminary, general design of the process based on data from an existing operation or on the results of the experimental development in pilot plants of the data supplied by a research work.* It often involves:

-a flow sheet of the main process, with indication of temperatures, pressures and compositions;

-a flow sheet of the auxiliary services, involving the same data;

-a scheme of the pipelines and control instruments;

-a material and energetic balance of the main process;

-a material and energetic balance of the auxiliary services;

-specifications of the fundamental equipment units; and/or

-an equipment layout.

This allows for a more precise estimation of the investment costs than at the previous step, since direct contacts may be made with the potential suppliers of equipment and inputs. Any feasibility study must be supported by a preliminary engineering adapting equipment, technical procedures and management methods to the particular social, economic, anthropological and environmental conditions of each project.**

c) *Detailed engineering:* It produces the drawings, models, lists of materials, specification sheets, etc., allowing for facing the manufacture and assembly of the equipment units and the construction of the buildings where those units will be lodged and/or of

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* In some cases, a direct scale-up of laboratory work is feasible.

** See Chapter II of the author's report entitled *Engineering and Pre-investment Work.*

the structures on which they will be installed.

d) *Procurement:* On the basis of the information supplied by the detailed engineering, the manufacturers and/or suppliers of the equipment and the enterprises taking care of the construction and assembly of the plant are selected, and the goods and services procured are checked to fit the pre-established specifications. Procurement is often in the hands of those executing the detail ed engineering. However, the production enterprises do sometimes purchase the detailed engineering from third parties and procure the equipment and construction and assembly services by themselves.

e) *Construction and assembly:* the supervision of these activities is usually carried out by those who took care of the detailed engineering.

f) *Start-up operation:* Those providing the preliminary engineering or the basic knowledge of the process are the ones who may better control its start-up.

g) *Technical assistance to production:* This refers to advice that may be given, so as to solve minor problems in production or plant maintenance.

h) *Quality control:* the data supplied along with the basic knowledge and/or its preliminary engineering does usually include specifications and operation manuals on the methods to be used for controlling the quality of inputs and final products. Sometimes, quality control supervision remains in the hands of those who have supplied the basic knowledge and/or the preliminary engineering for an additional term after the start-up of the plant.

i) *Personnel training:* Involves the training of the managers, supervisors and/or workers who will be involved in the process, at pre-existing similar plants and/or by means of any other organized method for transfering knowledge (courses, computer-simulated programs, participation in the preliminary engineering, in construc tion and in assembly)

The expression "process engineering" usually refers to the work involved in the design of the preliminary engineering. Then, the detailed engineering is also known as "project engineering".

I prefer to use process engineering for defining any engineering services rendered to process industries. That is how we may define a process preliminary engineering and a process detailed engineering, in the same way as we may show the difference between the preliminary engineering for the manufacture of electro-mechanic or electronic products and the detailed engineering of the installations needed for their production.

The way in which a given piping circuit is specified under preliminary engineering and under detailed engineering serves to give a clear picture of the differences in scope between one and the other.

Preliminary engineering provides data on:

- the nature of the fluid
- the flow rate
- the working temperature and pressure in the circuit
- particular observations on corrosion and isolation..

The detailed engineering of the same circuit develops a series of geometric projections and isometric drawings showing how and where the circuit will be installed in the plant. The bills of materials in detailed engineering provide indications on sizes, structures and materials, such as:

- the length of the circuit
- the diameter of the pipes
- the type of pipes to be used
- fittings (valves, elbows, curves, unions, etc.) contained in the circuit.
- type and thickness of the isolation material
- type and spacing of pipe supports.

Basic knowledge, preliminary engineering and detailed engineering constitute a logical chronological sequence, a kind of ontogenetic chain whose links connect the industrial plant with the laboratory when a new process is developed. For instance, nylon is the result of Carothers' laboratory work and is then developed by Du Pont, the enterprise for which Carothers used to work. Both the basic knowledge and the preliminary engineering arising from these first works allowed for shortening the chain in further undertakings. As from the second one, the detailed engineering for installing nylon plants under the same socio-economic and environmental conditions did only need to incorporate the improvements attained through work in the previous ones. But, if nylon plants are to be adapted to different local characteristics, a re-created preliminary engineering will be needed in order to design and select equipment, methods and procedures under these new conditions.

However, historically the three steps did not always appear in the above order. In spite of the fact that chemical industries are intrinsically science-based, many of their products started being empirically manufactured well before knowing why and how did a given process take place (basic knowledge) and how could such knowledge be applied to industrial use (preliminary engineering).

For instance, alchemists manufactured sulphuric acid by decomposing alum or copper sulphate by heat and receiving the so-formed sulphuric anhydride in water. On 1700, sulfur started to be burnt in glass containers, letting the resulting gases react to wet air, so as to oxidize sulfurous into sulfuric anhydride and to combine the latter with water. Fifty years later, nitrogen oxides are added, since it was discovered they could accelerate oxidation, although it was still ignored how did those oxides took part in the reaction. However, this allowed to change from small glass containers to large lead chambers and to start selling acid by tons, reducing its price in 90%.

On 1831, P. Phillips patented another empirically developed procedure. It was based on having sulfurous anhydride, produced by burning sulfur with oxygene, pass through a platinum or porcelain tube containing platinum wire or finely divided platinum heated to redness. This was a catalytic oxidation, whose mechanisms were scarcely known at that time. The mixtures were believed to need to have the same number of sulfurous anhydride and oxygene molecules, although the stoichiometry of the reaction does actually result from a ratio of 2 anhydride: 1 oxygene.

Only on 1901, Knietsch perfected this process at the Badische Anilin und Soda Fabrik, scientifically showing the previous mistakes and, 25 years later, the Monsanto Chemical Co. introduced the first vanadium pentoxide catalyst allowing for a much simpler handling of the process. The replacement of the old chamber method by the latter, called contact method, made acid prices to decrease another 90%.

This is a case in which the generation of the scientific knowledge was historically the last step in the development of the process. An intimate knowledge of the catalytic reaction allowed for the introduction of very important economies in the contact process, which is practically the only one in use nowadays.

This historical reversion of the science-technology-engineering sequence is still more frequent in the mechanic industries. "The 19th. century's industrial revolution had very little to do with anything scientific. The knitting machines and the other textile machinery had absolutely nothing to do with scientific understanding".*

Although many inventions are still coming from "tinkers", that is, from "a person who goes in the backshed in the garden and plays with little bits of brass and lenses and invents a new model of a mouse-trap, or a new way of plating metal"**, the most meaningful progress takes place when orderly sequences are applied, starting by a careful research work, following with the experimental development of the results obtained and ending up with the design and calculation of the production installations to which those results may be applied. This is the case in the process industries, specially since organic chemistry brought about artificial dyes and agro-chemical industries.

"Until World War II, the public image of the scientist was that of the chemist.... All other sciences were merely natural philosophy".***

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* Derek de Solla Price, *The relations between science and technology and their implications for policy formation*, FOA, Stockholm, 1972, page 21.
** *Ibid*, page 7.
*** *Ibid*, page 4.

B. SOME CHARACTERISTICS OF THE CHEMICAL INDUSTRIES

Product diversification

The chemical industries -as a sub-sector of the process industries- are noted by the homogeneity of their products. These are sold under little if any influence from factors such as market prestige or trustability of the trademark. Their market is preponderantly intra-industrial.

Chemical industries develop or modify their products at a slower pace than industries producing highly differenciated products.

The basic and intermediate chemicals are more homogeneous than the final ones. The latter diversify as a response to the growing sophistication of the markets.

All the sulphuric acids (basic chemical) with 98% concentration are identical and the manufacturers cannot argue but minor advantages that may scarcely influence their further utilization, such as a few less iron parts per million resulting from a more careful manufacturing process. On the other hand, when vinyl chloride (intermediate chemical) is polymerized, variations may be introduced in the process allowing, for instance, to claim higher yields when extruding the polymer (final chemical).

Even more variations may be introduced when formulating mixtures of the poly mer with plasticizers and fillers for its final application in the production of consumer goods.

Employment

Chemical industries are capital-intensive, specially at the level of basic and intermediate products. However, their capital intensity is not an intrinsic factor; it depends on the type of technology used. In any case, they indirectly promote the use of labour, since their end users do usually apply labour-intensive technologies. Also, the exploitations taking care of extracting and preparing the raw materials for the chemical industries are often labour-intensive.

The capital investment per work place in the chemical industry is 3 to 5 times higher than the average for all industries.*

The economies in personnel when the production scale is increased without changing the technology of the process seem to respond to the following equation:**

$$\frac{N_1}{N_0} = \left(\frac{C_1}{C_0}\right)^{0.25/0.33}$$

in which:

N_1 is the number of men to be hired per shift for a C_1 ton/year production capacity; and

N_0 is the number of men known to be needed for a C_0 ton/year production capacity.

Therefore, a 100% increase in the production volume would mean an increase in the personnel dotation between 19 and 26%.

Statistics of chemical industries in various countries suggest that every million dollars invested generate the following enrollments:***

- 6 professionals in chemistry for research and development, production and/or engineering.
- 2 professionals in chemistry for marketing work.
- 1 other technicians.
- 12 foremen and supervisors.
- 13 qualified process operators.
- 14 non-qualified regular workers.

Economies of scale

Investment economies resulting from increases in the production scale, without changing the technology of the process, respond to the equation:****

$$\frac{I_1}{I_0} = \left(\frac{C_1}{C_0}\right)^{0.5/0.8}$$

In which: I_1 is the investment to be estimated for a C_1 capacity; and I_0 is the known investment for a C_0 capacity.

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* B. Bucay, "Contribuciones para una teoría de la integración de la industria de proceso", *Revista del Instituto Mexicano de Ingenieros Químicos*, Mexico, October/November, 1973, page 11.

** B. Bucay, *ibid.*

*** Calculation performed on the basis of data contained in an article on human resources in the chemical and process industries in the *Revista del Instituto Mexicano de Ingenieros Químicos*, Mexico, December 1973/January 1974, page 38. Mexican pesos have been converted to U.S. dollars on the basis of a 12.5:1 exchange rate.

**** United Nations, *La Industria Química en América Latina*, New York, 1963, page 294. See comments on the economies of scale equation in page 51 of the author's report *Engineering and Pre-Investment Work*.

This means that increasing the production capacity in 100% involves investment economies ranging between 13 and 29%.

Nevertheless, by applying social criteria, technologies chosen or generated so as to fit local conditions in developing countries may result in investment costs per unit produced in small-scale plants comparable to those attainable with technologies selected or created for larger plants in industrialized markets following purely micro-economic objectives.

As an example, Fig. 1.2. shows the costs, under the conditions in India, involved in delivering up to 230,000 tons of nitrogen per year in fertilizers, comparing large-scale coal-based plants with small village-type bio-gas installations.*

FIG. 1.2. PRODUCTION OF FERTILIZERS (230,000 ton/year nitrogen-content)

	LARGE-SCALE COAL-BASED PLANTS	VILLAGE-SCALE BIO-GAS INSTALLATIONS
Number of plants	1	26,150 (8.8 ton/year/plant)
Capital cost	Rs. 1,200 million	Rs. 1,070 million (Rs. 41,000 p/plant)
Foreign exchange	Rs. 600 million	nil
Capital/sales ratio at Rs. 4,350 per ton of nitrogen.	1,2	1,07
Employment	1,000	130,750 (5 people per plant)
Energy	about 0.1 million MWH per year consumption	6.35 million MWH per year generation (through 5,000 cft/day of gas per plant)

The fact that Latin American countries have developed their chemical industries mostly on the basis of technologies transferred from highly developed countries, with little or no adaptation to their small markets, explains the difference usually observed between internal and international prices. This is still true, even when considering the fact that inter

* Example taken from Amulya Kumar N. Reddy, "Alternative technology: a view point from India", *Social Studies of Science*, 5, 1975, pages 331 through 342. Other examples from the chemical and other industrial and infrastructural sectors may be found in the author's report *Engineering and Pre-Investment Work*.

national prices do not always reflect the actual production costs in the big markets because the exports of surplusses are often subsidized.

Besides, production costs reported for large installations often correspond to plants operating at their nominal capacities. On 1968, it was pointed out that no ammonia plant in the 1,000 ton/day range was yet operating at its lowest possible cost level due to:*

	Incidence
-mistakes in the plant design	10%
-mistakes in the plant installation	20%
-quality defficiencies in the equipment	40 to 60%
-human mistakes in production work	30 to 10%

In low developed countries, the lack of skilled labour and engineering forces increases the possibilities for mistakes in the installation or operation of the plants and makes nominal capacity even harder to attain.**

The same source stated that the profitability of plants producing about 1,000 tons of ammonia per day was the same as that of the smaller 300 to 400 ton/day plants when, due to technical problems or market conditions, the utilization coefficients of the former were low.

Some equipment manufacturers were trying to standardize and produce series of 300 to 400 ton/day installations so as to lower their prices and attain capital investments per ton of ammonia produced similar to those obtained for larger installations.

In any comparison between local and international prices, the type of technology involved, the social costs and benefits, and the effects on human beings and the environment should also be considered, so as to avoid being mislead by oversimplified mathematics stating that the internal prices should not exceed international ones in more than 15 to 25%.

Preinvestment studies should design or select a technology allowing to

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* Juan Miro Chavarría, "Considerations techniques et économiques sur les engrais", *Chimie et Industrie - Génie Chimique*, Vol. 100, No. 3, page 262. I have rounded up the figures.

** See the author's report *Engineering and Pre-Investment Work*, page 61.

attain the lowest possible cost, while taking into account not only the production scale but also all the other local human, environmental, cultural, social and economic conditions. The resulting cost may then be still higher than the international one, because any of those conditions and not only the production scale may exclude the technology showing the lowest absolute cost. But the search for an alternative technology fitting those conditions may also lead to one resulting in a similar or even lower cost than the international one.

Availability of knowledge

Chemical technologies are complex and constantly evolve towards:

- different products as from the same raw material.
- different raw materials for manufacturing the same product.
- better yields and lower costs in manufacturing a given product with the same raw material.

That is how a large number of alternative technologies is made available for the same process or for a given product. They are, in turn, commercialized following various modes.

There is data available* showing that, among 1,271 process technologies offered in the United States by 227 enterprises that had developed them, 303 are negociated by 68 engineering firms. This shows that, in some cases, the commercialization of knowledge is separated from its production, although the creative units generating them and the engineering firms negociating them do often belong to the same economic pool. The division is isually made so as to attain more efficiency and readiness in each job through the use of specialized structures. In certain cases the division may obbey to global tax reduction purposes.

In any case, society profits from the experience accumulated by the teams during their previous captive work and both society and the production enterprise benefit with the economies resulting from the freed engineering teams being involved in different kinds of projects and able to perform

* Figures taken from "Process Technology for License or Sale", *Chemical Engineering*, April 20, 1970, pages 114 through 144.

more repetitive work.

As per the above figures, each creative unit would have produced an average of 5.5 technologies, while each engineering firm would have an average of 4.4 technologies for commercialization.

If the degree of concentration in creative work is studied among the universe of 227 enterprises under analysis, we may find that 9.3% of them offer 47.2% of the 1,271 technologies included in the sample.

Analogously, if the degree of concentration in the marketing of technology by engineering firms is calculated, we may find that 8.82% of the 68 engineering firms under consideration market 40.12% of the 491 technological offers made through these channels.*

A science based process, if freely available, may easily be reproduced by a skilled engineering team. Instead, an empirically based process is hard to be copied: whoever wants to implement it will depend on the experience of those who have succeeded in its development.

In an installation in which metallic sulphides are roasted with further thermal reduction of the metallic oxides, on one hand, and production of sulphuric acid from the gases, on the other, the most empirical process is often that of thermal reduction. The performance of the reduction furnaces does not accurately respond to mathematical calculations. These equipment units involve countless knacks in their design and construction, which must either be transmitted by those who have learnt them through previous experience or, otherwise, re-discovered through successive pilot tests with increasing amounts of material.

On the other hand, the design of reactors, absorption towers, scrubbers, heat exchangers, etc., for the catalytic oxidation of the sulphurous anhydride in the gases does perfectly respond to the present chemical engineering tools. Besides, plentiful bibliography is available, including heat transfer coefficients, reaction rates, physical and chemical data on the fluids involved in the process, etc.

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* The total offer (491) was not equivalent to the total number of technologies (303) marketed through engineering firms because some of the technologies were marketed by more than one engineering firm.

Added value

The added value is usually high in chemical industries. The marketable price of some intermediate or final petrochemical products may even reach 10 or 15 times that of their corresponding raw materials. For instance, when the price of benzene was 0.48, that of cyclo-hexanol -obtained from the former- was 1.90 and that of nylon 66, for which the latter is an intermediate, was 7.30.*

The above chain encompasses a particularly complicated set of processes: hydrogenation of benzene - successive oxidations of cyclohexane into cyclohexanol, cyclohexanone and adipic acid - combination of the adipic acid with hexamethylene diamine, in turn, obtained from butadiene through the intermediate adiponitrile. For less complex and less ramified sequences the multiplying factors may be lower: when cumene was quoted for 0.80, the resulting phenol reached 1.10 and phenolic resins were being sold for 2.10.*

Learning curve

Some economists support the idea that the unit cost of a product decreases as time goes by, after the start-up of the plant. The reduction would be a function of the experience acquired and this, in turn, would be measured as per the accumulated production.**

$$c(t) = a\,E^{-n}(t) \qquad\qquad E(t) = \int_0^t P_r\,dt$$

where:

- $C(t)$ is the unit cost at the time t, measured as from the start-up of the installation.
- a is a proportionality coefficient.
- E is the accumulated experience, at time t, measured by the integral of the respective production function.
- n is a coefficient that would range between 0.3 and 0.5 for the chemical industries.

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* Since this is only a comparative analysis, the currency being used may be disregarded. Anyhow, the data is based on actual prices, in French francs per kilo, as per the magazine *Chimie et Industrie*, Paris, October, 1972.

** B. Bucay, *op.cit.*, Page 12.

As per this expression, the unit cost of chemical products, at constant input prices, would decrease between 20 and 30% when experience is doubled.

I have not been able to submit the above equation to statistical verification. However, my experience in the chemical industry makes me doubt about its usefulness. The predominance of continuous processes requiring low employment and intensively using automatic controls allows for short training curves in chemical industries. In other words: the nominal levels of production are reached in a very short time and if, as it often happens, the facilities are slightly over-dimensioned (calculation security margins), that nominal level may even be surpassed without great effort. From there on, trouble-shooting and work towards process optimization are practically useless in trying to increase the productivity, unless the technology involved is substantially altered by modifying the equipment or changing the raw materials or intermediate inputs. But, in such cases, we would be under a different production function.

Besides, the permanence of the enterprise's human capital plays a leading role among the factors affecting the accumulated experience.

C. SOME PREREQUISITES FOR THE DEVELOPMENT OF A NATIONAL CHEMICAL INDUSTRY

Obviously, the conditions for the establishment and growth of chemical industries do not differ too much from those necessary for internal development as a whole.

The conditions described below seem to have supported the development of chemical industries in the first industrialized countries. Further on in this work, they will be compared with those affecting development in two Latin American countries.*

Market

Historical antecedents show that the development of the agricultural sector in a given country constituted the fundamental basis for the formation of an important internal market for chemical products. This was mainly due to the following facts:

- efficient agricultural development demanded increasing amounts of fertilizers, pesticides, steel, fuels and other products resulting from chemical production processes.
- in turn, the efficiency of the agricultural sector allowed for adequately and cheaply feeding the urban settlements originated by industries and for accumulating capital to support industrial investments.
- a higher purchasing power among peasants increased the demand for consumer goods obtained from chemical products.

Where this mutual supply of each other's lacks took place, a self-sustained and fast national development was observed. There, the socio-cultural groups connected with soil exploitation did not isolate from the rest of the economy and considered the business and industrial world as a natural prolongation of their primary activities.

Moreover, when the initial local industrialization process was consolidated,

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* See chapters III and VII on Argentine and Mexican chemical industries, respectively.

those countries tried to expand their chemical industries by capturing raw materials from less developed regions. Since then, chemical industries have not only satisfied the vegetative demand arising from larger populations and higher purchasing power, but have also excerted pressure on that demand by:

-reducing prices through economies of scale; and
-increasing transitoriness and diversification of consumer goods made from chemical products.

In so doing, little attention was paid by chemical industries to the following emergent situations:

-increased dependence from primary non-renewable raw materials, such as fossil fuels.
-alteration of environmental parameters, such as temperature and physico-chemical conditions of air and waters.
-damage to human beings as creatures of Nature.

Inputs, outputs, producers and consumers were nothing but figures offered to the new pagan god worshipped by entrepreneurs: the market.

Customs

Since the industrialization process did not simultaneously start in all countries, those whose development take-off was delayed had to establish custom protection tariffs against those who had got to have a low-priced surplus of chemical products for export. Sometimes, those lower prices were not due to larger production scales but to different patterns applied in the retribution of the local production factors.

On the other hand, when industrialization in this sector did not follow an integrated sequence -beginning with the production of raw materials and proceeding through basic and intermediate products to the final chemicals and to the consumer goods made with the latter-, the introduction of inputs non-produced in the country and necessary for the isolated terminal or intermediate processes had to be simultaneously favoured and controlled:

- preferential tariffs had to be granted, in order to avoid artificial price increases.
- controls had to be imposed so as to prevent over-invoicing.

Credit

Even under the best conditions of internal capital accumulation and application, the chemical industries, fundamentally capital-intensive, need credit support so as to face investment and working capital requirements.

Long term loans are normally granted for the purchase of equipment, mainly by development finantial Institutions in the Public Sector. Instead, the generation of working capital was left to the entrepreneurial activity in itself, aided with short-term credit by commercial banks.

Development financial institutions selectively use investment loans so as to promote:

- activities with strong multiplying effects, both downwards and upwards.
- industrial decentralization, in order to keep the labour freed by the agricultural sector from abandoning the countryside and crowding in a few big cities.

Such selectiveness may also consider the value added by the process being promoted that does actually remain in the country. When transfers abroad are taken into account, some industries may show negative figures. This is the case of some industries dealing with a very simple transformation of imported raw materials.

Raw materials

Those branches of the chemical industries using easily transportable ores, oils or intermediate chemicals, may be entirely based on imported inputs. Some other, demand local supply sources. A distorting situation repeatedly occurring in developing economies is that they import products deriving from locally available raw materials. On the other hand, development in this sector may hardly be considered as national if it is mainly based on imported raw materials or intermediates and even less if exclussively.

Following universal trends, chemical industries have frequently changed from one source of basic products to another, always searching for the cheapest. Thus, agricultural wastes, wood and other renewable materials were abandoned and coal, oil and natural gas were successively preferred. Very few people realized that the idea of cheapness was a pure mathematic abstraction allotting a price to non-renewable materials only including finance, labour and land costs and disregarding the fact that, by irrestrictly pouring these raw materials abroad, the countries gifted by Nature with abundant reserves of the same were actually devouring their most precious capital endowment.*

More environmentally and socially concerned policies may reverse trends preferring any renewable alternative source and saving the non-renewable ones as much as possible when they are the only expedients.

For instance:

- plastics made from agricultural products may be preferred to metals in any uses in which they are interchangeable.
- soap and detergents made from animal fats, vegetable oils or saccharose may be recommended instead of synthetic detergents deriving from petrochemicals.
- carbonic gas from fermentation processes or obtained by burning wood may save coal or oil.
- blowing pure oxygen instead of normal or enriched air through blast furnaces would allow for producing more pig iron with a lower consumption of coal, because there would be no need to heat inert nitrogen in the gaseous flow. Furthermore, the exhaust gases would only contain carbon dioxide and monoxide. By separating the latter and making it react with steam, hydrogen may be produced and, in turn, combined with nytrogen into ammonia without spending any extra coal.

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* Certain situations arising from considering non-renewable raw materials either as capital or as income are described by Schumacher, *Small is Beautiful*, Harper & Row, New York, 1973.

Knowledge

Chemical industries generate knowledge and incorporate it into their operations at such a pace, that the technical obsolescense of the procedures does often surpass the physical wear of the equipment.

This, and the challenge of designing chemical technologies fitting local conditions, call for constant support from science and technology by means of adequate research and experimental development. They also require that education be organized so as to:

- provide scientists with the most advanced knowledge available in each field.
- train engineers in the use of physico-mathematical tools for the creation or adaptation of chemical technologies and the calculation, design and optimization of chemical plants.
- form economists, social psychologists, environmentalists, architects able to work side-by-side with engineers in organizing chemical projects on multidimensional, multicriteria, systemic basis.
- prepare intermediate level technicians for both production and creative work.
- make labour aware of the permanent technological changes in this field, so as to provide them with the necessary flexibility to face the increasing complexity of their tasks.
- establish fluent communication channels between the users and the producers of knowledge.

The intensity in the offer of knowledge requires a very strict organization of each investment project so as to perform a careful selection and evaluation of the alternative technologies.

D. EVOLUTION OF CHEMICAL INDUSTRIES IN LATIN AMERICA

The development of chemical industry in Latin America started with the extraction of some available raw materials, which were locally processed only when they did not require complex transformations. Otherwise, they were exported and the products resulting from their transformation were later re-introduced.

Import substitution in this sector started with consumer goods manufactured as from imported final products of the chemical industries. Then, progress lead to the local production of those final chemicals with imported intermediates* and, much later, the local production chains started being integrated with basic and intermediate products.

The balance of payments is not proportionately improved as imports of chemicals are substituted because:

- foreign currency is spent in purchasing the capital goods required for their production that, at least initially, are not locally manufactured. This is due to the fact that import substitution of chemicals is usually started without previous planning and, therefore, the capital goods requirements are not anticipated on time for local manufacturing shops to develop so as to satisfy that demand.

- very high prices are paid for the imported technological knowledge needed for local production.

- the transfer of rights for the use of that knowledge does often, either implicitly or explicitly, tie up local industries to a supply of over-invoiced foreign inputs or to the procurement of foreign technical assistance for engineering and/or operating the facilities.

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* Note that some basic chemicals may be direct inputs in the manufacture of consumer goods. See page 2.

-foreign currencies drain off as a retribution to foreign capital supporting the local production.

-additional foreign currencies are spent in imports of capital goods and intermediate inputs required by side-industries promoted by the chemical sector.

On the other hand, there are several factors hindering exports of chemical products from the Latin American countries, such as:

-high cost or danger involved in shipping many intermediates and basic products, due to their chemical and/or physical conditions.
-export restrictions included in the license agreements through which the technologies were acquired.
-lack of experience on foreign trade among local firms.
-sales pressure on the potential customers excerted by the highly industrialized countries, anxious to get rid of their surplus of chemicals and profiting from their skill and experience in international trading.
-lack of governmental support to private initiative in this field so as to allow for competition in spite of the smaller scale in production.
-difficulties in transporting products within and through the Latin American hinterland, as opposed to means developed since long ago for their shipment to and from industrialized countries.

CHAPTER II

A SUMMARY
OF THE SOCIAL EVOLUTION
IN MEXICO AND ARGENTINA

One month spent in touch with the Mexican process engineering and industry may not serve to attain the same live experience acquired through 30 years of work in Argentina.

It is the usual weakness of foreign experts: nobody can, in a short stay, acquire a thorough view of national problems with the same intensity and accuracy as those who have been feeling those problems and thinking on them for a lifetime.

However, there is a positive factor in the foreign experts' situation: by being less involved and trapped in the social and cultural environment, they may reach more objectivity by preventing passion from fogging the picture. Nevertheless, they will always have to be supported by the knowledge and the experience of those for whom each problem has been an existential question.

It was under this conditions that I tried to establish a comparative analysis of the evolution of Argentine and Mexican societies. I felt such framework was needed to better understand particular differences in the development of their process engineering services further on analyzed in this report.

The Mexican process industry is older than the Argentine one. The precolombian cultures in the former did already handle some chemical and physicochemical procedures. In the sixteenth century, when America was revealed to Europe, the Aztecs, ruling Mexico since the legendary Tenochtitlan, had already inherited several important scientific and technological elements from other equally important cultures, such as the Olmeca (1200 to 500 BC), the Teotihuacana (1 to 900 AC) and the Maya (300 BC to 1600 AC):

- positional notation, including the use of the zero.
- the astronomic measurement of time.
- the construction of large buildings with stones and wood.
- cotton knitting and dyeing.

They had also developed writing, history, literature and philosophy.*

When the indigenous tribes in the Argentine wet pampas and Patagonia had not yet abandoned nomadism, more than 80,000 inhabitants were conglomerated in Tenochtitlan. At that time (1500 AC), only four European cities (Paris, Naples, Venice and Milan) had populations slightly over 100,000 inhabitants

* D. Cosio Villegas et al., *Historia Mínima de México*, El Colegio de México, 1974, page 40.

and none of the Spanish cities reached such number. Seville, at that time the largest, had 45,000.*

Mexico had developed urban areas a long time ago. Already on 1500 BC, an agricultural economy was consolidated and the Mesoamerican man was a permanent farmer, living in villages that did sometimes deserve the name of towns.** About one thousand years before Christ, that rural world started becoming urban in the area close to the coast of the Gulf of Mexico, where 350,000 people lived on 18,000 square kilometers.*** This urbanization process consolidated in Teotihuacan, which, on 500 AC, had probably 200,000 inhabitants, while none of the European cities, except for Constantinople, surpassed the 20,000 figure.****

These cultures were already using sodium chloride, which they extracted from the sea and from salt mines. They prepared lime as from limestone (calcium carbonate) and used the saponines contained in the root of the maguey and of other plants as detergents. Besides, they obtained sweetening materials from sugar cane and from the maguey, red dyes from cochineal and blue dyes from indigo.***** The Mexicas worked with native gold, silver and copper and had developed four different alloys.******

Except for the sedentary tribes in the North Western area, connected with the Inca culture, the Argentine semi-nomad indians had had no limitations to their freedom at the time of the Spanish conquest. On the contrary, Mexicans had been repressed in their instinctive lives for many centuries. Their main cultures entailed teocratic-militarv regimes that disregarded the psychical and physical life of the subdued masses.*******

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* D. Cosio Villegas et al., *op.cit.*, page 34.

** *ibid*, page 11.

*** *ibid*, pages 13 and 14.

**** *ibid*, page 25.

***** Enrique G. León López, *La Ingeniería en México*, Secretaría de Educación Pública, Mexico, 1974, pages 111 and 112.

****** *ibid*, page 114.

******* It is rather curious how certain subjugation and subordination feelings are still unconsciously maintained in the language. Mexicans, when faced to a question or indication they have not heard or correctly understood, do not ask, in turn, *¿cómo dijo?* (how did you say?), but answer *Mande*, literally meaning *Command me*, as a parallel of the English expression *I beg your pardon*.

In Argentina, there were practically no technologies for the conqueror to replace or absorb, while, in Mexico, many pre-existing technologies were either substituted or assimilated by the Spanish culture.

The Spanish conquest constituted a typical example of a private undertaking, organized mainly with private funds and trying to hurry benefits to compensate its efforts, without any matter for the conquered people and eluding the timid attempts for control made by some Spanish institutions. The Mexican indians were not any more sacrificed under the Huitzilopochtli altars and started dieing by-the-thousands in the mines or refining mercury for recovering amalgamated silver.

In Argentina, the conquerors found a subsistence economy, based in the natural fertility of its wet pampas. In the coastal region, snatched from their primitive inhabitants -who died in the struggle or refugiated in the deep South-, they established ports, in order to trade, supposedly only with Spain, but, in practice, also with Portuguese and English smugglers. In the Northern and Central hills and ranges, socially and economically connected with Peru, more cultured indians surrendered like in Mexico and, based on their labour force, a few industrial and mining undertakings and some urban centers were set up.

In Mexico, its already developed urbanism and mineral wealth gave way to more complex economies: since the very first years of the Spanish domination, textile factories, mines and ranches -aimed to supply food to the urban centers and to the mining works- were established. In the same, what we might call "modern" ways of human exploitation started being applied, such as the work of slaves brought in from Africa or the engagement of "free" workers who, for very low salaries and obliged to get their food supply and other items from the company's store, remained indebted for life with the entrepreneurs.

Groups of traders did soon appear, both in the Argentine main port (Buenos Aires) and in the capital of the New Spain.* Thev were the only ones able to invest the necessary capital for purchasing the goods arriving from abroad

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*-Name given to the Spanish viceroyalty established in the Mexican territory.

once-in-a-blue-moon and that were sold, little by little, during the rest of the time.

Further on, when both countries became independent, many of those interests in the foreign trade resisted any attempt towards substituting imports. However, Mexico -as opposed to Argentina- did also have strong groups of businessmen founding their power and privileges in the development of local industries.

While Buenos Aires, once independent, took the most industrialized European countries (France and England) as models and opened itself outwards, disregarding the hinterland, the Mexican creoles, when they seized power, anarchically turned inwards, trying to settle a new Spain in America and fighting the absorbent tendencies of their powerful Northern neighbour, which captured almost half of their territory in the 1840s.

When, in the 1850s, Juarez tried to promote economic growth and political organization in Mexico, on the basis of the liberal ideas in fashion at his time, he ran against the still feudal mentality of local land-owners and entrepreneurs. Instead, after 1853, the Argentines Alberdi, Mitre and Sarmiento and their generation had not difficulties in making the dealers and merchants in the ports and the landed classes in the pampas adopt laissez-faire policies based on the international division of work between central industrialized countries and peripheral countries feeding the men and machines of the former. Those policies brought along considerable modernization and growth, but little industrialization.

Growth and modernization in Mexico occurred at a much slower pace than in Argentina and followed different political patterns. The "porfiriato"*, a typical benign vernacular despotism, tried to repair the destruction successively accumulated by the independence war (1810-1821), the anarchical period (1821-1850), this including the United States interventions, the struggles during the Juarez reform (1855-1861) and the French occupation (1861-1867).

On 1910, when the "porfiriato" was coming to its end, Argentina showed almost 300 dollars, as an average income per capita **, a figure that Mexico did only

* Name given to the period in which the country was under the ruling of Porfirio Díaz (1877-1911).

**Based on CEPAL data quoted in N. González and R. Tomasini, *Introducción al Estudio del Ingreso Nacional*, EUDEBA, Buenos Aires, 1961, page 17. The Argentine pesos of 1950 were converted into dollars at the 10:1 exchange rate in force at that time.

reach fifty years later.* Buenos Aires was then building its first subways. The Mexican metro was only inaugurated sixty years later.

None of the two countries supported their national growth on internal policies leading to:

- -local capital accumulation.
- -an adequate generation and utilization of knowledge in terms of the production needs.
- -an equitative distribution of the wealth being generated.

As a result, social tensiones began to heap up. They burst out during the Mexican revolution and did only appease in that country by 1929, when an official political party was founded and started pacifically searching for national development. By the same time, Argentina went into an agitated period, characterized by a series of military coups, a slow-down in the growing pace and soaring inflation. Since then, in both countries, the State started to strongly regulate and control the national system and to appear as a direct agent in the production process.

In Mexico, forty-five years of political and economic stability (1930-1975) have contributed to soften tensions, but a fine tuning may still detect the mumbling of an army of poors, accused of being lazy, mentally slow and excessively fond of alcohol. Their ancestors were either indians, who constructed pyramids respecting the laws of perspective; built palaces with stuccoed walls covered with frescos; knew mathematics; organized a calendar differing from ours in only 2/10,000 of a day**; and designed aqueducts; or Spaniards who crossed the oceans and conquered continents with dispair and courage.

Nowadays, indolence and alcohol may be an adaptative response to repeated

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* As per figures supplied by the Banco de Mexico, quoted in Asociación Nacional de la Industria Química, *La Industria Química Mexicana en 1968*, page 3. On 1960, the gross product per inhabitant reached 4,413 Mexican pesos, which, converted at the 12.50 pesos per dollar exchange rate, represented 353 dollars per capita.

** R. Mousnier, *Historia General de las Civilizaciones*, Ediciones Destino, Barcelona, 1959, Vol. IV, page 431.

frustrations and to unhuman living conditions. Both frustration and misery have been aching since long ago: since the sons of the noble Mexicas could reach high positions through the Calmecac*, while those of the macegua1s** had to resign themselves to the low culture of the tribal schools***; or since the hierarchs of the conquest became the "lords of America", while their troops were contrived to perform here and again, the same humble tasks of their Spanish forefathers and muffle their rebellion against an unequal distribution of the benefits resulting from an adventure in which they had risked their lives.****

Mingled with this desperate regard on their own inside, where the Malinche's ghost***** may be recognized, an untamed and unreasoning pride may also be tuned: the same pride that lead the Aztecs to belive that Huitzilopochtli****** would make them lords, kings of whatever existed all over, with uncountable vassals that would pay them tribute.*******

Many highly creative, sensitive Mexican groups in the public, professional and scientific sectors are trying to combine atavistic internal trends with foreign advanced modalities in adequate proportions. They are looking forward balance between gratuitious ludic activities and efficiency in doing. They have to continuously fight against selfishness among elites that, after the revolutionary period (1910-1920), re-started the possesive accumulation of wealth and also hopelessness and anguish among large masses of people that are still missing even the most elementary items for covering and feeding themselves.********

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* The school reserved for the nobility among the Aztecs.

** Plebeian indians.

*** Cosio Villegas, *op.cit.*, page 40.

**** *ibid*, page 49.

***** Malinche, an Aztec indian woman, was Hernán Cortés' interpreter, advisor and lover. Since then, "malinchismo" implies preference towards relations with foreigners.

****** One of the Aztecs' gods.

******* Cosio Villegas, *op.cit.*, page 32.

******** A few live and certainly neither difficult nor risky experiences allow for grasping contrasts in Mexico. For instance, one may visit Cocoyoc, a touristic unit in which each hotel room has a private swimming pool with mild water, in addition to a bathroom at full comfort. As a counterpart, one may travel on a streetcar from downtown Mexico to Xochimilco, or go accross Yucatán on a public bus.

Having one of the super-industrialized poles of the world as a neighbour does nothing but increase the contradictions. Everything favours the transfer of technologies based in Northern socio-cultural patterns, not always adapted to the local conditions. But, at the same time, the colossus' creative and production units are always at hand for the Mexicans to learn efficient managerial techniques and organizational models that may be useful for their country's development.

In Argentina, during the same period (1930-1975), oscilating policies antagonized elements that should have instead been integrated:

- urbanization and rurality
- industry and agriculture
- modernism and tradition
- science and empirism
- outward moves and internal life
- public sector and private interests
- freedom and control
- pleasure and efficiency

Nowadays, "every" Argentine has his own untouchable evolution model for the country in an almost continuous spectrum ranging between two ridiculuous extremes: the return to the "chiripá"* and the "charqui"** of the colonial times or the unrestrained copy of sophisticated foreign schemes.

Meanwhile, Argentina is waiting for adequate development patterns to fit new internal and external configurations. Twenty and some million europeanized, literate inhabitants, almost 2.5 million square kilometers of rich continental land and a mild climate seem to have been vouchsafed to Argentina by Nature and History for it to conduct a pilot experiment leading to a progressive social change through the imaginative design and application of new policy instruments appropriate to the country's scale and conditions: a Scandinavian-like experiment, now indigenously implemented in a Southern continental extremity.

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* "Chiripá" is the name of a piece of cloth hanging from the waist and with one end passing between the legs to be fastened at the front.

**Salted and sun-dried meat.

During the period of intensive European migrations to Latin America (1870-1930), the lack of political and economic stability in Mexico lead emigrants to prefer Argentina for their new settlements.

In spite of the above, the Argentine population did not grow as fast as the Mexican one, due, among other factors, to:

- less influence of medieval Spanish ideas on interpersonal relations
- an earlier struggle against illiteracy through an educational system that was open to liberal trends from its very beginning.
- a faster formation of a large middle class.

The Mexican and Argentine population figures differed very little by 1937 (18.7 and 14.1 million inhabitants respectively) and, 34 years later, they had become further apart, the former having reached 50.8 million and the latter only 23.7 million.*

Mexicans are now becoming conscious of the obstacles for development arising from populations disproportionate to their resources, but they are still having troubles in fully accepting the possibilities of individual and social progress offered by a responsible parenthood and in extending this concept to the masses, allowing them to differentiate, as elites do everywhere, the pleasure associated with recreational and relational sex from the burdens inherent to reproduction.

Meanwhile, the Mexican drama is featured by a population explosion among the poor and a consumption explosion among the rich.

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* OECEI, *Argentina Económica y Social*, Buenos Aires, 1973, pages 106 and 108.

CHAPTER III

THE CHEMICAL INDUSTRY IN ARGENTINA

A. EVOLUTION OF ARGENTINE CHEMICAL INDUSTRIES

Market

In Argentina, agriculture did neither grow along with industrial development or in advance of it. Fig. III.1. shows how slow-downs in the economic global growth correspond with still more critical slow-downs in the agricultural sector.

FIG. III.1. CONTRIBUTION OF AGRICULTURE TO THE G.N.P.

Increase of the gross product(1) (at 1950 factor costs and prices)		
Sector	1900 through 1929	1930 through 1961
Primary activities	+ 210%	+ 52%
Secondary activities	+ 370%	+ 154%
Terciary activities	+ 307%	+ 129%
Whole market	+ 299%	+ 118%

Yearly figures (at factor costs)		
	Million U.S. dollars	
	1940(2)	1969(3)
Agricultural production	572.7	527.7
Industrial production	410.7	1,219.1
Construction	65.5	164.5
Whole market	2,462.5	3,457.1

Sources:
(1) C.F.I. (Argentine Federal Council for Investments) and I.I.E.F.C.G.E. (Economic and Financial Research Institute, of the Argentine Entrepreneurial General Economic Confederation).
(2) Argentine Republic, National Executive Power, Secretary of Economic Affairs, *Productos e Ingresos en la República Argentina 1935/54*, Buenos Aires, 1956.
(3) Statistical Bulletin of the Argentine Central Bank.

In spite of the above, agriculture does still involve a large percentage of Argentina's active population due to its low productivity. (See Fig. III.2.). Besides, people quitting their agricultural jobs reinforce underemployment and the lumpen proletariat in urban slums.

While this evolution took place in Argentina, other primary producers and exporters increased their share in the international market and many industrialized societies reached self-sufficiency in their food supplies and even a surplus. This considerably reduced Argentina's participation for these products (Fig. III.4.), but, internally, agricultural exports remained as the main source of foreign currencies. (Fig. III.5.).

FIG. III.2. POPULATION DISTRIBUTION BY ACTIVITY SECTORS

	1947		1960	
	Inhab.	%	Inhab.	%
Total active population	6,267,313	100.0	7,524,469	100.0
Primary activities	1,654,280	26.4	1,392,522	18.6
Secondary activities	1,795,254	28.6	2,304,834	30.5
Terciary activities	2,616,878	41.8	3,076,195	40.9
Unknown activities	200,901	3.2	750,918	10.0

Source: 1947 and 1960 National Census

The above data plus that on agricultural yields (Fig. III.3.) are an indication of a primitive soil exploitation.

FIG. III.3. 1972 AGRICULTURAL YIELDS

Country	WHEAT 100 kilos/hectare	CORN 100 k/hect.	BEEF(1) kilos/head	MILK kilos/cow/yr.
Argentina	16.1	18.6	230.5	1,976
West Germany	40.6	47.8	228.3	3,909
France	45.7	45.8	202.8	3,445
Great Britain	42.2	--	241.4	4,057
U.S.A.	22.0	60.8	256.0	4,659

(1) Calculated on the basis of the number of heads slaughtered and the amount of beef produced.
Source: FAO, *Production Yearbook 1972*, Vol. 26, Rome, 1973.

FIG. III.4 ARGENTINA'S PARTICIPATION IN INTERNATIONAL AGRICULTURAL EXPORTS

	Year	%	Year	%
Wheat				
Argentina	1934/8	18.6	1963	4.3
South America	1934/8	19.1	1963	4.4
U.S.A.	1934/8	4.4	1963	40.7
Wool				
Argentina	1934/8	16.8	1963	7.7
Australia	1934/8	51.0	1963	44.4
Beef				
Argentina	1934/8	56.0	1954	19.8
New Zealand	1934/8	6.6	1954	11.4

Sources: FAO, *Yearbook of Food and Agriculture Statistics 1955*, Vol. IX, Part 2, Rome, 1956.
FAO, *Trade Yearbook 1969*, Vol. 23, Rome, 1970.

FIG. III.5. PARTICIPATION OF AGRICULTURAL PRODUCTS IN ARGENTINE EXPORTS

NAB Classification	1947		1973	
	US$	%	US$	%
I Products of the animal kingdom and live animals	306,279,000	23.9	712,519,000	21.8
II Products of the plant kingdom	734,465,100	57.3	985,689,000	30.2
IV Products from food industries	239,465,200	18.8	468,436,000	14.3
I + II	1,040,744,100	81.2	1,698,208,000	52.0
I + II + IV	1,280,209,300	100.0	2,166,644,000	66.3
Total Exports	1,280,209,300	100.0	3,266,204,000	100.0

Sources: -Year 1969: INEC (Argentine National Institute of Statistics and Census), *Boletín de Estadística de la República Argentina.*
-Year 1973: INEC, *Intercambio Comercial.*

NOTE: Group I includes the following groups: Live animals, meat, by-products and livestock wastes, dairy products, hunting and fishing products. Group II includes: cereals, flux, flour and wheat by-products, oleaginous seeds, fresh fruits and other agricultural products.

Before, a 1% increase in the gross product in industrialized countries used to bring along an approximately equivalent increase in the demand for raw materials and food from the low developed countries. Nowadays, the increase in the local production and in trading among industrialized countries has reduced such parallel demand for primary products to 0.5% for each 1% increase in the gross product.

However, if -as indicated in Paul Bairoch's works*- the exchange terms between 1880 and 1938 were generally favourable for the low-developed countries and allowed them to constantly increase their income on exports, we may wonder why did not industrial take-off occur before and why, when industrial production started, did not local capitals have a bigger share. The answer may be partially found in the fact that most of the income originated by exports did not remain in the country.**

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* Quoted by Pierre León, *Economies et Sociétés de l'Amerique Latine*, SEDES, Paris, 1969, page 329.

** See comments on capital drains out of Latin America in Chapter 10, Section B, of this report, page 197.

The rest of it was mostly devoted to sumptuary consumption and not to expand primary production or to install industries. On 1887, Argentina spent 10 million pesos in importing wines, while its public sector had to borrow 38 million worth the same money from foreign sources.*

Cultivated land still represents only 50% of the total area apt for agriculture. 4.6% of the farms are bigger than 100,000 hectares and cover 74% of the cultivated land, while 67% of the farms are smaller than 25 hectares.** Manv of the large estates have been cropped for 60 or 80 years, with little or no efforts made for maintaining or increasing their yields. On the other hand, the small farms are often located at marginal areas, with very weak production economies.

All this results in a poor consumer market, because the above structural unbalance runs along with an unbalanced income distribution. The average internal gross product was 1,723.8 U.S. dollars per capita on 1971***, but, since 50% of the population seized 80% of the income,**** the other half (approximately 12 million inhabitants) received an average of 689 dollars.

Credit and foreign investment

Argentina made use of the foreign credit sources as from the very beginning of its independent life. Already on 1889, the amortization and interest charges could not be covered with the loans received during the same year.***** Those charges represented 1.4% of the exports in 1956 and 22.1% of the same on 1962.******

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*Ramón García and María E. Dennis, "La Industria Química Argentina", *Industria y Química*, Vol. 28, No. 1/2, Buenos Aires, 1970. page 46.
**Bank of London and South America, *Monthly Bulletin*, Vol. VI, No. 94, Buenos Aires, October 1969, page 662.
***OECEI (Bureau for the Analysis of International Economic Cooperation) *Argentina Económica y Social*, Vol. I, Buenos Aires, 1973, page 46.
****CEPAL (Economic Commission for Latin America), *La Distribución del Ingreso en América Latina*, 1970. This data refers to analysis on income distribution performed on 1961. More recent studies, showing less detailed tabulations on income distribution than the former, indicate that the situation has not been significantly altered. (See: CEPAL, *Estudio Económico de América Latina*, vol. III, 1973, pages 672 and fol.). That is why I have dared applying the 1961 income distribution figures to the national gross product in 1971.
*****Ramón García and María E. Dennis, *op.cit.*, page 46.
******Pierre León, *op.cit.*, page 333.

Within a first step (1870-1945), private foreign capitals preferred to invest in enterprises winning products from the soil, exporting agricultural products or supplying public services. A glance at the facilities remaining from this period produces a sensation of transitoriness. Railroads have one-way, narrow gauge tracks and look like having been designed for the transportation of products from temporary sources and not for permanent traffic. In forest exploitations, land is used up and then abbandoned.

Within a second step, after 1945, the public services pass on to the Government's hands and foreign investments turn over to import substitution.

During the first period, small chemical industries appeared as a result of the work of pioneers, either native or coming from abroad to found a new home in Argentine land. They responded to local needs and were installed under conditions that were as precarious as those pointed out for foreign investment. Only a few survived the above mentioned period. The first branches of large chemical corporations with headquarters in Europe and in the U.S. started to be founded as from the second decade in this century. They set up brand new installations, purchased some of those surviving the pioneer step or associated with the owners of the latter.

- On 1914, the French enterprise L'Air Liquide founded La Oxígena, for the production of industrial gases.
- Imperial Chemical, from Great Britain, started its operations on 1928, in cooperation with a local firm, Bunge & Born. Some years later, the association splitted and Imperial Chemical joined the American corporation Du Pont for implementing new projects between 1935 and 1953.
- On 1928, Corn Products Co., of the U.S., purchased Refinerías de Maíz.S.A., which had been operating at Baradero, Province of Buenos Aires, since 1913.
- On 1932, Rhone Poulenc, from France, started its operation in Argentina.
- Pechiney-Saint Gobain, another French firm, did the same in the fifties, associated to a local project whose development had started on 1941.
- The Argentine affilliate of Monsanto Chemical from the U.S. was founded on 1954.

These foreign investments generated the main chemical enterprises still present in the Argentine market: Duperial, Ducilo, Electroclor, Cía. Química, Indupa, etc.

Simultaneously, Fabricaciones Militares, the military-industrial complex, started installing its own chemical plants and supporting initiatives of national investors, like Atanor (1938) and Grassi (1940).

As from 1944, the State-owned petroleum corporation, Yacimientos Petrolíferos Fiscales, did also make a few attempts to diversify from the purely petroleum refining into petrochemistry.*

The Industrial Bank (now called National Development Bank), created on 1944, should have become an instrument so as to orient credits towards local investment efforts. However. it did soon start suffering a typical deformation appearing in many developing countries: its resources were applied to increase stocks and to speculative objectives, rather than to expand and modernize the equipment. That was how, on 1959, 56% of the money lent by such bank served fo finance current expenses to the detriment of loans for investments in fixed assets.**

Credit policies favoured terminal industries more than basic industries and were not used as an instrument for promoting an equilibrated regional development.

The Argentine growth (1870-1914) emptied the inland from its wealth and population and accumulated both of them in the littoral and, very specially, in Buenos Aires, the capital city, since 1880.***

The railroad was not outlined as per the need for uniting the various regions. It aimed to drain products from the interior to the river ports. Buenos Aires ressembled an octopus, extending its tentacles through the

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* Neither the list of foreign investments nor that of local ones are supposed to be exhaustive.

** Data collected from a non-published paper prepared in the Bank, on its evolution during the 1950-1969 period and its prospects for 1970.

*** 36% of the Argentine population lives in Buenos Aires and its surroundings, that is in the urban conglomerate known as the "Great Buenos Aires", covering 0.1% of the country's territory. See: OECEI, *op.cit.*, page 112.

railway tracks to suck the grains and cattle from the nearby wet pampa and to pick up other commodities from a few more distant places. But it was hard for the Northern regions to communicate with the South and for the Eastern provinces to directly link with the Western ones.

The isolation of the inland from technological and economic progress has further reduced the intrinsically small market, while the seclusion of one region from the other hindered the distribution of products.

Following the above infrastructural patterns, the first large installations in the chemical industry were set up around Buenos Aires, along the coast of the Paraná and La Plata rivers.

During the fourties and the fifties, some industrial complexes developed in the central Province of Cordoba -promoted by Fabricaciones Militares-, while a few other profited from the hydraulic energy available at Mendoza in the West and at Rio Negro in the South, or from the natural gas and petroleum sources in the far South(Province of Chubut) or in the extreme North (Provinces of Salta and Jujuy).

It is not until the sixties that ideas arise, at least in the public sector, on development poles looking forward the consolidation of the national geographical space by means of a more equitably distributed industrial network.

<u>Custom protection and industrial promotion</u>

The struggle towards obtaining custom regulations protecting the local industrial activities started by the end of the last century.

As from the first Argentine Industrial Fair (Córdoba, 1871) and, even more, after the foundation of the Unión Industrial (Association of Industrial Entrepreneurs - 1887), two neatly opposed schemes of development began showing their profiles. One was mainly based on the extensive exploitation of the richest agricultural land and the production of agricultural surplus with which the imports of manufactured goods could be paid. The other one looked for the local transformation of natural resources and for the substitution of industrialized imported items.

Instead of finding the complementarities in both models, their supporters fought with eachother and are still fighting and submitting the economy of the country to disequilibrating oscillations.

It is interesting to quote some comments of an American consulting engineer who worked for the Argentine chemical industry in the twenties.*

> The Argentine is practically a free trade country on salt and on many other industries which would flourish under a protective tariff, and much salt comes in from Cadiz.
>
> Textile dyeing here is an exasperating joke, to the industrial, but is satisfactory for European industrials. It is cheaper to import dyed yarn, because the duty on the dyed is less than on the undyed.
>
> Even the cotton would have to be imported, because that industry is not protected, and those who have planted cotton are going over to other crops. The Southern (U.S.) cotton planters should pass a vote of thanks to the present (Argentine) powers that be, in this country, for non protecting their own cotton industry.
>
> Ethylene dichloride will be used here some day in shiploads, because linseed and cotton seed and peanuts will be industrialized here -but not yet, because there is no customs protection, the secretary for that department being quoted as saying: "Any industry which requires protective duties, for its development and success, is artificial, and should not exist". It's a good thing that he was not one of the early congressmen of the United States.
>
> For patent medicines, the Argentine is a paradise. There are no regulations controlling this industry and the most fantastic advertisements are published, read, and believed. If there are any of the old line of American meditine men left, they should all come down here. This should be contrasted with the fact that the Argentine surgeon is looked up to in all parts of the world.
>
> I urge all purveyors of new drugs to come to this field. The sky is the limit, prices are high, no government control of advertisements or quality of drugs, and as the climax, a nation which eats heavily, enormously. It is not unusual to see a party of ten dining together, with a medicine bottle in front of each plate -and sometimes two!

There is only a single possitive case mentioned by Mr. Lamb in his article. It refers to a protectionist sector policy that would have contributed to the local manufacture of perfumes.

> The duties and internal revenue tax and even the inter-state taxes are now so high that all the European makers are building branches here and finding that just as good products can be made here as in Europe.

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* Mark R. Lamb, "What a reader of this Journal thinks about", *Industrial and Engineering Chemistry News Edition*, October 10, 1927, page 3. The brackets are mine.

On 1914, the Unión Industrial attempted to obtain the vote by the Congress of a series of legal instruments protecting the national industry. Among other things, they requested that "preferences should be given to the consumption of locally produced goods by public agencies". This program was not even discussed dut to "lack of time".*

On 1916, it was more precisely suggested that the law by which the government's budget for the year had to be approved should include a statement binding the public sector to the use of locally manufactured goods, except for those cases in which their prices exceeded those of imported goods in more than 5%. It was neither approved.*

Only on 1922, the Federal Government issued a decree by which "the bids called for by public institutions should consider the quotations of foreign products with the inclusion in their prices of the custom duties, every time a bidder is present offering locally-manufactured similar or equivalent items".**

The first comprehensive promotional policy goes back to 1944 (law 14630/44) and sets up additional customs duties and import quotas for products that were being manufactured in the country. On the other hand, free way was given to the imports of raw materials and equipment for the installation and expansion of those industries declared as of "national interest".

This policy was maintained during the two five-year plans of Perón's first ruling period (1946-1955). The second plan indicated that, in the production of socio-economic or defense essentials, the State would conduct industrial activities by itself, asking for the cooperation of other interested organizations when pertaining. The fundamental objective was the foundation of the heavy industries: iron and steel, basic chemicals and non-ferrous metals.

Later on, under different ideological orientations, other industrial protection and or promotion instruments were designed:

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* Ramón García and María E. Dennis, *op.cit.*, page 49.

** *ibid*, page 50.

-Law 14780 (1958) promoting foreign capital investments in the form of equipment, technology and/or foreign currencies, through exemptions on custom tariffs, exchange duties and/or internal taxes.

-Law 14781 (1958) for industrial promotion.

-Law 18587 (1970), revoking the two former and replacing them by a single legal instrument, sumultaneously establishing special promotion policies and defining the conditions under which foreign investments could be made. This law introduced sector and regional promotion and indicated that the National Executive Power was able to adopt the following measures:

a) Establish, decrease or increase import duties and also issue exemptions.
b) Prohibit the imports of certain items.
c) Grant tax exemptions and/or vacations.
d) Sell State-owned properties at promotional prices and conditions.
e) Grant subsidees.
f) Award preferential credit conditions.
g) Use the purchasing power of the public sector, giving preference to local goods.
h) Create and/or promote industrialized areas in those places defined by the law as "Development Poles".
i) Promote exports of industrial products.
j) Develop scientific research and experimental development services; organize technical assistance to enterprises and control technological transfers from abroad.
k) Invest in industrial projects by itself or in cooperation with the private sector.

Regarding foreign investments, the regime had two main characteristics: previous authorization by the State was required and profits became freely transferrable. The modalities for capital repatriation were to be fixed for each particular case.

On 1973, those instruments were again modified:

-Law 20557, on foreign investment, maintained the obligation to ask for previous authorization, but such permission led to a contract that had to be approved by the Congress, in case the foreign capital share were over 50%. Besides, the percentage of profits that could be drafted abroad was limited to a rate not exceeding either 12.5% or that paid by banks, in the country of origin and in its currency, on 180-day fixed-term deposits plus 4%, whichever was higher. As far as investments made previous to this law, a special tax was issued on their profit transfers, but investors willing to submit to the new law would be exempted from this tax.

On the other hand, new foreign investments were forbidden if:

a) involving limitations on exports;
b) non submitting to the Argentine court for tentative controversies;
c) dealing with activities connected with national defense, public services, insurances, commercial banking, financial activities, mass communication means, internal marketing services, agricultural or forestal exploitations, except when introducing new technologies of special interest for the country, and fishing, except when opening otherwise closed markets to the national products; and
d) procuring participation in national enterprises of local capital.

-Law 20560 maintained industrial promotion by means of direct participation by the State; preferential credit conditions; financial backing by the State to private undertakings looking for external loans; tax reductions, exemptions or vacations; price reduction on inputs supplied by State enterprises or agencies; subsidees; technological assistance; etc. It is more strict than the previous one in the search for regional equilibrium, since it prohibits the installation of new industries in the City of Buenos Aires and excludes from the above promotional policies those located at less than 60 kilometers from such urban center.

From the last instruments, the State neatly emerges as a direct producer and as a regulating and control agent applying custom and credit mechanisms for promoting investments

Knowledge

Argentina has still been unable to create a common culture among scientists, engineers and entrepreneurs, so as to allow for cross fertilization among universities, research and development institutes; consulting and engineering firms; and industries.

The process industry was formerly empirical, national and small. It grew with the introduction of foreign capital and technified through the use of technologies developed abroad. When the State and some strong local capitals came into the picture, the national contribution to the activity in this sector became more and more important, but technologies kept being imported.

At the beginning, both capital goods and engineering, construction and assembly services were purchased abroad. Local engineering and construction services started being incorporated little by little, beginning by civil engineering and construction and always profiting from lower local engineering costs.

Civil engineering, as a career, started being followed since very early,* mainly by the sons of well-to-do families, connected with the large fortunes arising from agricultural exploitation. These first engineers formed a constellation of brilliant structure calculists, while only a few became interested in the industrial business.

The new technical professions that arose from the industrial revolution in Europe and from the development of the United States were shyly introduced and did never reach the degree of coherence and the level of excellence of civil engineering.

For instance, mechanical engineering, incorporated to the programmes of the Engineering School of the National University of Buenos Aires on 1882, was suppressed on 1917 because "the engineering branches whose fields of action are based on the various extractive industries applied to the natural resources deserve preference as compared with those related with the final and supplementary manufactures more deeply rooted abroad and better fitted

* The first civil engineer received his diploma on June 3, 1870.

to the endowment of production factors in foreign countries."*

These newer careers were preferred by the sons of immigrants. Since their middle-class families had not been in the country for long, it was hard for them to make important connections with the country's economic and political sources of power and with foreign financial sources supporting local industrial installations.

When a rich family and a high level of training back an innate capacity, the professional is often encouraged to attempt for a favourable modification of the conditions under which his profession is exercised. In those cases in which professionals coming from wealthy families are not so sharp nor well-trained, they may prefer to abandon the profession and not to accept highly dependent working conditions; they know that their connections and fortune will allow them to find a well-paid substitute. On the contrary, those professionals with a modest origin, when facing difficulties in the professional market, tend to migrate or are forced to become alienated in structures where they are frequently missused.

That was how, at the time of Argentina's industrial take-off:

- local independent architecture and civil engineering and construction enterprises were available, while chemical or mechanical engineering firms had not yet been founded.
- foreign enterprises granted good contracts to the former, when building their chemical plants in Argentina, but preferred to create their own engineering departments, hiring local chemical and mechanic engineers for performing the detailed engineering of the processes.

During working peaks resulting from an increased number of chemical projects, production enterprises supplemented the services of their own engineering departments with those procured from local branches of the same process engineering firms serving their headquarters. Those branches were installed profiting of the same abundance of cheap technical labour that had induced the production enterprises to build their own local engineering departments.

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*This paragraph belongs to the report on which the decision was based and was quoted in a mimeographed publication on study programs issued on 1973 by the School of Engineering of the National University of Buenos Aires. Mechanical Engineering was re-established as an independent and separated career on 1953.

They did not intend to promote their services only among the transnational production enterprises installed in the country, but also among the largest local firms, specially those state-owned, which were known as making important "turnkey" agreements.

With very few and limited exceptions, there are no engineering firms or technological development centers able to convert the basic knowledge on a certain process into preliminary engineering, by means of an adequate experimental development, adapting such knowledge to the local conditions. Important and organized efforts towards the generation of basic knowledge on new chemical processes are also missing.

The Argentine chemical and petrochemical industries are strong procurers of foreign technologies (basic knowledge plus preliminary engineering). Research and experimental development in the enterprises are mostly devoted to the optimization of the processes in use. The creative units in the public sector tend to search for "pure" scientific knowledge rather than to develop usable technological knowledge or to use the latter by means of engineering.

One of the first Argentine engineers stated: "We have started by cultivating the exact and natural sciences at a time in which the nation had a need for the application of such knowledge and not for its advancement".*

The traditional Argentine landed classes were never enthousiastic about production diversification or innovation.

During his visit to Argentina, on 1969, an agricultural consultant from New Zealand, Mr. Campbell P. Mc Meekan, made the following funny comments:**

> 31 years ago, the Argentine Rural Society and the Argentine Meat Corporation invited me to visit this marvelous country. I gave advice to its producers so as to export 10 million heads of sheep per year. Fortunately, they did not follow my advice and New Zealand is nowadays exporting 22 million heads.

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* J. P. Romagosa, in a lecture given on 1899.- Quoted by J. P. Babini, "Breve historia de la Facultad de Ingeniería", *La Ingeniería*, Year LXXII, No. 1011, Buenos Aires, 1970, page 31.

** Newspaper *La Nación*, Section 2, Buenos Aires, May 31, 1969, page 3.

> 31 years later, while visiting dairy farms, I dare giving a similar advice, hoping they are paid the same attention as the previous one, so that New Zealand will not encounter the development of Argentine production as a hindrance.
>
> In my country -he added- every farmer has taken, at least, some university studies. There is no need for large investments to make a dairy farm technically adequate. Fundamentally, brain and imagination are needed. Without these attributes, the mere presence of capital is not enough.

On the other hand, Argentine industrialists look preferentially abroad for scientific and technical support. Global characteristics of Argentine culture and particular defficiencies in their formation as administrators, may be recognized as influencing such attitude.

A research work performed on 1960* shows that, among the managers and administrators of the chemical industries included in the sample:

- -22.8% had university studies (only 11.2% having graduated)
- -43.8% had only secondary studies (17.6% had finished secondary school)
- -33.4% had only primary studies (21.9% had finished primary school)

The situation among technicians, foremen and qualified workers, as per a sample from different industries, may be seen in Fig. IV.6.

As far as workers are concerned, all opinions coincide in praising their capacity for adaptation to new jobs and for learning new skills. Those of us who have had to install and start the operations of industrial units in semi-rural environments know how easy it is for workers to start operating complicated equipment and delicate control pannels, even though a few months before they only knew of the coarse work involved in farming. Among other factors, the low percentage of illiteracy** in the Argentine population may account for this aptitude and ability.

Returning to the historical testimony of Mark R. Lamb, the American consulting engineer mentioned before, we may find a reference to this subject:***

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* Alberto Aráoz, *Los Recursos Humanos en la Industria Argentina,* Instituto Di Tella, Buenos Aires, 1967.

** 8.5% on 1960, BID, *Progreso socioeconómico en América Latina,* Washington 1970.

***Mark R. Lamb, "Chemistry in Argentina", *Industrial and Engineering Chemistry News Edition,* July 20, 1927, page 3.

FIG. III.6. PERSONNEL EDUCATIONAL LEVEL IN ARGENTINE INDUSTRIES

	Years of Schooling (average)	Unfinished prim.school %	Unfinished second.Sch. %	Completed Sec.School or plus %
<u>Data for 7 enterprises 1966/1967</u>				
Highly-qualified workers	8.2	20.5	67.4	12.1
Same up to 25 years old	10.2	4.9	65.4	29.7
Foremen	9.6	13.1	53.2	33.7
Same up to 35 years old	11.1	5.8	41.3	52.9
Technicians	12.0	1.7	34.6	63.7
Same up to 25 years old	12.7	0.0	23.3	76.7
<u>Data for the country 1960</u>				
Technicians in all industrial branches	....	11.7	28.7	59.6
Technicians in equipment manufacturing industries	...	6.6	27.1	66.3

Source: Alberto Aráoz, *El cambio tecnológico y la preparación del personal medio en la industria argentina*, CINTERFOR (Interamerican Center for Professional Formation), Montevideo, 1967.

> One of the clauses which was considered most important in the first contract* obligated our engineer to remain four months to instruct the personnel, and to stay longer if required. This clause was based on an unfounded fear, since the employees of the Department were very soon doing better with the plant than the temporary American crew. In the new plant**, the old crew made short work of getting to capacity in seven days, to the delight of everyone concerned.

Argentine universities, submitted to the destructive tensions induced by successive political crisis, have not been able to form stable and high-level teaching and research teams. On 1974, Chemical Engineering was being taught at 14 engineering schools, but most of them did not have the necessary equipment for laboratory or pilot scale experimental work. Besides, except for some chairs of a singular level and orientation, teaching was repetitive and descriptive, and not enhancing creativeness.

Some figures will serve to show the structural weakness of the Argentine scientific and technical system and of its relations with the industrial sector.***

- -The total investment in research work is very low and did only represent 0.28% of the national gross product in 1968. On 1964, France reached 1.6%, Canada 1.1%, Japan 1.4%, the URSS 2.4% and the U.S. 3.4%.
- -The ratio between the number of scientific research workers in the public sector and the total population is also low: 4 to each 10,000, as compared with 15 in Yugoslavia, 37 in France and 91 in Checoslovaquia.
- -Most of the scientific research workers in the public sector (approximately 2/3 of the total) do not work on a full time basis.

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* He refers to the first contract signed by the company for which he worked with the Sanitary Works Department of the Argentine Government for the installation of a sulphuric acid plant in Buenos Aires.

** On 1927, the enterprise for which Mr. Lamb was working installed a second sulphuric acid plant for the same Governmental agency.

***Sources: -*Potencial científico y tecnológico nacional*, Argentine Council of Science and Technology, Buenos Aires, 1971.
-Alberto Aráoz, "Aspectos cuantitativos de la Ciencia Argentina", *Ciencia Nueva*, III, No. 16, Buenos Aires, May 1972, page 6.

- -Most of the research centers have not reached an adequate quantitative level as far as personnel and equipment units are concerned. As per the 1969 survey, 56% of the institutes had less than 10 scientists and the average of 13 scientists per institute is reduced to only four if personnel is considered on full-time equivalent basis.
- -Production enterprises are spending about 100 million dollars a year in technology imports and would have spent only 3 million dollars in research and development in 1968. The latter figure is to be carefully considered, because this item does often include expenses incurred in simple experimental work performed on existing installations towards solving manufacturing problems (trouble-shooting).
- -The public sector only devotes around 10% of its total research expenses to the engineering sciences connected with industrial and infrastructural works.
- -The expenses incurred in extension, that is, in promoting the utilization of knowledge, is only 7% of the total current expenses of the institutes dedicated to research work in the engineering sciences.
- -The Buenos Aires City area concentrates over one third of the research and development teams and about one half ot the total current expenditures in scientific and technological activities. The Pampean area, strongly developed and urbanized, follows Buenos Aires in importance, with 20% of the teams absorbing 20% of the national expenses. The other half of the teams is scattered all over the country, supported by only 30% of the public budget for current expenses in research and development.

Raw materials

Because of its large territory and its extension in the North/South direction (from paralel 21 to 55), with the resulting diversified climates, Argentina was gifted with a great variety of natural resources.

The North is rich in woods and forests and in many tropical and subtropical crops, such as tobacco, sugar cane, tea, tung, manioc, cotton, pineapple, citrus, mate, etc.

The Pampean area allows for easily growing cereals, pastures, legumes, vegetables, oleaginous seed plants, etc., with no need for irrigation. This area involves field raising of a huge livestock population.

The semiarid West and some valleys of the Southern plateau are apt for producing grapes, drupes and pomes under irrigation, while the Southern steppes (Patagonia) may feed millions of sheep.

The extense epicontinental seas are rich in a great variety of fish, crustacea and algas.

As far as mineral resources are concerned, Argentina does with important reserves of petroleum; natural gas; hard-to-coke coal; uranium, lead, manganese, zinc, copper, tungstene, iron ores, limestone, fluorites, salt, gypsum, sulphur and borates. as well as with lesser amounts of a large number of other minerals. It must also be noted that large areas on the Andean mountains and on their spurs, that may have rich subsoils, have not been fully explored as yet.

Following universal trends and based on pure microeconomic considerations, Argentina has shifted many of its chemical processes from the use of renewable resources to raw materials such as petroleum and natural gas. For instance, acetone and butanol, formerly produced through the fermentation of some startch-containing grains, are now being obtained by means of petrochemical processes. Soaps, from animal fats, have been largely substituted by synthetic detergents. Wood is scarcely taken into account as a source of chemicals. Neither is the hard-to-coke coal. On the other hand, the irreplaceable fossil fuels, mainly petroleum and natural gas, are indiscriminately burned in purely consumptive ways, specially in the urban areas, without making the countryside benefit with electricity. The hydroelectrical potential of the great rivers (Parana and Uruguay) and of the mountain streams is only beginning to be considered as an alternative energetic source along with nuclear power.

In the country once considered "the granary of the world", rich in a great variety of products from the plant and the animal kingdoms, neither the agro-chemistry nor the silvi-chemistry are developed. About 20 years ago, the first School of Agricultural and Industrial Chemistry in South America, founded in the Argentine province of Santa Fe on 1917, shifted into a classical School of Chemical Engineering, following the patterns in force in industrialized countries.

This should not be understood as criticizing the evolution of engineering formation and techniques. On the contrary, in order to develop or select technologies fitted to the particular environmental conditions and resources of Argentina, a Technology to Scale approach* must make use of advanced engineering instruments for design and evaluation, but:

- with the eyes on the surrounding landscape and the feet firmly stepping on local grounds;

and

- promoting the progressive transformation of landscapes and grounds for the benefit and with the participation of the populations settled on those grounds and surrounded by those landscapes.

* See the author's report *Engineering and Pre-Investment Work*, Chapters II and III.

B. SITUATION IN 1972/74

The yearly accumulated growth of the demand for chemical products, measured in U. S. dollars and at the 1972 prices, surpassed 15% between 1966 and 1972 and was estimated to be above 10% per year between 1973 and 1980.

On 1972, the demand, reaching 450 million dollars, was mainly satisfied by domestic production: only 22% was imported. As it may be seen in Fig. III. 7., chiefly intermediate and basic products were being imported on 1973. In Fig. III.8., global figures are supplied for some sections of the custom's nomenclatures, while Fig. III.9. provides the total imports and exports as per three large titles of the same classfication for two years: 1968 and 1973.

When these two years are compared with eachother, we may observe that, although unit values for both imports and exports of chemicals (title VI) have increased, the percentual increase of the latter (136.8%) is much higher than that of the former (32.4%). This would result from a series of combined factors: exports of products with a higher aggregate value; a more firm attitude in the negociations and closer control of over-invoicing in imports and of under-invoicing in exports. I dare say that the factor with a stronger influence was the first one.

On 1973, Argentine chemical and allied process industries encompassed a total of approximately 327 enterprises*, among which 67 were preferentially vinculated with basic, intermediate and final petrochemical products. A few other dealt with inorganic acids, bases and salts or with the extraction of metals from minerals.

The remaining majority of the 327 firms was not connected with the production but with the utilization of chemical products, through operations that do not imply further changes in composition at the molecular level.

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* The figure was obtained by adding the 187 member enterprises of the Cámara de la Industria Química (Argentine Association of Chemical Entrepreneurs), plus the 157 members of the Cámara de Industrias de Proceso de la República Argentina (Argentine Association of Enterprises in the Process Industry Field), and deducting the 17 firms members of both. The largest and most important national and transnational chemical firms are members of the association mentioned in the first place, while the latter reunites mostly small entrepreneurs in the chemical and related fields. The entrepreneurs in other process industries, such as the pharmaceutical, rubber, plastics and food ones, are separately associated.

FIG. III.7. ARGENTINE IMPORTS OF PRODUCTS FROM CHEMICAL AND SOME RELATED PROCESS INDUSTRIES (1973)

P R O D U C T	MILLION US$ CIF	AVERAGE UNIT CIF COST US$/KILO
.Phosphorus	1.5	0.65
.Sodium hydroxide	4.5	0.1
.Aluminum hydroxide	1.0	0.11
.Artificial corundum	1.0	0.30
.Sodium carbonate	10.0	0.07
.Sodium bicarbonate	3.5	0.29
..Xylenes**	2.7	0.14
.Saturated acyclic monoalcohols from C_7 to C_{13} inclusive	3.0	0.28
.Glycols and glycol ethers, including pentaerythritol	5.4	0.29
.Formic acid and its salts	1.0	0.26
.Vinyl acetate	1.5	0.21
.Acrylic and metaacrylic acids, their salts and esters	3.6	0.46
.Nylon intermediates (adipic acid and its salts, hexamethylene diamine and caprolactam)	20.1	0.59
.Amino alcohols	1.2	0.91
.Amino acids	5.9	1.7
.Acrylo nitrile	1.6	0.34
.Isocyanates	4.1	0.76
.Derivatives of pyrrole, imidazole, pyrimidine, pyridine and other cyclic compounds of pentagonal or hexagonal rings and one or two nitrogen atoms	8.2	20.5
.Drugs deriving from quinoline and purine, including caffeine	2.6	12.88
.Other alkaloids	4.1	263.67
.Ascorbic acid	1.3	5.21
.Sulfa drugs	3.1	26.71
.Steroid hormones	2.2	5,875.74
.Natural and synthetic glycosides	1.7	174.71
.Antibiotics	9.3	318.38

P R O D U C T	MILLION US$ CIF	AVERAGE UNIT CIF COST US$/KILO
.Sodium nitrate	0.9	0.08
.Urea	1.0	0.15
.Superphosphate	3.1	0.08
.Ammonium phosphates	4.9	0.13
.Potassium chloride	0.7	0.06
.Oleoresins and their derivatives	3.3	0.40
.Antioxidants and other oil additives	5.4	0.60
.Antiknocks	5.9	0.83
.Phosphoreted organic derivatives used as disinfectants, herbicides, fungicides, raticides and antiparasitic drugs	2.6	1.78
.Miscellaneous products*	22.2	0.50
.Polyester	1.2	2.5
.Polyethylene	9.4	0.33
.Polypropylene	3.3	0.37
.Vinyl polymers	3.3	0.61
.Cellulose derivatives	2.1	0.82
.Natural rubber	20.2	0.63
.Synthetic rubber	10.3	0.63
.Rubber products including some type of tires	3.0	2.4
.Synthetic dyes	9.4	5.9
.Titanium dioxide	6.0	0.53
.Polychromatic photographic films of instantaneous development	1.7	24.81
.Polychromatic cinematographic films	2.1	17.72
.Papers, cardboards and fabrics sensitized to reproduce polychromic images	1.4	9.28
.Cinematographic films already developed	1.0	33.43

Source: INEC.

* In this position of the custom's nomenclature, many different products are included such as catalysts, propylene derivatives, sealers, modified starches, compounds used in xerography, antioxidants for rubber, etc. The lists of miscellaneous are enormous. In one and the same item, more than 70 various, non-chemically-related products may be found. On the other hand, some items in the same section refer to only one type of products like enzymes, which could have been included among organic products.

**On 1973, the plant now producing aromatics had not yet been started.

NOTES: The above list includes those process industries derived products whose imports amounted to at least one million dollars, with only two exceptions. Pharmaceuticals, other than some fundamental drugs, metallurgical and food products have not been analyzed.

-In Argentina, import statistics may be read directly in dollars.

FIG. III.8. ARGENTINE IMPORTS: GLOBAL FIGURES FOR SOME SECTIONS OF THE CUSTOM'S NOMENCLATURE RELATED WITH CHEMICAL AND OTHER PROCESS INDUSTRIES (1973

Section		CIF VALUE MILLION US$
28	Inorganic products	35.5
29	Organic products	155.2
30	Pharmaceutical products	7.9
31	Fertilizers	11.9
32	Tanning and dyeing extracts, dyes, paints, varnishes, inks, etc.	18.5
33	Perfumeries, toiletries and cosmetics	2.5
34	Soaps, detergents and cleaning products	4.5
35	Albuminous materials and glues	0.9
36	Gunpowders and explosives	0.6
37	Photographic and cinematographic products	11.7
38	Various products of the chemical industries	49.4
39	Synthetic plastics, cellulosic ethers and esters, synthetic resins and manufactures made with those materials	38.0
40	Natural and synthetic rubber and rubber manufactures	37.0
48	Paper, cardboard and manufactures made with pulp, paper and cardboard	62.2
73*	Pig iron, iron and steel	414.0
74*	Copper	59.2
76*	Aluminum**	48.8

Source: INEC

* These sections, in addition to raw metals, include products manufactured by their mechanical working.

** The electrolytic aluminum plant, now in operation, was not yet producing on 1973.

FIG. III.9. EVOLUTION OF ARGENTINE FOREIGN TRADE IN PRODUCTS FROM THE CHEMICAL AND OTHER PROCESS INDUSTRIES

BRUSSELS CUSTOM NOMENCLATURE	TONS		TOTAL CIF VALUE THOUSANDS OF US$		UNIT PRICE US$/TON	
	1968	1973	1968	1973	1968	1973
	IMPORTS					
VI Products from the chemical and allied process industries	464,500	651,682	160,682	298,626	346	458
VII Synthetic plastics and resins, cellulosic ethers and esters, natural and synthetic rubber and manufactures made with these.	61,900	112,768	42,252	74,974	683	665
XV Common metals and manufactures made with same	1,085,300	2.411,920	199,758	548,636	184	227
	EXPORTS					
VI Same as above	186,000	138,813	48,036	84,820	258	611
VII Same as above	10,700	30,985	6,627	20,053	619	647
XV Same as above	256,300	588,682	32,490	137,892	126	234

Source: INEC

Notes: -Important titles covering products from process industries, such as pharmaceuticals and food, have been left aside. Their complexity would merit a separate analysis.

-Titles VII and XV include both products from process industries (metals, resines, polymers) and those obtained from their mechanical transformation)

The state-owned petroleum enterprise (YPF - Yacimientos Petrolíferos Fiscales) ranges among the 100 with highest sales in the world. 12 private Argentine firms, together with 29 in Brazil, 3 in Mexico and 1 in Colombia, all of them manufacturing chemical and petrochemical products, fertilizers and paints, range as top in sales figures within Latin America.*

The most important enterprises are affiliates of transnational corporations, which started substituting imports of final products and are gradually completing their production lines with some intermediate products. Nevertheless, many intermediates, such as the components of nylon, are still being imported.

On 1973, among the first 150 sales-ranking enterprises, 16 could be identified as chemical or petroleum refining industries. Fig. III.10 shows how state-owned enterprises, affiliates of transnational corporations and local private firms, among those leading enterprises, share that market.

FIG. III.10. MARKET SHARES AMONG LEADING ARGENTINE CHEMICAL ENTERPRISES (1973)

CATEGORY	ENTERPRISES		TURNOVER	
	NUMBER	%	MILLION US$	%
TRANSNATIONAL CORPORATIONS	11	68.7	874.9	36.7
STATE-OWNED ENTERPRISES	1	6.3	1,343.1	56.4
LOCAL PRIVATE FIRMS	4	25.0	165.2	6.9
T O T A L	16	100.0	2,383.2	100.0

Source: *Mercado*, VI, No. 263, Buenos Aires, August 8, 1974, pages 112 and 113. I have classified the enterprises in the three above categories as per my own criteria and based on my knowledge of the Argentine chemical sub-sector. The figures in Argentine pesos have been converted to US dollars at a rate of 10 A$ = 1 US$.

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* *Procesos*, Buenos Aires, Vol. XIV, No. 78, page 15.

Local private capital is split into a large number of small firms mostly devoted to the production of final chemicals (polymers for spinning, resines for plastics, solvents, etc.) and, above all, of market terminals (consumer or endurable goods obtained from final chemicals). Its participation in the production of basic or intermediate chemicals or metals is very scarce, except for some special cases, such as the production of aluminum.

In the latter case, the State's regulating and control power was used to incentivate investments of domestic private capital in the production of a basic product, making it as attractive as business in mass consumption goods.

The State is the only supplier of raw materials, such as natural gas, petroleum, coal and sulphur, and could also become the main supplier of basic products through its participation in aromatics and ethylene projects underway, some of whose facilities are being finished.

The only state-owned enterprise in the sample of leading firms (Fig.III.10.) is YPF, dedicated to the exploitation, transportation and distribution of petroleum and of its mass-consumption derived products (gasoline, fuel-oil, etc.). Its presence originates an exceptional share of the public sector in the market of chemicals. However, it must be taken into account that the investments required by this enterprise for locating and developing the fields and for further transporting the raw materials to the transformation and consumption centers are much larger than those demanded by enterprises manufacturing chemical products using petroleum and its derived products as inputs. In addition, the former often sells its products at social prices that keep no relation with actual production costs. For this reason, its high rank in the total sales volumes of the 150 leading enterprises does not always mean a corresponding high individual profitability.

YPF had fixed assets for 5,430 million Argentine pesos, considered at their original value, plus accounting readjustments, as of December 31, 1971. As of the same date and under identical accounting conditions, a private petrochemical enterprise manufacturing final chemical products showed fixed assets in its balance sheet for only 211 million pesos. However, while YPF had sales registered for 4,250 million pesos and a profit of 19 million pesos, the private enterprise sold, during the same year, 307 millions, with a profit of 46 million pesos.*

If, instead of considering the group of leading enterprises, we analyzed the total number of enterprises in the petrochemical field as of July 1974, as per data collected at the Argentine Secretary of Industrial Development**, we could have the following picture:

a) there were 22 enterprises producing basic and intermediate petrochemical products, among which:
   - 13 were controlled by transnational corporations;
   - 5 were national, and, among these, 2 were controlled by the State;
   - 1 belonged to a transnational corporation with main headquarters in Argentina.
   - 1 appeared as controlled by Argentine groups, but with a strong foreign participation.
   - 2 were very hard to classify as far as the nationality of their capital was concerned.

b) 35 national firms and 10 foreign ones were to be added to the above when considering the production of final petrochemical products.

c) Thus we had a total of 67 petrochemical enterprises, 23 of them foreign-owned; the rest may be considered as national, except for the nuances shown under a) above.

d) 11 of the 23 foreign-owned enterprises appeared in the list of the 150 firms with highest sales figures, while only 4 national ones were shown in the same (one of the latter was the enterprise with strong foreign participation).

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* Data taken from YPF's Balance Sheet and Profit and Loss Statement (printed and distributed by the enterprise) and from similar data obtained from the private firm during one of my interviews.

** Unpublished data obtained through personal interviews. Here again, the classification of enterprises in the various groups, as transnational, state-owned and private, is mine.

CHAPTER IV

TECHNOLOGY TRANSFERS

TO

ARGENTINE CHEMICAL INDUSTRIES

Most of the basic knowledge related with the processes used by the Argentine chemical industries has been procured abroad. We may say that the origin of that knowledge is 100% foreign in the production of basic and intermediate chemicals, while there are some autochthonous contributions in procedures for the manufacture of final chemicals and of endurable or consumer goods making use of those final chemicals. For the implementation of present chemical industrial undertakings, also the preliminary engineering of the projects was predominantly imported.

A work I performed with Francisco Sercovich at the National Register of License Agreements and Technology Transfers* allowed us to analyze a sample of 59 contracts filed** by 21 chemical industries.

The 59 contracts represented 25% of the 235 contracts filed by the firms in this sector and, on the other hand, the 21 enterprises to which they correspond represented 27% of the 76 enterprises -chemical and petroleum refining- that had filed contracts. These 76 enterprises constituted, in turn, 23% of the 327 firms considered as chemical and allied process industries because of their memberships to the corresponding entrepreneurial chambers.***

140 of those 327 firms could be considered as small and, among them, only 14 had filed a total of 19 contracts, showing an average of less than 2 contracts per enterprise. On the contrary, 62 of the 187 larger enterprises had filed 216 contracts, with an average of 3.48 contracts per firm, and a maximum of 14 for a state-owned enterprise.

The 21 enterprises whose contracts were analyzed may be classified as follows:

- 4 were large national enterprises
- 1 was a small national enterprise
- 11 were large foreign enterprises
- 1 was a small foreign enterprise
- 4 were hard to define as far as their nationalities were concerned.

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* Mario Kamenetzky and Francisco Sercovich, *Informe sobre Transferencia de Tecnología en la Industria Química Argentina,* Buenos Aires, December 1974. Report prepared for the INTI (National Institute of Industrial Technology) to which the Register reports and whose authorization has been obtained for using the data included in this report.

** By "contracts filed" I mean both registered contracts and those applying for register.

*** See footnote in page 59 of this report.

The contracts were classified as per the type of products to which they referred or by the type (or types) of technological assets and/or services procured:*

- 8 contracts referred to the manufacture of basic chemical products.
- 20 contracts referred to the manufacture of intermediate chemical products.
- 24 contracts referred to the manufacture of final chemical products.
- 10 contracts referred to the utilization of final chemical products.
- 9 contracts involved the transfer of basic knowledge.
- 10 contracts involved the transfer of basic knowledge & preliminary engineering.
- 1 contract involved the transfer of basic knowledge, preliminary engineering and detailed engineering.
- 2 contracts involved the supply of one or several technical services, such as procurement, personnel training, quality control, technical assistance to production, assistance for assembling and start-up operations.
- 18 contracts involved the supply of some of the above services together with the basic knowledge and the detailed engineering.
- 10 contracts involved the supply of some of the above services together with the basic knowledge, the preliminary engineering and the detailed engineering (turnkey operations).
- 5 included rights for the use of trademarks.
- 30 included the transfer of patent rights.**

The main conclusions of our research work are the following:

a) When the technological assets transferred aim to manufacture basic, intermediate or final chemical products, they are preferentially paid as a global amount, usually accounted by the procurer as an addition to the price of the fixed assets. Instead, technologies aiming to produce consumer goods are more often paid in the form of royalties calculated as a given amount for each unit sold or as a percentage of sales figures (see:

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* Some contracts referred to more than one product and/or involved more than one procurement.

** Very few of the contracts referred exclussively to trademark or patent rights. When reference to these rights were made, it was most usually in connection with the transfer of technological assets and/or services.

Fig. IV.1.). Sometimes, the procurement involves both the payment of royalties and of an initial lump-sum.

FIG. IV.1. MODALITIES IN PAYING THE TECHNOLOGY TRANSFERRED FOR THE PRODUCTION OF CHEMICAL PRODUCTS (percentages)

	P R O D U C T S			Contracts referring to the use of chemicals in other manufactures
	Basic	Intermediate	Final	
Global payment	78	67	9	4
Global payment plus royalties	11	33	73	23
Royalties	11	00	18	73
T O T A L	100	100	100	100

b) In the case of global payments, they are calculated on the basis of maximum previously-agreed yearly production rates and disregarding the time during which that rate, or a lower one, will be maintained. But, whenever the agreed maximum rate is surpassed, a proportionate supplemental payment must be made. This addition to the initial global payment allows for the procurer to go ahead producing at the new rate without any time limits.

c) The tendency of the technology suppliers to intervene in the procurers' business and/or to lengthen contract terms is stronger when contracts refer to the use of chemicals in the production of consumer goods than when they deal with the production of final chemicals and, still weaker, when the production of basic or intermediate chemicals is concerned.

d) The introduction of foreign technologies for the production of basic, intermediate or even final chemical products clearly appears as a means for acquiring the necessary knowledge. In the case of consumer goods, when procurers look for foreign technological alternatives, they are simultaneously searching for advantages in market competition.

e) The basic knowledge or the preliminary engineering are seldom purchased. The local procurer acquires the posession of the transferred technology but not its property; and even that posession is circumscribed by time and space limits in most cases. The receiving firm does only acquire rights to use it as regards to a specific plant. Any repetition in its use does generally call for a previous approval by the foreign contractor and for additional payments if global payments are involved. Only in very special cases (2 in 59) the receiving firm acquires the right to freely use the transferred technology after the contract due.

f) The suppliers of the basic knowledge often restrain the procurers' choices on those who are to perform the preliminary and even the detailed engineering. They impose the purchase of these services either from themselves or from engineering firms they control or which they operate as their exclusive licensees for the exploitation of the corresponding knowledge.

g) In those cases in which the engineering services are rendered by local firms operating under foreign technical assistance or control, it is often hard to establish the extension and level of the services domestically performed by only analyzing the contracts.

h) Explicit and/or implicit ties between the suppliers of the basic knowledge and those of the preliminary engineering, on one hand, and the low horizon of domestic engineering firms in preliminary engineering work, on the other, have reinforced dependence from foreign sources. Ties are not so strong in relation with detailed engineering, for whose execution local firms may be trusted.

i) As a rule, the available information in the Register on how the receiving enterprises have selected the technology is scarce. Such information does neither allow to differenciate the cost of a basic knowledge from that of its preliminary engineering. As a result of the reciprocal ties generally connected with their procurement, basic knowledge and preliminary engineering often appear as fused together. For this reason, an evaluation of the feasibility for local firms to perform the preliminary engineering becomes really difficult.

j) There was only one case, among the contracts under analysis, in which the contracting modality came close to more desirable patterns for an autonomous development. The nature of the supply was more neatly specified item by item and the receiving firm was allowed by the contract to have the property of the improvements it might introduce into the transferred technology.

k) Usually, the nature and contents of the patents protecting the transferred knowledge are not clearly specified. In som cases, one may not define, as per the wording of the contracts, whether those patents had been effectively registered in the receiving country. Many patent descriptions refer to peripheral aspects and to the usage of the involved products, and not to the essential matters regarding the core technology of the process.

l) The guaranties issued by the suppliers of basic knowledge and/or preliminary engineering mostly regard to the yields and technical coefficients of the transferred processes. In some cases, penalties are not indicated; in other, only the compromise of the supplier to come and help the local firm in trouble-shooting is established. Penalties often take the form of discounts in payments and, more rarely, of global indemnizations. The low number of contracts showing guaranties connected with the mechanical operation of the equipment is proportionate to the also scarce number of contracts including detailed engineering and assembly supervision among the supplies.

m) 15 of the 21 enterprises in the sample declared to perform local research and development activities. However, the creative work they list correspond mostly to adaptation efforts, process optimization and search for new product applications and do not involve the creation of a really new technological knowledge. The contracts show that the receiving firms do not make any efforts towards attaining the property of the improvements they might introduce in the transferred technologies.

n) Only 6 contracts in 59 show explicit ties regarding the supply of intermediate inputs. Such incidence is higher (19 over 59) as far as the supply of catalysts and equipment is concerned.

o) The above ties do sometimes assume an indirect form: instead of directly providing catalysts or equipment, it is specified that their local provision must conform to the specifications and designs furnished by the supplier of the technology, by the supplier of the engineering or by contractors, in turn, selected by either one of these two.

This affects efforts made towards substituting capital goods imports, and stimulates demand for additional foreign technology by the local manufacturers of capital goods who, in order to be able to accomplish with the above mentioned specifications, must acquire the corresponding knowledge from the same foreign sources where those specifications originated.

p) In certain cases, quality exigencies from abroad seem to have lead to a profitable and progressive technical change in the production structures of local equipment suppliers.

q) The files contain very little information regarding the technical and economic antecedents of the suppliers and their vinculations with other firms whose services are tied up or from which certain provisions are specially required.

An overall conclusion of the above analysis is that the local capacity for negociating technology transfer contracts should be strengthened. Since the present contractual conditions are definitely less favourable than those attainable, the State's regulating power may help in:

- getting more autonomy in the use of the transferred knowledge.
- procuring technologies appropriate to the country's conditions.
- making a careful adaptation of each one of the operations to those same local conditions, also aiming to use as much locally manufactured equipment as possible as per the development of the country's capital goods industries.

For this, the National Register of License Agreements and specific organizations for the chemical or process industries sector, such as the coordinating group proposed further on in this report, should prefer persuasive to compulsive methods. Persuasive methods should include, among other instruments, the following:

a) adequate financial support to the entrepreneurs assuming the risks involved in technological creation, adaptation or disaggregation;
b) direct help to small enterprises in their technological negotiations;
c) information retrieval on available technological alternatives and costs of the main inputs used and outputs produced by the sector;
d) establishment of minimum requirements to be fulfilled when negotiating technology transfers;

-disaggregated technical and cost information on what is being procured.
-specifications of the type and extension of the guaranties provided.
-description of the patents involved and of their local due dates.
-if the technology transfer is tied up to the provision of certain equipment, materials or services, this must be clearly justified.
-analysis on how the technology to be transferred will be adapted to local conditions and statement on which are those conditions the adaptation work will preferntially take into account.

Each negociation should carefully balance the social usefulness with the entrepreneurial risks and costs involved in:

-the technology in itself;

and

-the way in which it will be transferred and used.

Persuasion should be complemented by an education in engineering and economics aiming to the formation of creative, people-concerned professionals able to:

-generate, copy or purchase technologies as per the requirements in each project;
-ponder entrepreneurial, social and human costs, even those non-representable when technological alternatives are evaluated mathematically.

Simultaneously, general education should provide all those participating in the production process with sensitiveness towards local problems and willingness to assume risks.

In the long term, persuasion and education should pay better social benefits than strict compulsory regulations.

Compulsion does often bring along distorted ways of evading regulations. For instance:

-If entrepreneurs find it profitable to pay royalty percentages on sales higher than those admitted by regulations, they will be likely to find a way to slip the amounts exceeding those authorized.
-If the import of detailed engineering is forbidden, the corresponding

imported equipment may be over-invoiced so as to cover the hidden provision of the former.

On the other hand, some regulations may hinder the efficient work of the production system. For example:

- It may be worth to pay royalties higher than the maximum authorized when the technology being transferred has a tremendous social utility and is monopolistically appropriated.
- Regulations may require the unpackaging of any technology being transferred but certain technologies and some entrepreneurial situations may call for turnkey projects.

As opposed to yes-no mechanisms, I prefer regulation instruments:

- proportionate to the intensity and extension of the system variables we want to control;
- following the variation rate in time of the latter; and
- aiming to integrate the changes in the variables so as to make the system evolve towards previously designed goals.

In the field of technology transfer, ukases cannot replace a permanent dialogue between the entrepreneurial and the superstructural levels; a constant interplay of planners and control agents with the professionals evaluating, selecting and designing technologies for investment projects; a continuos confrontation of microeconomic costs with the costs to be paid for the effects of entrepreneurial activities on society, nature and human beings.

On the other hand, excessive regimentation originates an over-growing bureaucracy controlling that the regulations are not by-passed, while entrepreneurs react and invent new deflected routes.

CHAPTER V

RESEARCH AND DEVELOPMENT IN THE ARGENTINE CHEMICAL INDUSTRY

Article 84 of the income tax law dated 1972* stated:

> "Industrial manufacturing enterprises belonging to physical persons or corporations with home office in the country or to juridical persons set up in the same and performing scientific and/or technological research work for the benefit of the country, either by themselves or under contract with national specialized public or private firms or institutions, will be able to deduct the sums mentioned below from their tax balance, as far as they obtain approval for their research programmes as per the corresponding decree's regulations.
>
> a) An equivalent sum to the amount in salaries paid to the personnel dedicated to the promoted research work.
> b) 50% of the sums invested in amortizable fixed assets exclusively aimed for usage in such research work, including vehicles. In case those goods quit being used for such purpose within a period of two years after their procurement, the amount deducted at the time of procurement must be included as tax due in the tax balance sheet of the year in which this change takes place.
>
> The above deductions are to be understood as additional to the regular accounting of the same as expenses or amortizable investments, respectively.
>
> For the purposes established herewith, the following research tasks are considered as of national interest: design of prototypes, development of new processes, utilization of new raw materials, product engineering, operation of pilot plants and non-routine tests. On the contrary, the following tasks are not considered as covered by this promotional regulation: production planning and control, operational research, routine quality control, model improvement, market research, sales promotion, feasibility studies, research on business administration, research on work productivity, research on salaries incentivation systems and technical sales services. The Executive Power may anytime modify the list of research tasks covered by this clause, including or excluding activities on the basis of recommendations arising from the Undersecretariat of Science and Technology.
>
> In order to benefit from this law, enterprises must fulfill the requirements its regulations will establish".

The above mentioned regulations were introduced by Decree 1156/72, which placed their fulfillment under the control of the Undersecretariat of Science and Technology, under the Secretary of State for Planning and Action. Such Undersecretariat was supposed to:

- receive the research and development programmes filed by industrial manufacturing enterprises performing scientific and/or technological research work

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* *Argentine Official Bulletin*, Buenos Aires, July 4, 1972.

-determine, through appropriate technical and economic evaluations, whether the above programmes are or are not beneficial for the country;
-control the progress and execution of the approved research and development programmes;
-issue the pertinent certificates or written evidences for the enterprises to be able to include the corresponding deductions in their yearly statements filed with the tax authorities.

In order to accomplish these regulations, the enterprises had to file tax-reduction application forms that were specially prepared for such purpose by the above Undersecretariat. In these forms, enterprises had to include detailed information, which I considered was valuable for the evaluation of the research and development activities in the chemical sub-sector I was studying. For this reason, I asked the pertinent authorities for a statistical analysis of that information allowing to make some conclusions without affecting the privacy of individual files.

Since I found a good disposition, I prepared a methodology for data processing, based on which the Department of Information and Statistics of the State Secretariat of Science and Technology* prepared the data shown in Figs. V.1., V.2., V.3. and V.4.

The analysis of the data let me conclude the following:

a) The 57 enterprises looking forward benefiting from the tax reduction represented about 17% of the total estimated universe in the sector (327 enterprises).*

b) The average number of projects per enterprise appears as normal and proportionate to the financial potential in each group as per their sales figures. Besides, the ratio between the number of professionals and technicians involved and that of projects is also regular. Averages are 2.9 professionals and technicians per project, reaching 3.4 in the largest enterprises and coming down to 1.9 and to 2.3 in medium and small sized enterprises, respectively.

* On 1974, the Undersecretariat of Science and Technology became a Secretary of State and started reporting to the Ministry of Education.

**See footnote in page 59 of this report.

Fig. V.1. CARACTERÍSTICAS DE LAS EMPRESAS QUE SOLICITARON DESGRAVACION IMPOSITIVA DE GASTOS EN ID., DURANTE 1971, 1972 y/o 1973 CON AREAS DE ACTIVIDAD: 3511, 3512, 3513, 3529, 3530 y 3540 (relacionadas a "plantas químicas y petroquímicas" y "destilerías de petróleo").

Tramos de Facturación (en miles de $)	Cantidad de Empresas	Año Inscripción Inspec. Gral. de Just.		Gastos Totales Directos en ID. (en miles de $)					Desgravación Solicitada (en miles de $)					Impuestos a los Réditos Devengados (en miles de $)					Pago por Regalías (en miles de $)				
		Más Antigua	Más Reciente	Cant. de Emp. con Inform.	Total	Promedio por Emp.	Valor Máximo	Valor Mínimo	Cant. de Emp. con Inform.	Total	Promedio por Emp.	Valor Máximo	Valor Mínimo	Cant. de Emp. con Inform.	Total	Promedio por Emp.	Valor Máximo	Valor Mínimo	Cant. de Emp. con Inform.	Total	Promedio por Emp.	Valor Máximo	Valor Mínimo
TOTAL	57	1895	1970	57	51.011	895	10.576	0	56	50.119	895	14.983	42	56	99.026	1.768	17.125	0	56	30.002	536	4.060	0
Más de 50.000	24	1911 (1)	1968	24	39.395	1.641	10.576	0	24	41.570	1.732	14.983	68	24	91.319	3.805	17.125	0	23	27.436	1.193	4.060	0
De 10.001 a 50.000	23	1895 (2)	1970	23	10.560	459	3.389	42	22	7.078	322	1.182	42	23	7.099	309	1.018	0	23	2.041	89	907	0
Hasta 10.000	10	1937 (3)	1970	10	1.056	106	244	0	10.	1.471	147	268	63	9	608	68	345	0	10	525	51	450	0

(1) Se tienen 2 empresas sin información.
(2) Se tienen 3 empresas sin información.
(3) Se tienen 3 empresas sin información.

FUENTE: SECYT - Departamento de Información y Estadística - Elaboración Propia a partir de los certificados de solicitud de desgravación - presentados hasta Julio de 1974.

Fig. V.2.

CARACTERISTICAS DEL PERSONAL UNIVERSITARIO Y TECNICO Y DE LOS PROYECTOS PRESENTADOS POR LAS EMPRESAS QUE SOLICITARON DESGRAVACION IMPOSITIVA DE GASTOS EN ID., DURANTE 1971, 1972, y/o 1973 CON AREAS DE ACTIVIDAD: 3511,3512, 3513, 3529, 3530 y 3540 (relacionadas a "plantas químicas y petroquímicas" y "destilerías de petróleo").

Tramos de Facturación (en miles de $)	Cantidad de Empresas Con Inform.	Personal Universitario y Tecnico Dedicado a ID.								Proyectos Presentados												
		Total	Disciplina Científica							Total	Promedio por Empresa	Cantidad Máxima	Cantidad Mínima	Composición por Tipo								
			0704	0705	0710	0712	otros 07	otras D.C.	Sin Inform.					1	2	3	4	5	6	Combinación de: dos	Combinación de: tres	Sin Inform.
TOTAL	57	1.180	218	14	48	139	214	535	12	405	7,1	87	1	46	162	28	50	14	51	21	11	22
Más de 50.000	24	922	182	12	41	127	179	381	0	272	11,3	87	1	19	125	21	31	10	44	14	3	5
De 10.001 a 50.000	23	209	27	1	7	9	26	134	5	112	4,9	24	1	22	29	6	18	3	3	7	8	16
Hasta 10.000	10	49	9	1	0	3	9	20	7	21	2,1	4	1	5	8	1	1	1	4	-	-	1

FUENTE: SECYT - Departamento de Información y Estadística - Elaboración Propia a partir de los certificados de solicitud de desgravación - presentados hasta Julio de 1974.

Fig. V.3.

CARACTERISTICAS DE LAS EMPRESAS INSCRIPTAS EN EL REGISTRO NACIONAL DE TECNOLOGIA QUE SOLICITARON DESGRAVACION IMPOSITIVA DE GASTOS EN ID., DURANTE 1971, 1972 y/o 1973 CON AREAS DE ACTIVIDAD: 3511, 3512, 3513, 3529, 3530 y 3540 (relacionadas a "plantas químicas y petroquímicas" y "destilerías de petróleo").

Tramos de Facturación (en miles de $)	Cantidad de Empresas	Año Inscripción Insnec. Gral. de Just.		Gastos Totales Directos en ID. (en miles de $)					Desgravación Solicitada (en miles de $)					Impuestos a los Réditos Devengados (en miles de $)					Pago por Regalías (en miles de $)				
		Más Antigua	Más Reciente	Cant. de Emp. con Inform.	Total	Promedio por Emp.	Valor Máximo	Valor Mínimo	Cant. de Emp. con Inform.	Total	Promedio por Emp.	Valor Máximo	Valor Mínimo	Cant. de Emp. con Inform.	Total	Promedio por Emp.	Valor Máximo	Valor Mínimo	Cant. de Emp. con Inform.	Total	Promedio por Emp.	Valor Máximo	Valor Mínimo
TOTAL	18	1929 (1)	1964	18	26.536	1.474	10.576	0	18	28.629	1.591	14,983	68	17	61.108	3.595	17.125	0	17	21.941	1.291	4.060	0
Más de 50.000	15	1929 (1)	1961	15	25.918	1.728	10.576	190.	15	27.210	1.814	14.983	68	15	60.468	4.031	17.125	0	14	21.637	1.546	4.060	0
De 10.001 a 50.000	2	1942	1953	2	618	309	422	196	2	1.151	576	678	473	2	640	320	437	203	2	229	115	136	93
Hasta 10.000	1 (2)	1964	1964	1	0	0	0	0	1	268	268	268	268	-	-	-	-	-	1	75	75	75	75

(1) Se tiene 1 empresa sin información.

(2) Dentro de este tramo de facturación, se tiene una empresa sin información sobre inscripción en el Registro Nacional de Tecnología.

FUENTE: SECYT - Departamento de Información y Estadística - Elaboración Propia a partir de los certificados de solicitud de desgravación — presentados hasta Julio de 1974.

Fig. V.4.

CARACTERISTICAS DEL PERSONAL UNIVERSITARIO Y TECNICO Y DE LOS PROYECTOS PRESENTADOS POR LAS EMPRESAS INSCRIPTAS EN EL REGISTRO NACIONAL DE TECNOLOGIA QUE SOLICITARON DESGRAVACION IMPOSITIVA DE GASTOS EN ID., DURANTE 1971, 1972 y/o 1973 CON AREAS DE ACTIVIDAD: 3511, 3512, 3513, 3529, 3530 y 3540 (relacionadas a "plantas químicas y petroquímicas" y "destilerías de petróleo").

Tramos de Facturación (en miles de $)	Cantidad de Empresas Con Inform.	Personal Universitario y Tecnico Dedicado a ID.								Proyectos Presentados												
		Total	Disciplina Científica							Total	Promedio por Empresa	Cantidad Máxima	Cantidad Mínima	Composición por Tipo								
			0704	0705	0710	0712	otros 07	otras D.C.	Sin Inform.					1	2	3	4	5	6	Combinación de: dos	tres	Sin Inform.
TOTAL	18	775	141	12	39	119	153	304	7	192	10,7	87	1	9	89	15	18	8	37	9	-	7
Más de 50.000	15	742	138	12	38	117	149	288	-	184	12,3	87	1	6	88	15	18	7	37	9	-	4
De 10.001 a 50.000	2	26	3	0	1	2	4	16	-	4	2	3	1	-	-	-	-	1	-	-	-	3
Hasta 10.000	1	4	-	-	-	-	-	-	7	4	4	4	4	3	1	-	-	-	-	-	-	-

FUENTE: SECYT - Departamento de Información y Estadística - Elaboración Propia a partir de los certificados de solicitud de desgravación - presentados hasta Julio de 1974.

c) As it was expected for this sector, the biggest project concentration (40%) deals with the development of new processes, followed by projects on non-routine tests and on product engineering (12.5% of the total number filed for each type). On the other hand, our attention is called to the fact of the small number of projects for work in pilot plants (only 3.4% of the total) and in diversification of raw materials (only 7%). On the contrary, the design of prototypes, which is more typical of mechanic, electrical and electronic industries, fills 11% of the total. It must also be taken into account that 8% of the projects refer to more than one type of work and that 5.5% do not specify the nature of the projects as per the established codes. I suppose that at least part of the projects combining two or three types of work must refer to the development of new processes or to product engineering with simultaneous experimental steps in pilot plants.

d) As far as the personnel employed is concerned, a good proportion is observed between chemical engineers (approximately 18% of the total) and mechanical engineers (approximately 12%); as a response to an industry requiring the design of equipment that may functionally adapt to the process and, at the same time, follow good calculation and structural design patterns. It is hard to guess which are the branches of engineering considered under the high percentage of professionals declared as being other than mechanical, chemical, industrial or civil engineers. Instead, it can reliably be supposed that professionals and technicians included under other scientific disciplines are mainly chemical scientists and technicians.

e) An average of 20 professionals and technicians are shown as working for each enterprise. In the highest sales figure level, this average would raise to 38, while it would come down to 9 in medium sized enterprises and to only 5 in the smallest ones. The above averages* do not admit any comparison with the armies of scientists, engineers and technicians usually assembled by the large chemical transnational corporations. Hoescht, for instance, announces that its various laboratories and experimental development centers harbor 10,300 members**, while Rhone Poulenc's research

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* No matter how low these figures may appear when compared with the standards in more industrialized countries, there is a common belief among the officials in charge of implementing the promotional instrument under analysis that personnel dotations reported to be dedicated to R&D are exagerated in most of the applications filed.

**Advertisement published in *La Recherche*, Paris, December 1971, Vol. 2, No. 18, page 1006.

and development forces include 6,000 biologists, chemists and technicians*, but their sales, net income and payroll figures for 1973 are as follows:**

	Sales Million US$	Net Income Million US$	Employees
Hoescht	5,591	176	155,450
Rhone Poulenc	3,300	127	116,531

f) The enterprises under analysis were paying yearly royalties for about 3 million U.S. dollars, while investing approximately 5 million dollars in internal research and development work in the same period. This means that they would be spending approximately 1.6 monetary units in internal technological creation for each unit sent abroad as a retribution for imported technologies. This ratio reaches 2.1 if the group of small enterprises is considered, rises to 5.2 for the medium-sized firms and comes down to 1.4 for the largest ones.

However, in turn, small enterprises are the ones making less investments in research and development and those purchasing less know-how abroad; they constitute 17.5% of the sample, but have a participation of only 2% in the total of research and development expenses and pay only 1.7% of the total amount of royalties. Medium-sized enterprises, representing 40% of the total sample, contribute with 20% of the total expenses in research and development and with 6.8% of the royalty payments.

g) If a yearly sales figure of 3 million dollars*** is considered as the average for medium sized firms, the average of 46,000 dollars spent by each enterprise in research and development would approximately represent 1.5% of the corresponding gross sales. Similarly, considering annual gross sales of 500,000 dollars as the average for small firms, 2.0% of the same would have been applied, as an average, to research and development.

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* Advertisement published in *La Recherche*, Paris, October 1974, Vol. 5, No. 49, page 812.

** Data collected from "The Fortune Directory of the 300 Largest Industrial Corporations outside the U.S. ranked by Sales", *Fortune*, Vol. XC # 2, August 1974, page 176. The Hoescht figures include totals of subsidiaries that are 50% owned. Rhone Poulenc's figures include prorrated figures of subsidiaries that are 33 to 55% owned where assets are more than 1 million US$ and of companies that are 15 to 33% owned where assets are more than 20 million US$.

*** At the time the analysis was made, Argentine pesos could be converted into dollars by applying a 10 to 1 exchange rate.

On 1958 and 1959, chemical industries were spending similar percentages both in Canada and Japan, but in the U.S. figures as high as 4.3% were found.*

h) For the period 1971/73, to which the collected data refers, income taxes represented, as an average, 33% of the enterprises taxable income. Therefore, we may approximately calculate the ratio between the declared expenses in research and development and the profits probably attained by the enterprises under analysis calculated on the basis of the taxes they stated they would have to pay. The ratio would be 17% for the whole set and would become 14% for large enterprises, 49% for the medium-sized ones and 57% for the small ones. The exceptional and incredible percentages for small and medium-sized enterprises could result from exageration of the expenses in research and development. However, considering that the ratio between the same and the sales figures seems to be normal, I dare say:

-that those high ratios between research and development expenditures and taxable incomes may result from more skill and favourable conditions among small firms to struggle against taxation;

but, also,

-that even a very minor creative effort may easily exceed the forces of small business,

and

-that it is very hard for a small enterprise to obtain the number and level of people and the equipment a creative effort demands.

Always taking average taxes due and average taxation indexes as the basis for calculation, the average taxable income for a large enterprise in the sample would have been about one million dollars; approximately 90,000 dollars for medium-sized firms and close to 20,000 for the small ones.**

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* Lawrence W. Bass, *The Management of Technical Programs*, Praeger, New York 1966, page 9.

** At the time the analysis was made, Argentine pesos could be converted into dollars by applying a 10 to 1 exchange rate.

i) If the subset of the sample whose contracts are filed at the National Register of License Agreements and Technology Transfers are analyzed (Figs. V.3. and V.4.), we may see that:

i) Only 30% of the enterprises in the sample are registered, covering 73% of the paid royalties. This means there ought to be enterprises paying royalties and non registered, although the difference could also be explained bv the fact that, since the due date for registering was 3.1.72, those applications filed during 1970 and 1971 could involve payments of royalties and show no indication of having been registered.

ii) The ratio between direct expenses in research and development and royalty payments is 1.2:1 for the whole subset, while in medium-sized enterprises it reaches 2.7:1. The only firm appearing in the lowest sales range shows no data on its yearly expenses in research and development. It could well be an enterprise that would be willing to start its activities in case of approval of the four projects for which tax reduction was requested.

iii) The analysis by categories would lead to thinking that the biggest number of enterprises paying royalties and still non registered was among medium and small-sized ones, which are always reluctant to this type of controls because thev lack adequate organization and structures so as to quickly respond to the requirements for data involved in registering.

iv) The aroup of 15 large enterprises (62% of the subset in the highest sales range and 28% of the total sample) that had registered technology transfer contracts appears as the most powerful and the one making the biggest contribution to creativeness in the chemical subsector. Among them, we may find:

-the biggest investor in research and development of all the sample, with about one million dollars a year; and
-the most profitable enterprise, with a probable annual taxable income of about 5 million dollars.*

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* Calculated with the same criteria as under h) above.

This group represents 65% of the total expenses in research and development reported by the subset of enterprises in the highest sales range and 50% of the expenses in the total sample. On the other hand, it pays 79% of the total royalties corresponding to the highestrank of enterprises and 72% of those paid by the total sample.

It employs 62% of the personnel shown for the whole sample and carries out 45% of the total number of projects filed. It would have an average of four people dedicated to each project and its research and development teams would reach an average of 50 people per enterprise.

The application of the tax reduction law came upon some difficulties in the statistical analysis of scientific and technical activities. Some people understand that only those expenses aiming to produce new scientific and technological knowledge should be accounted for under research and development. As per this restricted criterion, in the particular case of chemical and petrochemical industries, we would be authorized to consider a given work as research and development only if it aims to discover a new process of chemical change. The optimization or modification of existing processes and work aiming to solve manufacturing problems would be excluded.

An opposite and very broad criterion would include under research and development even routine technical activities connected with every-day production, such as quality control, technical sales service, production planning and periodical sales analysis. All of them were excluded from the Argentine law, as well as incentives to research on administrative technologies.

The law did also deny tax reductions on any expenses incurred in market research*, pre-investment studies, detailed engineering activities or the adaptation of foreign-procured technologies, in those cases in which such adaptation did not call for experimental work and could be performed by merely redesigning the purchased preliminary engineeering.

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* We must duly differenciate the market research work needed to soundly base decisions in pre-investment work from periodical sales analysis that are often identified with the same expression. I suggest that the former should be called "market and situational analysis" (see Chapter III of the author's report *Engineering and Pre-Investment work*), while the latter should be identified as "sales analysis".

I feel that in many low developed industrial structures it could be convenient to stimulate some of the excluded activities that often serve as antecedents for the enterprise further going into more complex research and development work.

Even the adaptation of foreign technologies to the local conditions requires previous experience in handling the technologies already in use. Their trouble-shooting also calls for the work of scientific and technical teams, may strongly influence the evolution of the enterprises and results in positive effects for the country's economy.

On the other hand, market analysis and pre-investment studies are important steps when organizing the knowledge needed for any investment project. Their careful execution highly influences the appropriateness of the technology that will be finally selected or developed and, hence, the efficiency with which the country will allocate its resources. These studies demand consulting and engineering teams able to focus the evaluation and selection or design of technologies under a multidimensional, multicriteria systemic approach.

The deduction of the amounts invested in pre-investment studies and market and situational analysis from the taxable income would stimulate the formation of the multidisciplinary teams necessary for performing this type of work either within the enterprises or as independent consulting and engineering firms. The latter would make society benefit from the economies gained through repetitive work and from cross-fertilization in the execution of different projects.*

Additionally, when a government tries to promote creative activities among production enterprises, it is very hard for the agents in charge of evaluat-

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* In future statistical analysis similar to the one performed under my inicia tive, it should result both interesting and useful to separate the expenses incurred in research and development work carried out within the production enterprises from those contracted outside the enterprises with private or public research institutions or with consulting and engineering firms.

ing the programmes to issue opinion, on the mere basis of the filed applications, on the entrepreneurial and social utility of the projects and on the efficiency expected to be attained in their execution.

Nothing can replace a permanent dialogue and a close contact between those agents and the entrepreneurs and professionals and technicians working in the production system. For instance:

- Some projects may be justified as from a pure microeconomic point of view but may unnecessarily duplicate efforts, just because the enterprise has not been able to detect already available alternative sources for the knowledge it needs. The control agents might then help entrepreneurs in acquiring that available knowledge with similar or even better results for the enterprise than those expected from the corresponding research project.
- Isolated entrepreneurial projects may be advantageously transformed into cooperative efforts and, thus, stronger and better qualified research and development teams would be formed. If the control and evaluation agents animate their roles with a broad intelligent vision of each economic sector, they might be able to promote this type of action.
- The expenses in research and development incurred by small and medium sized production enterprises may often be channeled out of the same and into private or public research and development institutes or firms making those enterprises benefit from the economies supposedly attained through larger scale creative work.
- The filed forms may indicate that three engineers will be dedicated to a project. However, when the plant is visited, one may find that they devote most of their time to the routine of the production line and ocassionally supervise the tests performed by a technician on the problems connected with the project.

All this calls for very high level professionals in the agencies in charge of applying the promotional instruments. They should have experience in both production work and in creative tasks. They should serve as a double-way communication channel between:

- scientists and engineers in the public sector or in private independent consulting and engineering firms;

and

- entrepreneurs, managers, scientists and engineers in private or public production enterprises.

The evaluation and control activities required by policy instruments similar to the one being discussed might well be performed by technical sector coordinating groups such as the one proposed in Chapter X of this report for the Argentine process industries.*

More broadly, the statistical figures under analysis show that, as it is to be expected from industrial structures highly dependent on foreign technologies, efforts among local production enterprises are mainly devoted to minor creative activities and not to the development of new technologies or of additional scientific knowledge, no matter how important those efforts are as referred to sales volumes or to the amount of royalties being paid. This is shown by the low percentage of projects aiming to work with pilot installations or to study the use of alternative raw materials. I am inclined to believe that most of the filed projects dealing with development of new processes or with non-routine tests are really adaptations or improvements to existing processes or redesigns of single operations. This assumption is supported by the percentage -relatively high for the chemical sub-sector- of projects referred to prototype design.

Nevertheless, adaptations, improvements and redesigns should not be discouraged; they may even have higher local priority than certain more outstanding and sophisticated research projects aiming to increase universal scientific knowledge.

Emphasis should also be placed on the promotion of activities aiming to organize the available knowledge into investment projects (market and situational analysis, pre-feasibility and feasibility studies) and to efficiently use it in their implementation (detailed engineering).

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* See also Chapter VII of the author's report *Engineering and Pre-Investment Work*.

The solution of development problems has not only -nor mainly- been impeded by lack of knowledge, but by:

-political and particular interests distorting or entangling its use.

-lack of skills for adequately organizing it into investment projects.

-the absence of objectives leading to its human and environmental concerned application.

CHAPTER VI

ARGENTINE PROCESS ENGINEERING AND CONSULTING ENTERPRISES

A. ENGINEERING FIRMS

As it has been previously stated, Argentine chemical industries receive most of their technological knowledge (basic knowledge of the processes plus their preliminary engineering) from abroad. On the contrary, the detailed engineering is mainly performed locally, either by engineering departments in production enterprises, or by specialized engineering firms.

As from the fifties, Argentina started surpassing the step in which industrial installations were brought in as huge puzzles that local engineers assembled, following detailed drawings also coming from abroad. Since then, the largest chemical firms organized engineering departments, some of which showed an outstanding evolution and brought along the first experimental development and technology adaptation projects performed for the chemical sub-sector within the country.

The demand placed on independent engineering firms was scarce. They were only busy with the civil engineering work needed for building industrial facilities. That was how, while local architecture and civil engineering have gone beyond the take-off period, Argentine firms specialized in process engineering are still struggling for development.

Among the five enterprises listed in a guide of suppliers for the process industries as providing process design services*, only two are actually in a condition so as to undertake such job and just for the food industries.

A third one is a transnational corporation with main headquarters in Argentina, further on described in detail in this report (Case D in Fig. VI.1.), that had the basic knowledge to perform the preliminary engineering for iron and steel projects.

One of the other two is more a romantic idea than a reality, despite the fact that it even offers the possibility of undertaking complete turnkey projects based on technologies of their own. Its proprietors have the experience and technical knowledge and the skill to do that, as they have proved through work carried out for Argentine and foreign medium and small

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* *Guía de Proveedores de las Industrias de Procesos,* a special issue of the magazine "Procesos", Buenos Aires, 1971. "Process design" is used in this guide as an equivalent to "process preliminary engineering". I have only been able to gather data about 4 of these 5 enterprises.

FIG. VI.1. DATA ON SOME ENTERPRISES PROVIDING PROCESS ENGINEERING SERVICES IN ARGENTINA

	A	B	C	D	E
TYPE OF ENTERPRISE	PRIVATE NATIONAL	AFFILIATE OF TRANSNATIONAL CORPORATION	PRIVATE NATIONAL	TRANSNATIONAL WITH MAIN HEADQUARTERS IN ARGENTINA AND ARGENTINE NATIONALIZED CAPITAL	PRIVATE NATIONAL
CAPITAL	-	180,000 US$*	1 MILLION US$*	4 MILLION US$*	50,000 US$
STARTED OPERATIONS IN ARGENTINA ON	AUGUST 1975	1957	1966 CIVIL WORK 1970 INDUSTRIAL INSTALLATIONS 1974 INFRASTRUCTURAL WORKS	1946	1956
STARTED INTERNATIONAL OPERATIONS	-	1915	-	1946	1958
GROSS SALES - YEAR	-	6 MILLION US$* - 1973	8.6 MILLION US$* - 1973/4	39 MILLION US$* - 1973/4	2.5 MILLION US$ - 1975
MAIN ACTIVITIES	CONSULTING-PRELIMINARY ENGINEERING-DETAILED ENGINEERING-PROCUREMENT - CONSTRUCTION, INSTALLATION & START-UP SUPERVISION - TECHNICAL ASSISTANCE	DETAILED ENGINEERING - PROCUREMENT - CONSTRUCTION - ASSEMBLING	DETAILED ENGINEERING - PROCUREMENT - CONSTRUCTION - ASSEMBLING	CONSULTING - PRELIMINARY - ENGINEERING OF IRON AND STEEL PLANTS & OF INFRASTRUCTURAL WORKS - PROCUREMENT - CONSTRUCTION - ASSEMBLING	PRELIMINARY ENGINEERING DETAILED ENGINEERING PROCUREMENT - EQUIPMENT
ECONOMIC SECTORS COVERED	PROCESS INDUSTRIES - MAINLY CHEMICAL AND PETROCHEMICAL	CHEMICAL - PETROCHEMICAL - IRON & STEEL - NON-FERROUS METALS - FOOD INDUSTRIES - PHARMACEUTICAL - PULP & PAPER	INDUSTRIAL - HOUSING - INFRASTRUCTURAL	IRON & STEEL - METAL WORKING - INFRASTRUCTURAL	PROCESS & ELECTRO-MECHANIC INDUSTRIES
PERMANENT PROFESSIONALS AND TECHNICIANS	55	220	174	350	50
ADMINISTRATIVE CLERKS AND WORKERS	62	2,030-1974**	694-1974**	2,600-1974**	350
NUMBER OF ARGENTINE CUSTOMERS WITH PROCESS INDUSTRIES: -STATE OWNED -PRIVATE NATIONAL -TRANSNATIONAL	4 2 2 -	19 7 4 8	4 3 1 -	12 2 2 8	ASSEMBLY WORK 78 ENGINEERING 9 4 } 83
NUMBER OF CHEMICAL PROCESSES WHOSE DETAILED ENGINEERING WAS PERFORMED IN ARGENTINA	39 1/	36	3	4	12
INTERNATIONAL ACTIVITIES	—	250 CONTRACTS IN LATIN AMERICA FOR 1 MILLION US$	—	1946-1971: PARTICIPATION IN: -67 PROJECTS: TOTAL INVESTMENT COST APPROX. 1,300 MILLION US$, IN LATIN AMERICAN COUNTRIES OTHER THAN ARGENT. -74 PROJECTS REST OF WORLD TOTAL INVESTMENT COST 650 MILLION US$.	2 PROJECTS IN CHILE 1 PROJECT IN BRAZIL 1 PROJECT IN URUGUAY 1 PROJECT IN ISRAEL
MISCELLANEOUS	1/ SINCE THIS FIRM DEVELOPED AS FROM THE ENGINEERING DEPT. OF A NATIONAL CHEMICAL ENTERPRISE, THE EXPERIENCE INDICATED REFERS TO THAT GAINED IN THE PARENT CO. PART OF THEIR ENGINEERING WORK WAS SUPPORTED BY THE R&D WORK PERFORMED BY THE PARENT PRODUCTION ENTERPRISE	—	-THEIR MOST AMBITIOUS PROJECT IN THE PROCESS ENGINEERING FIELD HAD AN ESTIMATED TOTAL BUDGET OF 20 MILLION US$* -OFFICES AND WAREHOUSES COVERED 6,000 SQ. METERS; 2,500 OF THEM THEIR OWN (1974) -IN THEIR 1973/4 BALANCE SHEET, 18.5% OF LIABILITIES APPEAR AS FINANCED BY BANKS AND 48% OF THEM BY SUPPLIERS AND CONTRACTORS.	-BETWEEN 1946 AND 1971 THEY PARTICIPATED IN 92 PROJECTS, WITH TOTAL INVESTMENT COST OF 1,600 MILLION DOLLARS, IN ARGENTINA. DETAILED ENGINEERING WORK FOR 50 PROJECTS WAS UNDERWAY ON 1975. -IN THEIR 1973/4 BALANCE SHEET, 12.3% OF THEIR CURRENT LIABILITIES APPEARED AS FINANCED BY SUPPLIERS AND SUBCONTRACTORS, 7.9% BY BANKS AND 33.6% BY OTHER FINANCIAL SOURCES -FIXED ASSETS IN THE SAME BALANCE SHEET AMOUNTED TO 14% OF TOTAL ASSETS WHILE REALIZABLE ASSETS CONNECTED WITH PERFORMED WORK AND SERVICES REACHED 37.3%.	

* THESE FIGURES IN THE U.S. CURRENCY WERE CALCULATED ON THE BASIS OF AN EXCHANGE RATE OF 10 ARGENTINE PESOS PER US DOLLAR. THE REST OF THE FIGURES WERE DIRECTLY SUPPLIED IN DOLLARS.

** THE YEAR IS INDICATED BECAUSE THE NUMBER OF WORKERS VARIES WITH THE AMOUNT AND TYPE OF WORK UNDERWAY.

sized enterprises, but they have not been able to set up a permanent team. At the time the analysis was made, they did not have a single engineer or technician on a full time basis in their payroll. Besides, the owners could not devote permanent attention to this business because they earned their lives by administering industrial undertakings whose processes they had contributed to develop.

The same guide also listed five enterprises as supplying detailed engineering. One of them is the same transnational corporation listed under "process design", although it has larger and better organized teams for detailed engineering than for the former. These are also prepared to undertake the construction and installation of the facilities they engineer.

Another transnational branch does also have sufficient installed capacity for this type of combined engineering and construction works, but is more circumscribed to electrical ancilliaries of industrial processes.

Two other firms in the same list are really shops building equipment and offering the services of their engineering departments to third parties.

The fifth enterprise listed also performed combined engineering and construction services, but disappeared at the time this analysis was made, after having participated in a very important project sponsored by an enterprise of the Argentine public sector. For this project the Argentine firm made an agreement with the Spanish branch of a transnational engineering firm. The latter took care of practically all the engineering work, for which it employed 500,000 men-hours, while its headquarters would have only contributed with 2% of the total engineering time. The Argentine enterprise would have just executed the overall construction and assembly installation work, estimated in four million men-hours, employing almost two thousand people during work peak periods. The latter did also actively cooperate in the supply of locally manufactured equipment units and materials, representing 47% of the whole installation.*

*Information gathered from articles and advertisements published in *Ingeniería Química*, No. 34, IV, Madrid, January 1972 and from interviews with professionals who worked for the Argentine firm. The Spanish source does not even mention the participation of the local enterprise. I was not able to detect whether the participation of the Argentine firm was calculated on the total number of physical units or on monetary values. I assume it was on the latter but, even so, I ignore whether the figures on which the participation was established did or did not include the civil works.

No matter how contradictory it seems, the local enterprise was dissolved after having taken part in this 40 million dollar project, apparently due to financial difficulties arising from its participation.

Recently, an engineering firm was founded as from the engineering department of a large national chemical enterprise. This move follows universal trends among large enterprises preferring to separate their routine production work from activities aiming to organize and implement investment projects.* The main characteristics of this firm have been listed under "A" in Fig. VI.1.

In the same figure, the rest of the columns refer to:

B. The Argentine branch of a transnational corporation performing both construction and engineering activities on the core technologies of process industries. This transnational corporation is shared by a U.S. and an European consortiums.

C. A national civil engineering firm which is starting to undertake some projects in the process industry field. Its capital was built up through the construction of dwellings and its accumulation allowed for the firm's diversification into infrastructural works and industrial construction.

D. A transnational construction and engineering corporation with main headquarters in Argentina, mostly executing metallurgical projects and infrastructural work. It frequently associates with enterprise B for large process industries projects.

E. A national process construction and engineering firm acting as a contractor also for other type of industries. It was formed twenty years ago by young professionals after a short experience in the engineering department of the same chemical enterprise that further on generated enterprise A.

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* See more comments on these trends in page 116 of the author's report *Engineering and Pre-Investment Work*.

The evolution of enterprise D was quite interesting. It was founded in Europe on 1945 and meant to immediately leave that continent, moving their technology and capital to set up operations in Latin America. They selected Argentina as their base. Here, they formed their engineering and construction teams, aimed to design and build the metallurgical and metal working plants in which they decided to make their first investments. At the same time, they started competing for large infrastructural works, while profiting from the idle capacity of their engineering and construction forces: gas and oil pipelines, installations for the production and distribution of electric power, roads, etc.

Their old links with the afresh started European industrial activity allowed them to represent equipment and material manufacturers whose products were employed in many of the above works and some of which did soon start being locally manufactured by firms in the group.

Their activities extended from Argentina to the rest of Latin America and were re-started in some European, African and Asian Mediterranean countries, profiting from the old, previous-to-migration connections of the capital owners.

The enterprise's policy is not to fear diversifying into fields out of its own stock of knowledge. For this, it associates with more specialized engineering or construction firms or with manufacturers of equipment with engineering departments specialized in the processes in which those equipment units are employed. In other cases, the customers provide the preliminary engineering of the core process and the firm integrates it with the engineering of the civil work and of the peripheral services through a detailed engineering of the whole process plant.

Anyhow, its main activity is not in the field of process industries. The nucleous is actually constituted by the engineering department of a construction firm that searches other customers for its engineering services so as to even its work load and to acquire experience in fields in which its own economic group may develop interest and/or the construction division may look for new clients. That is how they have competed for and obtained the engineering work of some nuclear power plants whose construction is carried out by other enterprises.

Through most of the firms listed, it may be clearly realized that Argentina repeated development patterns by which engineering groups specialized in chemical, electric, electronic and mechanical technologies sprout from civil engineering and construction parent firms. Foreign groups working in developing countries did soon drop their interest in controlling business related with the construction of dwellings and abandoned this field in the hands of local engineers. Before long, the latter were also admitted to compete in large buildings and infrastructural public works. Since any industrial installation does also require buildings to shelter its equipment, construction firms promptly became acquainted with the problems related with the peripheral technologies of the industrial procedures and a little later with those derived from the core technologies.

Whenever the social, cultural and economic conditions were favourable, the propensity to also deal with those problems naturally lead to specialized departments within the main civil engineering organizations and, later on, to enterprises under separate structures and with individual personalities. These "sprouts" often make use of the services of the "old root" for the design and construction of the buildigns and structures that will respectively shelter and support the equipment units that, in turn, they will design, build and assemble.

Nevertheless, within dependent, stop-and-go economies, it is not easy to move from building dwellings to handling complex infrastructural or industrial projects. A recent Argentine case serves to illustrate some of the obstacles. The execution of a dam and hydroelectric power plant aiming to supply the necessary power to an aluminum plant being installed down in the South of the country seems to be leading the Argentine construction firm that won the bid for those works to summon its creditors on account of financial problems apparently arising from difficulties in the implementation due to defficiencies in the engineering the contractor received from the project sponsor. As per a notice* paid by the contractor, it seems that:

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* *La Opinión*, Buenos Aires, December 3, 1974, page 4. (The comments between brackets are mine).

- the contractor's financial commitments in building up the physical and human capital demanded by the works were very high;
- project inadequacies brought along frequent and long stand-stills aggravating the contractor's financial problems;
- the modifications to the project more than doubled the cost of the necessary construction work and, in turn, increased the contractor's financial needs.

A big transnational firm -with easy access to international and local financial sources- would not have had any troubles in keeping men and machinery inactive for long periods or in bearing extra work loads. On the contrary, it would have highly benefited from an increased total cost of the project.

Another example:

At a given time, the local process engineering enterprise I mentioned as a romantic idea decided to attempt its take-off profitting from a bid called by a Government-owned enterprise committing the foreign supplier of the technology to associate with local engineering firms. At a very high cost, it looked for and finally reached a proper combination between a French-Italian team possessing an adequate technology, already experienced in several installations and a team of top level local engineers and technicians with plenty individual antecedents in the process industries field. However, the envelopes filed with the bid were not even opened, arguing that "the local firm had no antecedents".

The evolution of process engineering in Argentina is frequently trapped in this kind of vicious circles: local firms cannot get adequate jobs because they have neither antecedents nor permanent teams and cannot have antecedents and permanent teams because they do not get adequate jobs.

The above examples and situations lead me to make a few comments on financing engineering activities.

Local banks are mostly used to finance *passive* entrepreneurial attitudes, such as those involving the purchase of technological packages and their immediate productive implementation, resulting in products whose potential demand does not require complicated market research works so as to be evident.

They usually do also support *defensive* attitudes looking after maintaining certain positions in the market, by means of the addition of new items to present production lines, the improvement of the existing products or process optimization. It is vox populi that financial entities give bigger loans to those who have more money and only loan to those who have some.

They rarely face the risk implicit in an *aggressive* entrepreneurial attitude looking forward the local development of new products, new processes or new services. However, the Archimedes, Edisons and Arthur D. Littles in developing countries should be financially supported.* A synergic association between knowledge and entrepreneurial spirit needs from capital to catalyze its transformation from a potential to a reality.

The local offer of engineering services should be supported by the banks, among other means, by the latter insuring the correct execution of the work. Support would be granted as per the work volume that each team could absorb and as per the efficiency they might attain in project management. On the other hand, banks should also cover the risks run by the engineering firms in those cases in which erroneous technological decisions made by their customers may result in delays and in idle physical and human resources.

Financial entities should use all kinds of credit forms so as to ease the physical installation and the formation of permanent engineering teams. For instance, leasing** allows for the procurement of equipment when the

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* The advertising slogan of a French financial incorporation, the Société pour le financement de l'innovation (SOFINNOVA), ran: "On 250 BC, we would have financed Archimedes". SOFINNOVA's shareholders are large national and private banks and industrial firms, such as the CGE, Rhone Poulenc, L'Oreal. Four U.S. firms were said to be interested in buying 12% of the French firm's capital on 1972. The data was collected from *Le Point*, Paris, October 2, 1972, page 81. Venture capital exists in the U.S. since 25 years ago. Financists support inventors with capital and managerial advice and, further one, benefit from the sale of their participation, after the enterprise is in operation.

** A lease involves the purchase of an equipment unit by a bank or a financial entity, and its renting for exploitation for a sum that, within the contract term, will cover approximately 90% of the price of the same, plus the current financial charges. Further on, the lessee may either purchase the unit for the balance price or sign another rent contract for smaller sums. The lessor retains the property of the leased unit, which may not be seized by other creditors, while the lessee is in charge of its maintenance.

engineering firm does not have sufficient funds and when the scarce money available should preferentially be devoted to the enrollment of high-level personnel, the opening of new markets, publicity, etc.

These activities would oblige financial institutions to either form their own technical departments or borrow knowledge from ad hoc technical bodies as the one proposed in chapter X of this report for coordinating technical activities in the Argentine process industry sector.

B. FORECAST OF THE ARGENTINE MARKET OF ENGINEERING SERVICES

Investments and current expenses in the Argentine public sector could reach the following figures between 1974 and 1977:*

-total public investment would range between three and five thousand million U.S. dollars per year, at the 1973 prices.

-the National Government's annual current expenses would maintain in approximately three thousand million dollars, also at the 1973 prices.

-the large projects and programs, mostly managed by State enterprises and agencies, would lead to an approximate investment of 15,500 million dollars, as per the following figures:

	MILLION US$
.syderurgical program	1,140.0
.petrochemical program	581.0
.pulp and paper program	383.0
.naval construction program	400.0
.copper project	34.0
.agricultural development program for the Chaco semi-arid area	2,100.0
.fishing development program	150.0
.Salto Grande project	463.0
.Yaciretá-Apipé project	2,458.0
.Alicopa hydroelectrical complex	593.0
.Río Tercero nuclear center project	250.0
.Program for the construction of dwellings	6,400.0
.Potable water and sewage national project	547.0

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* Data has been taken from the *Plan Trienal*, República Argentina, Poder Ejecutivo Nacional, December 1973. Figures in U.S. dollars have been calculated on the basis of 10 Argentine pesos per dollar. In the meantime, between my preparing the Spanish preliminary report (1974) and my writing this revised English version, Argentina has undergone shocking political and economic changes and soaring inflation: it is now extremely difficult to identify which programs and projects still survive and to ascertain the validity of the figures. Nevertheless, they remain as good indicators of what is to be done in the near future.

Among those large total figures, process industries would call for investments of over two thousand million dollars during that three year period, only considering the syderurgical and petrochemical programmes, the pulp and paper plants and the copper project.

Considering that detailed engineering does usually require 10% of the investment, the execution of the above mentioned projects would devote two hundred million dollars to the engineering market, that is, almost a yearly average of 70 million.

A structure liable to give a response to such demand should provide seven million men-hours, on the basis of a ten dollar average cost per hour. This would involve almost four thousand people working on a full time basis (8 hours a day, 20 days per month and 11 months in a year), split into approximately 1,500 engineers and 2,500 technicians and draftsment (considering a ratio of almost 2 auxiliary men for each professional).

At least for the petrochemical program, it was understood that 75% of the potential demand on the construction and capital goods industries could be satisfied by the local market and that the remaining 25% would have to be covered with imports. The latter percentage includes payments on technology, basic knowledge and preliminary engineering.

Services from process engineering firms would also be demanded by other projects, such as those dealing with nuclear power plants, potable water and sewage systems, fishing, and rural development in the Chaco semi-arid region.

C. CONSULTING SERVICES

I have not been able to analyze Argentine consulting firms as thoroughly as engineering firms and, therefore, I am doing without data on their financial capacity, on their capital origin and on the reach of their human resources. Thus, my comments in this field are mainly based on facts observed during my consulting activities in the Argentine market.

Argentine consulting and engineering firms have never been neatly differenciated. Engineering firms are often involved in market analysis and in pre-feasibility and feasibility studies, while, in turn, many consultants provide services connected with preliminary or detailed engineering and supervise the construction and assembly of industrial and civil works.*

That is how, when analyzing the list of member enterprises of the Argentine Chamber of Consultants, we find one of the firms that are also offering process design services in the Guide of Suppliers for Process Industries, while some of the other 47 member consulting firms do with calculation and design teams that are qualitatively comparable to those at some engineering firms.

On the other hand, some consulting firms do not even have sufficient and qualified human resources for the tasks involved in the organization of knowledge. Their manpower is assembled for each project. Individual experts are hired and brought together in teams that, at the most, last out the project.

On 1960, the Consejo Federal de Inversiones (CFI - Federal Council for Investments) was organized, as per an agreement among provincial governments, "to perform studies, analyze projects tending to economic development and provide technical assistance to the provincial governments".**

In order to accomplish these aims, the CFI was not only supposed to evaluate projects filed by the provinces, but also to help them in

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* See the distinction made between consulting or pre-investment work and engineering or project execution work, in Chapter I of the author's report *Engineering and Pre-Investment Work.*

** C.F.I., *Plan de Acción 1970*, Buenos Aires, Page 1.

organizing new ones. That is, a good part of its action involved typical consulting pre-investment work. That was how it was understood by its officials who, since then, have been shifting between two working modalities that could have coexisted but that, in practice, excluded eachother: during certain periods, the CFI tried to become a large national consulting firm in itself; some other times, it preferred to delegate the project evaluation and organization tasks into other enterprises or entities, either private or public and to dedicate itself only to coordination and supervision work.

The alternate application of these two operating methods brought along the formation and destruction of the internal teams* During those periods in which the CFI relied on third parties, its action did not considerable contribute to the progress of private consulting firms.

When procuring consulting services outside its own organization, the CFI assumed that, if enterprises were allowed to freely compete with eachother, only the strongest, the most capable and the best organized would succeed. The practical results showed the "atomization" of the Argentine firms and the predominance of large international consulting groups in the most important projects, specially in those for infrastructural work on which the CFI could not exert any influence.

In the contests connected with works demanded by the CFI, the proposals were first selected as per the antecedents of the offerers. In order to evaluate them, the individual merits of the experts who had compromised to participate in each team were considered. Evidently, that is the only means for a new team to obtain its first job and start activities as such. The CFI should then have helped those groups to attain cohesion and permanence and to develop, among other things, by means of an adequate retribution allowing them to build up capital. But, when the prices were discussed with the selected firms, the CFI allowed for very low fees to be paid to experts and, therefore, teams were inflated not only to accumulate antecedents by summing up individual merits, but also to get a price that would cover the real fees of those who were actually going to work in the project. Even so, the possibilities for satisfactorily retributing the

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* At the time this research work was performed, the CFI was again preferring to act as a consulting organism in itself and again trying to constitute adequate internal teams for such work.

experts' work and for obtaining net incomes liable to be capitalized for sustaining future work were so low that the teams hardly survived the project for which they were set-up.

The following observations were made in relation with two quotations filed with the CFI by two different enterprises on 1971 and they may be taken as typical examples of the figures under discussion at that time:

i) The expenses concerning project managers, first and second level experts and auxiliary project technicians do not explicit social charges, thus confirming that the professionals and technicians were not under a permanent payroll but contracted as independent workers on a temporary basis. In other words, they were to pay retirement and other social charges by themselves.

ii) Instead, the quotations showed that the clerks and secretaries were the only ones hired on a permanent basis, since the social charges on their salaries appeared as being paid by the bidders.

iii) In one quotation, the profits were reported to be 10% of the total obtained by adding expenses in personnel; the specific expenses of the project, such as travel expenses, payment of surveys and rent for vehicles and offices; and incidentals. In the second quotation, profits increased to 15%.

iv) The hourly fees paid to personnel in the various levels, in U.S. dollars (calculated at the official exchange rate in force at that time: 7.51 Argentine pesos per dollar), would be the following, on the basis of 160 hours per month:

-managerial level	3.75
-first level experts	2.50
-second level experts	∿ 1.90
-auxiliary technical personnel	1.25

v) Services were being offered at an average hourly price of 2.6 US$ in one case and of 3.6 US$ in the other. In the latter case, the quotation was accepted after a discussion between the CFI officials and the consulting engineers which lead to a price reduction to US$ 3.2 an hour.

It is interesting to compare the above figures with the sales prices for design engineering at the Andean Pact member countries summarized in Fig. VI.2. We have also included the prices that were usually paid for those services in the United States, Canada and France, by the same time.*

As far as Mexico is concerned, the information I have been able to collect shows the following overall picture:

i) The members of the board and the professionals in the managerial level of consulting or engineering firms were getting approximately 3,000 US$ a month, that is, approximately 18.75 US$/hour.

ii) The lowest pay to technicians at the auxiliary level, such as to a beginner draftsman, was about 300 US$/month, that is ~1.9 US$/hour.

iii) Under a 1:2 ratio between engineers and technicians, an hour of engineering had a direct average personnel cost of approximately 3 US$, considering medium salaries of 1,000 and 400 dollars per month for engineers and technicians respectively. Adding 40% for social charges (vacations, retirement, Christmas Bonus, holidays, etc.) a cost of 4.2 US$/hour was reached.**

iv) Overhead (including personnel training and administration, and sales expenses) was calculated as 80% of the direct personnel costs, raising hourly costs to 7.6 US$.

v) Considering a 15% profit on costs, final sales prices ranged around 9 US$/hour.

Regarding the precariousness of the teams, a report by an Argentine enterprise stated that: "...it would not be proper to get a specialized job and then form the technical team"; and referring to its own policy of searching for specialists in advance, it indicated that this "..allows for increasing the participation of the enterprise in the evergrowing range of alternatives

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* The data on Canada, the U.S. and France has been taken from *Bases para una Política de Desarrollo de la Ingeniería de Estudios*, Asociación de Ingenieros Consultores de Chile. Both this publication and most of the data on the Andean Pact countries were made available to me by Francisco Sagasti.

**In this case calculations were made on the basis of 200 working hours per month.

FIG. VI.2. ENGINEERING SERVICES SALES PRICES IN US$/HOUR (includes salaries, social charges, overhead, incidentals and profit)

	PERU	BOLIVIA	COLOMBIA	CHILE	ECUADOR	ANDEAN AVERAGE	U.S.A.	CANADA	FRANCE
PROFESSIONALS									
-Specialists	15/22	12/15	11/13	14/18	11/14	13/16	25/30	20/25	20/26
-15 years experience or plus	12/20	10/12	9/12	12/15	9/11	10/14	20/25	17/20	18/20
-5 to 15 years experience	8/15	8/10	7/9	8/12	7/8	8/11	15/20	12/17	12/18
-less than 5 years experience	7/12	6/9	4/7	6/9	5/6	5/9	13/15	9/12	10/12
TECHNICIANS									
-Designers with 15 or more years of experience	5/8	4/6	3/5	5/7	4/5	4/6	12/15	9/12	10/13
-Draftsmen with less than 15 years of experience	4/6	3/4	2/4	3/5	2/3	3/4	10/12	8/12	8/12
-Assistants	2/4	1.5/2.5	1.5/3	2/4	1.5/2	2/3	6/10	6/9	5/9

NOTE: The lowest and the highest figures registered are given for each case.

offered by the Argentine industrial sector".

As brilliant as they individually may be, a set of experts, temporarily associated to perform a specific project may not be compared with an integrated interdisciplinary, permanent team benefiting from both the "cross fertilization" involved in organizing various projects and the economies attained through the repetition of others.

In spite of their structural weakness, some Argentine consulting teams are still giving shelter to some very valuable professionals and technicians able to analyze development problems and to organize projects aiming to solve those problems under a multidimensional approach, encompassing cultural, social, economic, human and environmental considerations. However, since the retributions do not allow for a full-time dedication, these activities are shared with positions in the public sector or in private production enterprises. Thus, approximately 50% of the 48 professionals representing the member firms at the Argentine Chamber of Consultants had had a public function at one time or another in the Argentine political life.

Talented teams, apt for organizing knowledge as per the local needs, may also be found both in public and private research centers. Some of them have difficulties in assuming that knowledge is a commodity that is to be offered following the requirements of its demanders, who may prefer one type of technology to another, but who are also open to stimuli towards using those more appropriate to their society, their cultural and their natural environments, when the offerers are willing to influence in this direction. They have not yet internalized the fact that the entrepreneurial spirit may and must be compatible with creativeness, with independent criteria and with the social orientation of the works.

On the other hand, some of those teams have not found a way -or have not looked for it- so as to generate the necessary capital in order to develop their organizations by adequately marketing their consulting services. They often curtail themselves from a convenient retribution by subconsciously submitting to old myths linking knowledge with purity and money with dirtness.

"*Pure research* is a term you donot use, unless you automatically consider that something else is contaminated or dirty".*

The use of money and knowledge has more than one dimension and more than one direction.

A participative rural development project for whose organization a complex consulting team may demand a large amount of money could highly benefit the country. Instead, a project developed by a "pure" research institution without any profit for the latter, may lead to undertakings concentrating money in a few pockets, injuring the environment or having little influence on employment.

* Derek de Solla Price, *The Relations between Science and Technology and their implications for Policy Formation*, FOA, Stockholm, 1972, page 3.

CHAPTER VII

THE CHEMICAL INDUSTRY IN MEXICO

A. CONTEXT UNDER WHICH THE MEXICAN CHEMICAL INDUSTRIES EVOLVED

On 1963, the richest 5% of the Mexican population seized 38.3% of the income, while the poorest 50% shared only 17.5% of the same. The average yearly income among the latter ranged between 300 and 700 U.S. dollars per family, while that of the richest was about 12,000 U.S. dollars.* The poor do not have the sufficient resources so as to procure decent living quarters, food and clothing, while many industrial structures have been installed with the single purpose of satisfying superfluous desires of the rich.

On 1970, 61.9% of a sample of enterprises manufacturing endurable goods and 72.8% of a similar sample manufacturing consumer goods, were using less than 75% of their installed capacity. When the reasons for this misused installed capacity were surveyed, 68.4% and 72.2% of the firms in the respective samples did somehow indicate that the market capacity had been over-estimated.**

On 1911, 80% of the Mexicans lived on agricultural activities. However, 95% of the rural population did not own a single piece of land.*** Since then, 66 of the 95 million hectares formed by natural pastures and cultivable land**** in the Mexican territory have been distributed among 2.5 million farmers, resulting in an average of about 26 hectares per unit.

"Most of the land requires large investment so as to become really profitable to the receiving farmers".*****

In spite of this, as a general rule, public investment in irrigation systems, roads and credit was mostly devoted to already existing private commercial farms -non resulting from the land distribution nor being affected by the same- which, under those conditions and due to their larger size, were able to apply modern techniques so as to increase their productivity.

***El Perfil de México en 1980*, Siglo XXI, Mexico, 1970, page 37.

**M. Ramírez Rancaño, *La Burguesía Industrial*, Instituto de Investigaciones Sociales, UNAM, Mexico, 1974, pages 184 and fol.

***H. Harms, *Geografía Universal*, Ateneo, Buenos Aires, 1969, Vol. 5, page 142.

*****ibid*, page 154.

******Revista del Banco de Londres y América del Sud*, Buenos Aires, October 1969, Vol. VI, No. 94, page 665.

Reynolds* considers that the agricultural policies followed in Mexico after 1910 -and specially after 1940- were dual. On one hand, by means of small inalienable land units (ejidos), they promoted subsistence farming among large masses of peasants. On the other, by favouring medium and large-sized properties by means of structural works and credit, they increased the availability of food and industrial crops for the urban centers and for export. I dare say it was actually a triangular play, since, as Reynolds himself reports, some ejidos were united and organized into cooperatives, that, by applying advanced techniques, were able to compete with the most productive rural firms.

Nevertheless, cooperative farming was the weakest of the three agricultural policies and the first one to be discontinued, while the system of individual very small ejidos was slowly impaired by pressures exerted by interests controlling the commercial farms and handling the marketing of the agricultural goods.

The owners of the ejidos are now needing technological education, credit and the support of appropriate infrastructural work, so as to obtain products from their exhausted and eroded soil.** Without that public aid, the ejidos are now only in force as a kind of social security for the peasants: when they cannot find a job in a commercial farm or in an industrial plant, they may go back to their own piece of land. Although forbidden by the law, the ejidos are often rented or exploited on a societary basis: the peasants, when working somewhere else, do always find a way to evade the regulations and to get some rent from their piece of land.***

"Due to its continuous disregard for small farmers, the land reform programme must be considered as still far from completion"****, in spite of the

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*Clark W. Reynolds, *La Economía Mexicana: su Estructura y Crecimiento en el Siglo XX*, Fondo de Cultura Económica, Mexico, 1973, pages 166 and fol.

**About 25% of the territory has a 25% slope and erosion risks become critical when slopes are above 10%, unless control techniques are applied. H. Harms, *op.cit.*, page 158.

***Clark W. Reynolds, *op.cit.*, footnote in page 185.

*****ibid*, page 195.

fact that it arose from a revolutionary outburst under the slogan *Land and Books!* *

Since a minimum level of subsistence was secured for a large number of peasants, by -to a certain extent- fixing them to the land, and, since a regular food supply was attained for the urban centers from the commercial agricultural exploitations, the cost of living has not been excessively increasing.

It is interesting to compare the yearly percentages of increase in the cost of living in Mexico and in Argentina, between 1945 and 1966, shown in Fig. VII.1.

FIG. VII.1. INCREASE IN THE COST OF LIVING (%)

YEAR	MEXICO	ARGENTINA	YEAR	MEXICO	ARGENTINA
1945	7.5	19.7	1956	3.7	13.4
1946	24.7	17.7	1957	6.0	24.7
1947	13.0	13.5	1958	12.3	31.6
1948	6.0	13.1	1959	2.0	113.7
1949	5.4	31.1	1960	5.9	27.3
1950	5.9	25.6	1961	0.9	13.5
1951	13.5	36.7	1962	0.9	28.1
1952	15.2	38.7	1963	0.9	25.9
1953	3.0	4.0	1964	2.7	22.1
1954	6.1	3.8	1965	3.5	28.6
1955	15.8	12.3	1966	4.2	31.9

Sources: For Mexico, *El Perfil de Mexico en 1980*, Vol. 3, Siglo XXI, Mexico, 1970. For Argentina, Instituto Nacional de Estadística y Censos.

* K. S. Karol, a newsman at Le Nouvel Observateur, in Paris, in an article reproduced by the Buenos Aires paper *La Opinión*, June 30, 1974, under the title "La Imaginación al Poder", tells the following anecdote: During the 1960 Former-President Lázaro Cárdenas' tour along areas that had benefited from his land reform programme, an old peasant came close to him and, familiarly, asked him: "Daddy Lázaro: you gave us the land, but 'they' came back for it, because we did not have the means to make it valuable. You built a school and a hospital for us, but 'they' came and turned them into a garrison and a brothel. Dad Lázaro: what's this revolution you've made?"

Reynolds points out that -as compared with the rest of the Latin American countries- the balance reached in Mexico between its agricultural and industrial development is rather strange.*

This was a balance attained at the expense of a large pauperized mass resulting in a limited local market and in cheap labour permanently available to the agricultural and industrial entrepreneurial world. This may so earn profits by just giving a response to the demand of the privileged sector.

The average agricultural yields (see Fig. VII.2. and compare with Fig. III. 3.) are still low. However, Reynolds indicated that, between 1942 and 1961, there has been a flow of surplus from the agricultural to the industrial sector, through financial intermediaries, as a response, in turn, to a reversed flow arising from infrastructural works performed by the Government for the benefit of the commercial rural sector and partly financed with taxes collected from the industrial one.

FIG. VII.2. AGRICULTURAL YIELDS IN MEXICO ON 1972

PRODUCTS	UNITS	YIELD
Wheat	100 kilos/hectare	27.2
Corn	100 kilos/hectare	11.4
Beef	kilos/head	165.9
Milk	kilos/cow/year	1,100.0

Source: FAO's *Production Yearbook 1972*, Vol. 26, Rome, 1973.
NOTE: The data on beef was calculated on the basis of the number of heads slaughtered and of the amount of beef produced.

The agricultural and mining sectors, as well as those traditional industries manufacturing essentials, are likely to have produced a surplus that could have been transferred for further industrialization, well before the above mentioned period, but the fear resulting from the continuous revolts and wars must have drained it out of the country.

* Clark W. Reynolds, *op.cit.*, page 189.

The scarcity in internal capital and in production and managerial technologies seems to have led to a kind of *triple entente* among the government, local entrepreneurs and foreign interests.

Thus, even though the participation of local capital in the industrialization process is increased, the percentage of income drained outside the country is also higher, due to a simultaneous increase in the financial and technological indebtment.

On 1965, 52.3% of the assets in foreign enterprises installed in Mexico were locally financed. Such percentage reaches 63.6 on 1970.* About 2,353 million dollars were registered to have come into Mexico between 1957 and 1970, considering foreign investment, profit reinvestment, availability of accumulated profits and accounts payable among enterprises. During the same period, 3,359 million dollars were taken out of the country, considering payments on profits, interests, royalties, etc.**

Since the end of the revolutionary period (~1920), the State has been permanently involved in the industrialization process, both as a direct producer and as a superstructural agent regulating, controlling and promoting private investments. Among its 166 different undertakings in commerce, finance, transportation, research and development, and many other fields, 46 are industrial enterprises created between 1920 and 1969.***

Between 1970 and 1973, the Mexican Government is reported to have purchased the majority or at least 50% of the shares in 11 additional enterprises and a minor share of another 10.****

As a promotional and regulating agent, the Mexican Government aided both local and foreign entrepreneurs by means of custom protection, cheap loans and tax reductions.

Gross fixed capital formation in 1970 was split as follows: 65% by the

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*B. Sepúlveda and A. Chumacero, *La Inversión Extranjera en México*, Fondo de Cultura Económica, Mexico, 1973, Table 25.

**M. Ramírez Rancaño, *op.cit.*, page 111.

***These figures were calculated on the basis of a list of Government agencies and enterprises contained in El Perfil de México en 1980, *op. cit.*, page 192. I have added Teléfonos de México and Vehículos Automotores Mexicanos.

****Mario Ramírez Rancaño, *op.cit.*, page 206.

private sector and 35% by the public one. The foreign enterprises shared 8.5% of the private sector's contribution and generated 12.6% of the total country's production. They paid 20.3 of that year's total income tax.*

Foreign investment is preferentially oriented towards the most dynamic and terminal sectors, in which there is very little action by the State, or towards those fields involving very complex technologies or the production of capital goods. Thus, in 1970, almost 74% of the foreign investment had concentrated in the so-called manufacturing industries and the participation of foreign enterprises in the total production of this field reached, in the same year, 27.6%.**

The preferences shown by foreign enterprises when investing in the manufacturing industries are shown in Fig. VII.3.

The Mexican regional unbalance does not occur between the ports and the hinterland, as it does in Argentina. On the contrary, it follows widely spread patterns in the geography of underdevelopment: it has a rich North and a South whose poverty resembles that of its neighbouring Central American isthmus. In the North (Nueva León, Baja California, Chihuaua, Durando, Sonora, Sinaloa, Tamaulipas and Cohahuila), 67% of the population enjoys and benefits from electricity, while its average income per capita is 1.3 times the country's average. In the South (Campeche, Tabasco, Yucatán,

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* B. Sepúlveda and A. Chumacero, *op.cit.*, Tables 11, 14 and 22 of the Statistical Appendix. For these authors:
-Foreign investment is the amount of money invested, independently of its goals. It involves the enterprises' accounting capital owned by foreigners plus external short and long term debts.
-The contribution to the formation of fixed capital refers to the amounts invested in purchasing machinery, equipment, buildings, sites, etc. Such money may come from both local and foreign shareholders and from local or foreign loans. It is obtained by deducting the capital invested in fixed assets at their purchasing prices and at the beginning of the fiscal year from the same value at the end of the same fiscal year.

** Percentages were calculated based on data of Tables 1 and 14 in the Statistical Appendix of B. Sepúlveda and A. Chumacero, *op.cit.*, pages 120 and 170. In these tables, manufacturing industries appear as an item, differenciated from agricultural, mining, oil, construction, electricity, commercial, transportation and other activities. Among manufacturing industries, these authors include: food products, beverages, tobacco, textiles, clothing and footwear,wood and cork products, furniture, paper, printing and editing, leather and leather products, rubber products, chemicals, metallurgy, mineral products excepting coal and petroleum, construction of machines and apparatus, construction of transportation equipment, and a few minor ones.

FIG. VII.3. MEXICAN MANUFACTURING SUB-SECTORS PREFERRED BY FOREIGN INVESTORS (1970)

	FOREIGN INVESTMENT		PARTICIPATION OF FOREIGN ENTERPRISES IN THE PRODUCTION OF THE SUB-SECTOR	
SUB-SECTORS	Million US$	Percentage invested in the sub-sector in relation with total invested by foreign enterprises in manufacturing industries	Million US$	Percentage
Chemical Ind.	618	29.7	1,194	67.2
Manufacture of electrical machinery, apparatus and appliances	215	10.3	609	79.3
Manufacture of transportation equipment	212	10.1	695	49.1
Food products	148	7.1	389	8.6
Manufacture of metallic products excepting machinery and transportation equipment.	125	6.0	241	37.0
Manufacture of machinery, other than electrical.	113	5.4	263	62.0

Source: Data in Figs. 2 and 15 of the Statistical Appendix in B. Sepúlveda and A. Chumacero's work, *op.cit.*, pages 122 and 173. Production figures have been converted to U.S. dollars using an exchange rate of 12.5 Mexican pesos per dollar. Both investment and production figures have been rounded up.

Quintana Roo, Chiapas, Guerrico and Oaxaca), only 28% of the inhabitants has access to the use of electricity and their average income per capita is 0.43 times that of the whole country.

On 1965, only 16% of the Mexican population was protected by the Mexican Institute of Social Security. However, in Oaxaca, this average was as low as 2% at the same time.*

Due to historical reasons, the Central area, which includes the Federal District and Veracruz, the main Mexican port on the Eastern Gulf, shows the highest figures in population and wealth. This area is also benefited by a mild climate.

The North and the Center encompass, in addition to a large area of small ejidos, many large commercial private properties using selected seeds, pesticides, fertilizers, modern management technologies and cheap labour coming from the subsistence farming sector, for the production of industrial crops (cotton, sugar cane) and food (wheat, milk, beef). Fishing and the production of petroleum, coal, iron, zinc, lead and copper are also concentrated in the Northern and Central areas.

Instead, subsistence farming predominates in the South, where the peasants in the ejidos are still using corn cultivation techniques that remind the ones applied by the Aztecs.** Plantations of coffee, banana and agave; creole cattle raising and traditional manual arts are other of the main activities in the Southern area.

The industries installed in the North, centered around Monterrey -and to a lower extent in Mexicali- were preferentially a response to the U.S. demand for products resulting from the transformation of the rich ores in the hills and from a soil fertilized through irrigation.

In the Central area, as a belt to the Federal District and in Guadalajara and Puebla, industries were created for the substitution of imported consumer goods demanded by large urban populations, but, in turn, originating imports of intermediates and capital goods required for their production.

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* These figures were calculated on the basis of data contained in "El Perfil de México en 1980", *op.cit.*, Vol. I, Fig. 8, page 70.

** K. S. Karol, *op.cit.*

When the country started unifying itself, thanks to better communication and transportation means, the North and the Center tended to supplement each other's production and some investments started to be made in the manufacture of intermediate products. Regional interconnection also widened the markets: for instance, beer produced in the North is now being consumed in Oaxaca.*

In the South, Nature is mostly exuberant; however, the poor Mexicans living there are more exposed to its blindness than enjoy its beauty. In the North, great human efforts are required to make Nature fruitful and the income produced through those efforts is not equitably distributed.

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* C. Reynolds, *op.cit.*, page 211.

B. PRESENT SITUATION

The development of the Mexican chemical industry was closely related with the evolution of the exploitation of the country's wealth in petroleum and gas.

The history of most of the oil rich countries shows the difficulties encountered by young nations when trying to recover their fossil fuel wealth from foreign hands. Mexico was not alien to this kind of dramas: when it nationalized its petroleum, the expropriated enterprises destroyed materials and flooded wells.*

Nationalization took place on 1938, under President Lázaro Cárdenas' Government, all its oil wealth remaining in the hands of a Government agency called Petróleos Mexicanos (Pemex), created on June 7 of that year. Before the nationalization, activities in this field almost exclussively devoted to the extraction and export of raw petroleum. After 1938, Pemex oriented the undertaking towards obtaining fuels and lubricants so as to satisfy the demand of the local market. That was how the distillation industry did actively develop. Also the distribution systems were improved by means of the installation of an important net of oil ducts, gas ducts and poli-ducts, which reached over 9,000 kilometers by 1961.**

Pemex is the number-one enterprise in Mexico, with a budget that ranged in 1,200 million dollars by 1968.***

Pemex is the only enterprise producing basic petrochemical products in Mexico: ethylene, propylene, butylenes and many other olefinic, paraffinic and aromatic hydrocarbons. As per the regulations now in force, Pemex is supposed to elaborate by itself -with no association with local or foreign interests- more than forty-five basic and intermediate products (see Fig. VII.4.).

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* For more details, see the interesting work by Angel de la Vega Navarro, *La Société Nationale Mexicaine Pemex et l'Engineering*, IREP, Grenoble, December 1970, mimeographed.

** H. Harms, *op.cit.*, page 157.

***Asociación Nacional de la Industria Química, *La Industria Química Mexicana en 1968*.

FIG. VII.4. CHEMICAL PRODUCTS THAT ONLY PEMEX IS AUTHORIZED TO ELABORATE
(no participation of private interests is allowed)

Ethylene	Ethyl alcohol
Propylene	Ethyl benzene
Butylenes	Ethylene chlorohydrin
Acetaldehyde	Aromatic extracts for carbon black
Acetylene	
Cyanic acid	Isoprene
Acrylonitrile	Methanol
Acrolein	Meta xylene
Isopropyl alcohol	Naphthalene
Ammonia	Ortho-xylene
Benzene	Ethylene oxide
Butadiene	Propylene oxide
Cyclohexane	Para-xylene
Chloroform	Perchloroethylene
Allyl chloride	Poly butylenes
Ethyl chloride	High-density polyethylene
Methyl chloride	Low-density polyethylene
Vinyl chloride	Polypropylene
Cumene	Styrene
Ethylene dibromide	Carbon tetrachloride
Dichloro ethane	Polypropylene tetramer
Methylene dichloride	Toluene
Propylene dichloride	Trichloroethylene
Dodecyl benzene	Vinyl toluene

Source: Sampson, S., *La Industria Química y Petroquímica en México,* IV Congreso Interamericano de Ingeniería Química, Buenos Aires, Abril, 1969.

The manufacture of another 100 and some chemicals derived from the aforementioned (see Fig. VII.5.) may be indistinctly performed by either composite enterprises formed by Pemex and private capital, both local or foreign, or by enterprises belonging exclusively to Pemex or to private entrepreneurs. These investments call for a previous authorization by the Mexican President and for a minimum local capital of 60%. Most of these products are either intermediate or final chemicals but not consumer goods.

The rest of the products do not require any authorization and are free to private iniciative, with no consideration being given to the capital origin.

These regulations find support in Article 27 of the Mexican Constitution that, on 1917, well before petroleum nationalization, established that:

> "The nation has absolute ownership of all the minerals and substances found in veins, stratums, masses or deposits whose nature is different from the regular soil composition, such as the minerals, from which metals or metaloids may be extracted for their industrial use; deposits of precious stones, rock salt and the salt marshes directly formed by sea water; products deriving from rock decomposition when their exploitation calls for subterranean work; phosphates liable to be used as fertilizers; the solid mineral fuels; petroleum and all the solid, liquid or gaseous hydrocarbons".

Between January 1961 and December 1972, manufacturing permissions were issued for products listed in Fig. VII.5. to 110 enterprises, involving, as a whole, 5,491 million Mexican pesos investment (439 million dollars).*

On 1967, the accumulated value of private investments in fixed assets for the chemical industry had reached 10,745 million Mexican pesos (approximately 860 million dollars).**

Between 1957 and 1967, foreign investment contributed in this sector with more than 330 million dollars in financial funds (accounting capital plus debts with their foreign headquarters). 76% of this came from the U.S.***

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* These figures have been calculated on the basis of data shown in: Instituto Mexicano del Petróleo, *Desarrollo y Perspectivas del Sector Secundario de la Industria Petroquímica*, Mexico, July, 1973.

** S. Sampson, *La Industria Química y Petroquímica en México*, IV Congreso Interamericano de Ingeniería Química, Buenos Aires, April, 1969.

***Estimation based on data contained in Table 4 of the Statistical Appendix in B. Sepúlveda and A. Chumacero, *op.cit.*. Figures were rounded up.

FIG. VII.5. PRODUCTS THAT ONLY ENTERPRISES WITH AT LEAST 60% LOCAL CAPITAL MAY ELABORATE, AFTER THE MEXICAN PRESIDENT HAS GRANTED THE CORRESPONDING LICENSE

- Accelerators & antioxidants f/rubber
- Butyl acetate
- Cellulose acetate
- Ethyl acetate
- Isopropyl acetate
- Vinyl acetate
- Acetone
- Acetophenone
- Aceto cyanohydrin
- Acetic acid
- Acrylic acids
- Adipic acid
- Aryl sulfonic acids
- Benzoic acid
- Fumaric acid
- Isophthalic acid
- Nitric acid
- Maleic acid
- Malic acid
- Monochloroacetic acid
- Terephthalic acid
- Chlorphenoxyacetic acids
- Additives for lubricants
- Alkyl phenols
- Acetic anhydride
- Diacetone alcohol
- Polyvinyl alcohol
- Adiponitrile
- Organic amides
- Phthalic and maleic anhydrides
- Aniline
- Anthraquinone
- Benzidine
- Benzaldehyde
- Benzoates and perbenzoates
- Bisphenol
- Butanol
- Polyvinyl butyral
- Butyraldol
- Butyraldehyde
- Caprolactam
- Carboxy methyl cellulose
- Cyanates
- Cyclohexanol and cyclohexanone
- Aniline, benzidine, tolidine and toluidine chlorhydrates
- Chlorobenzenes
- Benzyl chloride
- Choline chloride
- Polyvinyl chloride
- Copolymers of vinyl chloride and vinyl acetate
- Copolymer of styrene and butadiene
- Crotonic aldehyde
- Acetylene derivatives
- Dithio carbamates
- Dialkyl dithiophosphates
- Non-ionic detergents and surfactants
- Diphenylamines
- Dimethyl terephthalate
- Ethanol amines
- Glycol ethers
- 2-Ethyl hexanol
- Ethylene glycols
- Ethylencyanohydrin
- Epichlorohydrin
- Phenols
- Formaldehyde
- Ammonium phosphates
- Phthalates
- Hexamethylene diamine
- Synthetic rubber
- Intermediates for dyes
- Methyl methacrylate
- Methyl amines
- Methyl, ethyl and hydroxiethyl cellulose
- Methyl isobutyl carbinol
- Methyl ethyl acetone
- Ammonium nitrate
- Nitro toluene
- Carbon black
- Nitro-benzene
- Mesityl oxide
- Polyacrylonitrile
- Chlorinated paraffins
- Penta chloro nitro benzene
- Penta chloro phenol
- Pentaerythritol
- Propylene glicols
- Polystyrene
- Calcium pantothenate
- Parathions and malathions
- Benzoyl peroxide
- Diterbutyl peroxide
- Methyl ethyl acetone peroxide
- Acrylonitrile-butadiene styrene copolimers
- Epoxy resins
- Ammonium sulphate
- Synthetic tannins
- Toluidine
- Tolidine
- Trinitro toluene
- Tetraethyl lead
- Urea

Source: Sampson, S., *op.cit.*

Within a list of 242 subsidiaries of large U.S. corporations operating in Mexico*, a quick analysis allows for detecting 40 as operating chemical industries.**

Approximately 78% of the total accumulated investments of those 242 enterprises was devoted to the so-called manufacturing industries in 1970 and, in turn, 33% of this percentage was dedicated to the chemical sector.***

On 1970, the financial means of all the foreign enterprises in the chemical sector divided as follows: 45% accounting capital, 16% debts contracted abroad and 20% debts contracted locally.****

Within the chemical sector, the petrochemical industry showed an excessive installed capacity on 1971 (see Fig. VII.6.). However, such installed capacity would apparently be insufficient for satisfying the demand expected for 1977, as foreseen in 1973.*****

According to the statistics, the secondary sector (mainly intermediate and final petrochemicals) worked under 35% idle capacity in 1971. This situation might have resulted from:

- the demand from the terminal industries being lower than expected;
- some intermediate sequences having not been integrated; and/or
- the expected export volumes having not been reached.

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*B. Sepúlveda and A. Chumacero, *op.cit.*, pages 251 and fol.

**The economical activities considered as chemical industries do often vary among the various public agencies in Mexico. Thus, the Banco de Mexico includes the manufacture of medicaments and pharmaceuticals, as well as perfumes, cosmetics and similar products. These items are not included in the statistics of the Asociación Nacional de la Industria Química. On the other hand, the industrial census included both the manufacture of plastic materials and that of consumer goods made with them, including toys and footwear, under chemical industries. As per our definition in Chapter 1, the latter would not even be included among process industries. For a detailed description of the statistical differences, see: Instituto Mexicano del Petróleo, *op.cit.*, pages I-1 through I-4.

***B. Sepúlveda and A. Chumacero, *op.cit.*, Table 2, page 234.

*****ibid*, Table 4 of the Statistical Appendix.

*****Data on the foreseen consumption for the various products in 1977 may be analyzed in: Instituto Mexicano del Petróleo, *op.cit.*, pages I-84 and I-85.

FIG. VII.6. PETROCHEMICAL INDUSTRY - INSTALLED AND USED CAPACITY - 1971

	INSTALLED CAPACITY (Tons/year)	USED CAPACITY (%)
Secondary sector		
Artificial and synthetic fibers	106,630	71.2
Polymers of synthetic fibers	87,700	60.5
Resins*	213,320	57.3
Plasticizers	46,750	43.5
Fertilizers**	1,477,500	64.8
Pesticides	15,695	62.7
Elastomers	85,000	57.3
Auxiliary products for rubber	48,736	62.5
Various products	196,510	58.7
Intermediate products	427,757	75.4
TOTAL SECONDARY SECTOR	2,705,598	65.1
BASIC SECTOR	1,692,648***	80.3
T O T A L	4,398,246	70.9

* Does not include polyethylene, which is registered under the basic sector.

** Does not include ammonia, which is registered under the basic sector.

*** For carbon dioxide, the sales figures were taken as equivalent to the installed capacity. For sulfur, the capacity of the new plant at Refinería Madero was not considered because it was not yet in operation on 1971.

Source: IMP, *Desarrollo y Perspectivas del Sector Secundario de la Industria Petroquímica,* Mexico, 1973, pages 1 through 11.

The 20% idle capacity observed in the basic sector* and the importation of some products (see Fig. VII.7.) that could be obtained from other basic or intermediate ones that were being manufactured in Mexico serve to corroborate the above assumptions.

In order to allow for a comparison between the Mexican and Argentine imports of products from process industries, Fig. VII.8. shows the total Mexican figures for the same sections of the Brussels Customs Nomenclature included in Fig. III.8. for Argentina.

Mexico does with some autochthonous technologies in the chemical industry and in the whole process industries sector. I can mention, for instance:

i) The use of reducing gases instead of coke in the metallurgical extraction of iron, as developed by a Mexican production firm.

ii) The obtainment of alumina as from alunites, considering the lack of bauxites; the process underway at the University of Guanajuato is simultaneously producing potassium and ammonium sulphates that are being used as fertilizers.

iii) The processes for manufacturing newsprint from bagasse, developed by two different engineering firms in association with Mexican entrepreneurs.

iv) The production of ammonium sulphate perfected by an engineering firm, following original ideas of two Mexican technicians.

* The statistics we are analyzing include some products, such as polyethylene and polypropylene, under the basic sector, while, following the criteria proposed in Chapter 1 of this report, they would be considered as final chemicals.

FIG. VII.7. MEXICAN IMPORTS OF PRODUCTS FROM CHEMICAL AND SOME RELATED PROCESS INDUSTRIES (1972)

	MILLION US$ CIF	AVERAGE UNIT COST CIF US$/Kilo
Phosphorus	8.1	0.43
Sodium	1.0	0.38
Ammonia	6.2	0.04
Sodium hydroxide	1.1	0.08
Aluminum oxide and hydroxide	7.0	0.08
Artificial corundum	0.7	0.29
Calcium hypochlorite	0.9	0.51
Calcium Phosphate	0.7	0.22
Sodium carbonate and bicarbonate	0.9	0.06
Sodium tetraborate	1.5	0.13
Butadiene	5.4	0.11
Non-saturated acyclic hydrocarbons	4.4	0.12
Styrene	1.1	0.13
Aromatic hydrocarbons	2.0	0.10
Trichloroethane	1.0	0.16
Vinyl chloride	4.3	0.11
Phenol and nitrophenol	2.5	0.29
Propylene oxide	1.9	0.20
Ethylene oxide	3.3	0.16
Acetaldehyde and Butyr aldehyde	4.1	0.14
Cyclo hexanone	1.8	0.34
Methyl methacrylate	2.0	0.40
Terephthalic acid and dimethyl terephthalate	11.8	0.31
Tartaric acid	0.9	0.87
Sodium glutamate	1.0	0.83
Toluilen diisocyanate	1.5	0.66
Mercaptans	1.1	0.91
Tetraethyl lead	1.9	0.78
Hexagonal heterocyclic compounds	2.3	28.61
Caprolactam	12.0	0.47

FIG. VII.7. (continued)

Ascorbic acid	1.0	4.40
Carotene	1.2	49.83
Natural and synthetic hormones and derivatives	2.6	254.36
Antibiotics	8.7	84.50
Ammonium sulphate	5.4	0.03
Ammonium nitrate	2.3	0.06
Sodium nitrate	1.1	0.07
Potassium sulphate	1.1	0.05
Potassium chloride	1.9	0.03
Insecticides	4.5	3.02
Fungicides	1.1	3.10
Herbicides	0.8	3.13
Sizes, mordants and other preparations used in textile, paper leather and related industries	1.2	1.29
Petroleum coke for electrodes	1.9	0.09
Catalysts	2.7	0.71
Polyethylene terephthalate	17.9	0.83
Polyvinyl alcohols	1.1	0.65
Polyvinyl chloride	2.0	0.37
Polyvinyl chloride	2.0	0.37
Polypropylene	4.9	0.30
Polyethylene	9.7	0.28
Nitro cellulose	2.0	0.57
Natural rubber	7.2	0.36
Synthetic rubbers	4.3	0.70
Rubber products incl. some types of tires	2.2	0.46
Quebracho* extracts	1.4	0.29
Sensitized papers for radiographs	1.2	5.13
Polychromatic photographic films incl. those for instantaneous development	3.0	17.73
Black and white photographic films	1.8	11.37
Polychromatic cinematographic films	2.4	14.72
Cinematographic films already developed	1.0	20.36
Papers, cardboards and fabrics sensitized to reproduce polychromic images	3.5	4.86
Developers, fixing baths and photog. emulsions	1.2	1.36

*Extract rich in tannins from the homonymous South American tree.

Source: *Anuario Estadístico del Comercio Exterior de los Estados Unidos Mexicanos - 1972*, Secretaría de Industria y Comercio - Dirección Nacional de Estadística, Mexico, 1973.

NOTES: -Pharmaceutical, metallurgical and food products have not been analyzed.

-The list only includes those items related to process industries derived products in which imports amount to at least twelve million Mexican pesos. The figures in the latter currency have been converted to U.S. dollars, applying an exchange rate of 12.5 Mexican pesos per dollar.

FIG. VII-8. MEXICAN IMPORTS: GLOBAL FIGURES FOR SOME SECTIONS OF THE CUSTOM'S NOMENCLATURE RELATED WITH CHEMICAL AND OTHER PROCESS INDUSTRIES (1972)

Section		CIF VALUE MILLION US$
28	Inorganic products	46.6
29	Organic products	209.8
30	Pharmaceutical products	8.7
31	Fertilizers	13.9
32	Tanning and dyeing extracts; dyes, paints, varnishes, inks, etc.	15.2
33	Perfumeries, toiletries and cosmetics	7.2
34	Soaps, detergents and cleaning products	6.1
35	Albuminous materials and glues	2.8
36	Gunpowders and explosives	1.8
37	Photographic and cinematographic products	21.8
38	Various products of the chemical industries	34.4
39	Synthetic plastics, cellulosic ethers and esters, synthetic resins and manufactures made with those materials.	70.8
40	Natural and synthetic rubber and rubber manufactures	26.7
48	Paper, cardboard and manufactures made with pulp, paper and cardboard.	63.8
73*	Pig iron, iron and steel	116.2
74*	Copper	3.6
76*	Aluminum	28.6

Source: *Anuario estadístico del Comercio Exterior de los Estados Unidos Mexicanos, 1972,* Secretaría de Industria y Comercio, Dirección General de Estadística, Mexico, 1973.

* These sections, in addition to raw metals, include products manufactured by their mechanical working.

CHAPTER VIII

MEXICAN PROCESS ENGINEERING AND CONSULTING ENTERPRISES

A. ENGINEERING FIRMS

General comments

The Mexican process engineering teams developed sheltered by a strong demand from foreign enterprises, specially transnational corporations, installed in the country, and with little support from local entrepreneurs and from the Mexican Government.

The first who, in Mexico, followed the new engineering careers connected with industrial development were the sons of traditional, high-society families, culturally influenced by the United States, where those new disciplines were booming since the beginning of the century. Most of the new engineers made their postgraduate studies in American schools and, simultaneously, started getting in touch with the decision-making sources for private U.S. investments in Mexico. Those vincula supplemented already existing links between the North American capitals in Mexico and the Mexican financial circles acting as their support.

The personal acquaintances arising from commercial contacts, reinforced by social gatherings in Mexican clubs, restaurants and selected homes, replaced the requirement for formal antecedents when foreigners procured local services. Even more, they served to convince foreigners of the advantages involved in using local independent services, as opposed to building large engineering departments within their affiliates or bringing in detailed engineering from their headquarters with no adaptation to local conditions.

This was not the case in Argentina, where, as stated in Chapter III*, the engineers working on the new industrial technologies did not belong to, nor were coopted by, the social classes acting as intermediaries or local partners to foreign interests building the most important Argentine industrial undertakings related with those new technologies.

Imports of detailed engineering were soon discarded in both countries because local services were much cheaper than those from the United States. However, this does not serve to explain why transnational corporations preferred those local services to be external in Mexico and internal in

* See pages 50 and fol.

Argentina. I dare say that this may only be explained by socio-cultural factors such as those described at the beginning of this Chapter and in Chapter III.

Contracting the detailed engineering with local firms, external to the production enterprise, entails less risk than forming internal teams. The human resources involved in the latter must be retributed whether there is demand for their services or not within the enterprise and it is hard to get rid of them when there is little work, because:

-they are later on hard to replace, when valuable;
-in each new expansion period, the training expenses would be incurred again; and
-dismissal indemnization costs are high.

Engineers and technicians working for engineering firms are fast in getting experience, due to their participation in different projects. Those working for an entrepreneurial pool gain in thoroughness by means of a certain specialization in the technologies operated by their employers but do usually loose both flexibility and some creativeness.

Anyhow, even in Mexico, confidence on local capabilities started growing gradually, and, as in Argentina, began with civil works. But the Mexican further evolution was faster: once they passed the test of the first modest execution and organizational tasks with which they were entrusted, local firms saw an acceleration of the demand for their services. Successive projects of increasing complexity were granted to them.

In the area of the Mexican Federal District, civil work had very serious difficulties: the soil is very loose for foundations and is even sinking, while other areas suffer from strong seismic movements.

The good performances of the Mexican civil engineering when answering those challenges have contributed to the generation of a favourable predisposition to use the local engineering capacity also in other technologies.*

At the very beginning, even the Mexican construction firms based their work on foreign civil engineering, but soon the aforementioned local peculiarities obliged them to look for local services. Furthermore, those services were required to solve, not only strictly civil engineering problems, but also mechanical and electrical questions encountered in construction work.

On the other hand, process engineering firms soon learned that:

- customers were highly attracted if integrated teams were offered for their projects with a project manager coordinating the work of engineers specialized in each one of the fields demanded by the project (task forces);
- working as a contractor paid higher profits than pure engineering.**

Thus, a two-way tendency originated: the old construction firms branched out into engineering firms and engineering firms gave rise to new construction and assembly enterprises.

As a general rule, both engineering and construction firms build very little equipment. The purchase of the same, including shop inspection and receiving at the building site, (procurement), is undertaken either for a percentage of the purchased value or by invoicing the men-hours dedicated.

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* Many original construction methods are worth being quoted, such as that of using control piles, performed by Eng. Manuel González Flores; that of "flotation", invented by Eng. José A. Cuevas; or the impressive reinforced concrete structures developed by Juan O'Gorman. Other interesting examples of Mexican civil engineering works are: the roofing and foundation structures, designed following paraboloid outlines; the highways and bridges in mountain areas; and, very recently, the many partial solutions afforded by Mexican engineers to difficulties encountered in building the Capital's underground system. For more details, see: E. G. León López, *La Ingeniería en México*, Sep-Setentas, Mexico, 1974. This author describes the case of the Fine Arts Palace, started before the 1910 revolution by the firm Milliken Bros., from New York, and finished on 1932 under drawings by the Mexican engineer Federico Mariscal, who had to build new supports under the original foundations to stop the sinking of the initial structures, which had been designed without considering local conditions.

** As an average, 10 to 12% of the expenses in a project pay for engineering services, 30 to 35% represent the construction and installation costs and about 50% is money invested in equipment.

I was able to learn about an interesting case that may serve to illustrate some aspects of the evolution as outlined above. When a large transnational corporation installed its first plant in Mexico, its project manager, needing support from the local engineering forces, made arrangements with a firm that had just been installed by Mexican engineers. That manager became a close friend of the Mexican engineers and, as he started trusting them more and more, he gave them more and more work.

For its second investment, the foreign corporation made a joint venture with the public sector and the new project manager decided to contract the whole engineering and construction work with a U.S. firm. As this occurred along with an inflationary period, the normal execution of the project was perturbed and, supposedly, in order to stay within his budget, the foreign contractor supplied some second-class items and surreptitiously omitted some other. As a result, the plant started operating with many difficulties.

The third project was entirely in charge of the corporation's Mexican branch, which entrusted its engineering again to the local engineering firm that had taken care of the first plant. Since then, such collaboration kept *in crescendo*.

The same corporation is also installed in Argentina, but here, only very little of its demand for engineering work is satisfied by external firms. Thus, while in Mexico the whole process industry sector may benefit from technical standards learned by the local engineering firm from the foreign production one, in Argentina this same highly valuable knowledge is kept captive within the affiliated production enterprise.

<u>The main private process engineering firm</u> (shown as "A" in Fig. VIII.1.)

The first engineering firm in the process field was founded on 1949 as per an initiative of two Mexican chemical engineers. Nowadays, it is the most important one, not only by its seniority but in its installed capacity and in the amount of work performed. It started with a 12-dollar capital and with 3 employees: the two founders and a relative, acting as a secretary. Now, they affirm they are managing 10,000 people and their list of works shows they have participated in the engineering and/or construction of 160 new plants or expansions of existing ones, for 73 different enter-

FIG. VIII.1. DATA ON SOME ENTERPRISES PROVIDING PROCESS ENGINEERING SERVICES IN MEXICO

	A	B	C
TYPE OF ENTERPRISE	PRIVATE NATIONAL	PRIVATE NATIONAL	MEXICAN-U.S. PRIVATE
CAPITAL	ENGINEERING FIRM* US$ 800,000 CONSTRUCTION FIRM* US$ 2 MILLION	US$ 240,000	-
STARTED OPERATIONS IN MEXICO ON	1949	1964	1971
STARTED INTERNATIONAL OPERATIONS	1958	-	-
GROSS SALES - YEAR	CONSTRUCTION US$ 11 MILLION-1973 ENGINEERING ~US$ 14 MILLION-1973	~ US$ 2 MILLION - 1973	-
MAIN ACTIVITIES	CONSULTING - PRELIMINARY ENGINEERING - DETAILED ENGINEERING - PROCUREMENT - CONSTRUCTION AND ASSEMBLING	CONSULTING - PRELIMINARY ENGINEERING - DETAILED ENGINEERING - PROCUREMENT - CONSTRUCTION AND ASSEMBLY SUPERVISION	CONSULTING - PRELIMINARY ENGINEERING - DETAILED ENGINEERING - PROCUREMENT CONSTRUCTION AND ASSEMBLY SUPERVISION
ECONOMIC SECTORS COVERED	PROCESS INDUSTRIES, MAINLY CHEMICAL AND PETROCHEMICAL. AS OF 1971, 143 PROJECTS OVER A TOTAL OF 160 REFER TO THIS FIELD	PROCESS INDUSTRIES, MAINLY CHEMICAL AND PETROCHEMICAL. 48 PROJECTS OVER A TOTAL OF 55 REFER TO THIS FIELD	PROCESS INDUSTRIES, MAINLY CHEMICAL AND PETROCHEMICAL. ALL THE PROJECTS LISTED REFER TO THIS FIELD
PERMANENT PROFESSIONALS AND TECHNICIANS	1,500	250	160
CAPACITY IN DETAILED ENGINEERING MEN-HOURS/YEAR	1,800,000	350,000	150,000
ADMINISTRATIVE CLERKS AND WORKERS	8,500	-	-
NUMBER OF MEXICAN CUSTOMERS WITH PROCESS INDUSTRIES: -STATE-OWNED -PRIVATE	 4 52	 3 35	 2 9
NUMBER OF CHEMICAL PROCESSES WHOSE DETAILED ENGINEERING WAS PERFORMED IN MEXICO	52	25	15
INTERNATIONAL ACTIVITIES	3 PROJECTS IN NICARAGUA 2 PROJECTS IN THE DOMINICAN REPUBLIC 1 PROJECT IN BRAZIL 1 PROJECT IN BOLIVIA 6 PROJECTS IN PERU 1 PROJECT IN COLOMBIA	1 PROJECT IN COLOMBIA 1 PROJECT IN VENEZUELA 1 PROJECT IN PERU	
MISCELLANEOUS	THEIR OFFICES COVER 10,000 SQUARE METERS	APPROXIMATELY 500 SQUARE METERS AVAILABLE FOR ENGINEERING WORK	OFFICES COVER APPROXIMATELY 1,000 SQUARE METERS

* From a legal point of view, they constitute two separate firms, nevertheless operating under the same name and management.

prises.* Eight of those projects involved their own technologies and in two other cases, the preliminary engineering was developed in a joint venture with a Mexican State-owned enterprise.

In order to have an idea of the stability of their work, the fact may be quoted that, on December 1973, the firm had 33 projects underway and had signed contracts for another 8 not yet started. Six months later, June 1974, five of the previous 33 projects had been completed, as well as 3 of the 8 new ones. The total number of projects underway had increased to 40 and there were 6 additional new contracts awaiting to be started. One of the works underway represented a total investment of about 150 million U.S. dollars. Some others ranged around 15 million worth the same money.

The enterprise's growth may be measured by comparing the above figures with those of December 1968, when their agenda included 11 works underway and 5 new contracts, the largest project involving a total investment of 50 million dollars.

The first one who trusted them was a Mexican entrepreneur and a friend of the family of one of the two founders, who, satisfied by a few minor initial studies, finally conferred them the whole responsibility for the installation of a sodium sulphate plant. With this realization as an introductory card, on 1956, a large U.S. corporation contracted them for the execution of a project aiming to recover sodium sulphate from a coagulation bath in the process of manufacturing an artificial fiber.

As from those initial works, the orders from the same firm and from other transnational ones became more and more frequent. By 1960, the take-off period could be considered as left behind, the firm being firmly launched in its way for progress.

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* The personnel figure (10,000) seems to be high, if compared with their sales (25 million dollars) in 1973. (See Fig. VIII.1.). The Argentine engineering and construction enterprise "D" (See Fig. VI.1.), with an estimated payroll of almost 3,000 people, declared sales for 39 million dollars in its balance sheet for the 1973/74 fiscal period.

As in the Mexican case both figures are estimates gathered from interviews, either the payroll has been exagerated or the invoicing under-estimated. Errors may specially slip when appraising labour involved in construction and assembly work, by taking peak demands for yearly averages.

They had a good support from one of the strongest private banks in Mexico, in which they are well-known due to family links. Transnational corporations looking for local savings so as to partially finance their assets often submit their projects to that bank, which, in turn, when promoting some local projects, searches for the possibility of complementing them with foreign financement. When evaluating the above projects, the bank usually uses the engineering firm under analysis for examining and estimating costs and for performing pre-investment work.

Two are the main organizational objectives of this firm:

- to acquire experience in many different processes, so as to form efficient working teams (across-the-sectors specialization); and
- to perfect their training in each one of the engineering and allied disciplines needed to adequately shape the various taks forces (across-the-disciplines specialization).

Several division managers report to the general management still in the hands of the two founders. The engineering division encompasses two departments:

- the project department is divided, in turn, into four specialized areas: petroleum and petrochemical; manufactures and processes; mining; and steel. It responds to the across-the-sector specialization objective.
- the technical department gathers the experience of the task forces and, with those elements of technical knowledge that will be repeatedly used, prepares calculation patterns and design standards for architectural, civil, mechanical, electrical, piping, instrumental and process engineering work. It responds to the across-the-disciplines specialization objective.

Other divisions are in charge of:

- construction and assembly work.
- procurement.
- special studies.
- control of other enterprises, sprouting from the group as a result of an investment diversification policy and producing goods (salt, T.V. tubes) or services (evaluation of enterprises, building of infrastructural works).

A sort of auditing department, directly reporting to the general management, takes care of the internal work programmes of the cost estimations and of their control. Also reporting to the general management, there is a department of public relations in charge of contracting personnel and of keeping fluent links with customers and with the scientific institutions. Three psychologists perform psychometric tests in personnel selection and help to work-out conflicts arising in or among individuals as a result of divergent options and desires caused by their simultaneously:

-living their own private lives,
-occupying a given position in a hierarchical scale,
-enrolling in informal pressure groups within the enterprise, and/or
-identifying themselves with their functional roles.

Great efforts are made by the enterprise in training their personnel, through programmes involving:

-short intensive courses for introducing the enterprise's working practices and standards to new engineers and technicians.
-attendance to the yearly meetings of the Instituto Mexicano de Ingenieros Químicos, of the American Institute of Chemical Engineers, of the American Institute of Project Managers and similar ones.
-specialization in a certain operation: water treatment, distillation, heat exchange, reinforced concrete, etc., through courses in Mexican universities and/or in firms supplying equipment. All the internal work related with a given subject is organized so as to pass through somebody who has followed the respective specialized courses.
-sector specialization, by means of university training and work in plants that are typical of that sector.

Personnel turn-over is high among people with less than one year in the firm. Approximately 50 of each 100 newly-enrolled men leave the enterprise as soon as they acquire a minimum formation. That is how they are somehow serving as a training center for smaller enterprises, both engineering and production ones. Among senior people, rotation is as low as 3%.

They went through an interesting experience as far as training on pipeline flexibility is concerned. They specialized young Mexican engineers in the subject by means of the usual practices: local and foreign training courses. These professionals acquired an extraordinary theoretical level and the technical papers they prepared on the subject were even accepted for publication by the American Institute of Mechanical Engineers. However, the enterprise felt that, when facing practical applications, they paid too much attention to details and did not discriminate those cases in which the rule of thumb was to be applied from those in which computer calculations were a must. In order to do away with the difficulties continuously arising from this too-intellectual approach to reality, the firm decided to hire an expert from the U.S., so as to introduce the practical aspects. This hurted the feelings of the Mexican engineers, who resigned; but it seems that the firm, with the aid of the foreign advisor, has been able to form new local personnel with both high theoretical level and practical efficiency.

The policy of hiring a foreign expert for internal training of their personnel was applied again in the case of model making.

Other private process engineering firms

In the second place among process engineering firms in Mexico, we may find another national enterprise (named "B" in Fig. VIII.1.) that, as opposed to the first one, does not perform construction work, in spite of the fact that it sprout from a civil engineering and construction enterprise.

Within a third dimensional level, we may find a group of firms whose main features are that they do with less human and physical resources than any of the former and that most of them are associated with foreign engineering firms, the latter participating with up to 49% of their shares in certain cases. Fig. VIII.1. shows, under "C", the characteristics of one of those enterprises.

One of the local small firms displays a particular policy. Formed by a Mexican engineer, it became a team of process specialists (about 40 people) dedicated to design complicated operations or highly sophisticated pieces of equipment for large process industries. Production enterprises and other engineering firms, even the largest ones, supplement their own engineering forces by contracting this highly specialized group. Apparently, the main idea in this enterprise is not to grow too much and prefer intensive and thorough work in the process field, instead of conquering large contracts obliging them to create pluridisciplinary task forces and to encompass technologies of different industrial sectors.

Foreign engineering firms, even those having their own branches in Mexico or associated to some of the smallest Mexican engineering firms do sometimes go into joint ventures or special agreements with some of the two largest local ones for certain works in which the foreign firm delivers technology at a preliminary engineering level and the local enterprise performs the detailed engineering and/or the construction work. This type of associations was operating in copper exploitations at Cananea, in the Laguna Verde nuclear power plant, in an ammonia plant for Pemex and in a paper plant sold to Peru.

The Mexican Petroleum Institute as a public engineering enterprise

When petroleum was nationalized, the countries whose companies had been affected, blocked the Mexican imports of spare parts for installations and of basic and intermediate products for the oil industry, such as tetraethyl lead for naphtas.* Some engineering firms, closely connected with the foreign enterprises, decided they would not work for Pemex. However, a U.S. firm that had been strong mainly in steel technologies up to that time, opened to the oil field and started serving the State enterprise, while a U.S. based transnational corporation joined the Mexican Government for the local production of the antiknock.

It seems that some of the earlier Pemex's administrators preferred not to contract local engineering firms because they were affraid of being imposed untrustful candidates by some Mexican politicians. Their arguments in favour of using foreign experienced enterprises were based on the high degree of skilfulness and profficiency needed for the successful accomplishment of petroleum and petrochemical undertakings. Otherwise, under the shadow of political influences, enterprises would have flourished just for the purpose of getting Pemex's works, without worrying about training the necessary qualified human resources and about attaining effieiency by means of an adequate equipment.

When Pemex got to have its main initial projects underway in the hands of serious, internationally renowned enterprises, it invited the major local process engineering firms to collaborate in coordinating and supervising the

* A. de la Vega Navarro, *op.cit.*, page 3.

various works distributed among several firms. This happened by 1957/8 and, two years later, the same local firm performed the engineering work for a Pemex plant due to manufacture cyclo-hexane with a foreign technology.

As an additional step in shifting detailed engineering from foreign to local suppliers, on 1965, the Mexican Petroleum Institute (Instituto Mexicano del Petrôleo, further on "the IMP") was created. This is a decentralized agency, with legal capacity and with its own patrimony, intended to provide Pemex with the necessary technological services for an optimum operation of its plants and for the execution of new projects.

At the beginning, the formation of the IMP reduced demand by Pemex on the local private engineering enterprises. Nowadays, in spite of doing with a payroll of over 2,000 people, among which 600 are professionals, the IMP is supplementing its own potential with engineering supplied by other Mexican firms. I should emphasize the fact that the largest Mexican enterprise ("A" in Fig. VIII.1.), working simultaneously in process engineering and in industrial construction, was uninterruptedly being employed by Pemex as a contractor, even during the period in which the IMP satisfied all of Pemex's requirements for engineering work.

The IMP owns a site of 120,000 square meters within the Federal District and has developed into a complex of 20 buildings, with 33,500 square meters of covered area. It does with equipment in laboratories and shops and with furniture representing an investment of over 10 million dollars and has created working centers in four places of the Mexican countryside.

The IMP is now, at the same time:

- -an engineering team, designing industrial installations mainly for Pemex;
- -a consulting group, organizing petroleum and petrochemical investment projects; and
- -a technological institute, developing technologies for the chemical and petrochemical sub-sectors.

The Department of Economic Studies and Industrial Planning is the nucleous of the IMP's consulting activities. It has prepared a long-term evolution programme for the petroleum and basic petrochemical industries, which allows Pemex authorities to have a good referential framework so as to make decisions. There are three programmes that have been finished (1969/78, 1970/80, 1973/82) and that are revised every year.

Other typical consulting work performed by this department involves:

- evaluation and preparation of investment projects.
- cost research on well drilling.
- product distribution models.
- market research work.

The same department will execute a project aiming to optimize petroleum transportation and distribution in Ecuador, for which the IMP has just won a bid.

The departments of Exploration, Exploitation and Process Technology may be viewed together as a sort of technological institute. They have developed and are developing products, processes and procedures, like the following:

- catalysts for some processes performed by Pemex.
- measurement of thermodynamic parameters needed for engineering calculations.
- geological and geophysical work for supporting the search of new petroleum fields.
- additives and other chemical products utilized in the various phases of the petroleum exploitation.
- calculation programme for optimal spacing among wells.
- calculation programme for establishing pressure drop in different piping systems and under different flow conditions.
- secondary recovery of oil by injecting water or steam.
- hydro-desulfurization.
- selective demetalization of heavy residues.
- isomerization of normal paraffins and xylenes.
- manufacture of alkylphenols.
- cryogenic recovery of liquefiable hydrocarbons from natural gas.
- obtention of polyethylene.
- asphaltic resins.

The IMP is in a condition so as to offer its own technologies for four oil refining processes, for six petrochemical processes, for the ellaboration of three different types of catalysts and for the manufacture of additives to be used in ten different applications. Naturally, the main user of these technologies is Pemex. However, a plant for demetalization of heavy residues has already been sold to Colombia and a private Mexican enterprise has been licensed for the use of a process to obtain nonil-phenols.

The foreign commercialization of the developed technologies is sometimes performed under joint ventures with Mexican private engineering firms. That was how the largest of the latter quoted, together with the IMP, for an international bid opened by Peru, aiming to expand an oil refinery.*

Engineering, within the IMP, is principally carried out by the Project Engineering Department. By 1974, this department had completed 11 projects for Pemex, involving a total investment of over 63 million dollars. During the second half of that year, another 26 projects were underway, also for Pemex, involving investments for almost 362 million dollars. Estimations indicated that 2.3 million men-hours, including the work of professionals, technicians, draftsmen and clerks, were going to be needed for the completion of those projects.

Auxiliary departments -materials technology, electronics, computation and information- serve to support both research and experimental development work and that connected with engineering and technical assistance to industries.

It is also worth mentioning the training work performed by the IMP:

- 686 specialization courses were organized between 1967 and 1974. These were aimed to professionals and dealt with a great variety of subjects, like materials technology, processing seismic records by computers, directional drilling, scale-up of pilot plant data to industrial operations, homogeneous and heterogeneous catalysis, quality control, systems engineering, control of refineries, etc. 10% of these courses were taught by foreign experts.

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* The bid was won by French enterprises of the public sector, offering better financial terms. The costs jointly incurred by the Mexican enterprises in preparing and presenting their offer would amount to 50,000 dollars.

- During approximately the same period of time, 3,423 courses were given to over 55 thousand workers and technicians on more than 200 different subjects: machinery; tools; mechanics of internal combustion engines; welding; procedures in drilling, finishing, repairing and maintaining wells; carpentry; computing techniques; procedures in administrative work; pedagogic techniques to be applied in kinder gartens; techniques for handling patients and for the maintenance of hospital equipment; etc.

The IMP is supposed to have reduced Pemex's costs in project engineering. De la Vega Navarro* said, on 1970, that the price being paid by Pemex to the IMP was estimated to be 30% lower than what it would have had to pay to foreign engineering firms. The estimation I was able to obtain for 1974 indicated that the cost of an hour of IMP's engineering work was between 10 and 12 dollars. If this is true, those costs would represent approximately 50% of the prices for which foreign engineering was normally sold and would be slightly higher than the average prices quoted by private Mexican engineering firms during the same year.

Pemex will still be needing foreign technologies both in the short and in the medium term. Some of them may not be procured unless the detailed engineering is simultaneously purchased, either because the technology suppliers impose this or because the obtention of financial help is tied to a similar condition arguing that by so doing, risks in the project implementation are reduced.**

The IMP-Pemex team constitutes a good example of an alliance among creation, engineering and production. The human resources in Pemex are thus allowed to concentrate in production and in trouble-shooting. This, in turn, generates optimization projects related with the existing installations or a search for new processes or products, which the IMP could then evaluate, organize and execute, either with its own or with somebody else's technologies and using its own or other engineering forces. The final step, that is, the construction of new installations or the modification of the existing ones, would again remain in the hands of Pemex. The latter could, in turn,

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* De la Vega Navarro, *op.cit.*, page 4.

** De la Vega Navarro, *op.cit.*, page 20, points out that, between 1958 and 1964, Pemex would have paid 64 million dollars for engineering work performed outside the country.

procure supplementary work from construction and assembly firms already installed in Mexico.

I came to thinking that, under this synergic association, the Pemex offices abroad might act as sales agents, not only for the engineering working capacity of the IMP, exceeding its obligations with Pemex and/or for the technologies the IMP develops, but also for the technologies and/or engineering forces available for export from all the Mexican process engineering firms.

The IMP seems to have followed a healthy policy on this respect. It was not tempted by the easy and prestigious road of the so-called "pure research" nor ran after the chimera of attaining technological autharchy for Pemex. It preferred to start by helping Pemex in solving its most immediate problems and by acquiring expertise in petroleum and petrochemical process engineering on the basis of the already installed facilities. Technological development would then come as a result and would be oriented by and to production. Scientific research would be performed when required for supporting technological development with knowledge not otherwise available.

My visit to the IMP was too short and I could not judge whether such ideal is being reached or not. Since it is a universal evil, it is highly probable that the IMP must also have research teams that are more worried about the consensus of their colleagues all over the world than about applying their knowledge in their surrounding reality. But the Institute, as a whole, seems to prefer the latter position and is trying to deepen its interplay with the Mexican economy and society.

B. THE FUTURE OF PROCESS ENGINEERING IN MEXICO

During the last twenty years, the Mexican process engineering has quantiatively grown and qualitatively improved, but it looks like the demand might exceed the installed capacity in the near future.

Private process engineering firms, that is, excluding the IMP, are estimated to be able to generate approximately three million men-hours per year.*

The probable demand, as from 1974, was estimated to be as follows:**

FIG. VIII.2.

Sector	Project execution estimated periods (years)	Estimated investment (million US$)	Necessary engineering men-hours
Mining	8	870	7.250.000
Chemical and petrochemical	5	350	2.900.000
Petroleum	7	1.160	12.000.000
Fertilizers	5	40	420.000
Steel	5	800	8.300.000

This results in an average of 5 million men-hours to be required per year, during the first five years, without considering the hours process engineering firms may be demanded to devote to projects connected with power plants and food industries.

The demand of the chemical and petrochemical sector seems to have been undervalued in the above evaluation. The IMP assumed that investments for the production of intermediate and final petrochemicals could reach the following figures between 1975 and 1980.***

* Eng. Rafael Pardo Grandison's estimation in 1974. Personal communication.
** Eng. Enrique Ruanova Dufoo's estimation. Personal communication. It must have been made considering that engineering represents between 8 and 10% of the total investment in an industrial project and that a man-hour in this engineering field is being sold in Mexico for a price ranging between 8 and 10 dollars.
***This figure was built on the basis of Figs. II-13, III-11, IV-19, V-12, VI-10 and VII-10, in *Desarrollo y Perspectiva del Sector Secundario de la Industria Petroquímica*, IMP, Mexico, 1973. The investment figures in Mexican pesos have been converted considering an exchange rate of 12.5 Mexican pesos per dollar.

FIG. VIII.3.

Products	Estimated Investment (million dollars)
Artificial and synthetic fibers (excluding polypropylene)	321.6
Synthetic resins and plasticizers	76.7
Polymers	95.1
Fertilizers	17.4
Pesticides	16.6
Elastomers and related products	17.6
Intermediate chemicals	264.6
TOTAL	809.6

Translated into engineering men-hours, these figures would show a higher unsatisfied demand than that resulting from Fig. VIII.2.

Solutions may come from:

a) a simultaneous growth of all the existing firms, maintaining approximately the same market share they now have;
b) a more accelerated growth of the group of smalles enterprises;
c) a more intensive flow of foreign engineering;
d) a combination in different proportions of all the above modalities.

Simultaneously, we may observe that the Mexican engineering firms look forward projecting themselves abroad, specially into other Central and South American countries. The export tendency is supported by:

- the search for counteracting internal recessive periods with foreign demand, assuming that the probabilities of coincidence among recessive cycles are few;
- the increase in prestige attained working abroad, in turn, generating more local business;
- higher returns on investments in research and development obtained when selling their own technologies abroad.

That is how the biggest process engineering firms are actually performing international activities. By 1974, the managers of that ranking first were already planning to do business with the Arabian countries, with the Asiatic South East and with the Far East, in addition to Latin America, where they had been working for quite some time.

National success or failure in forming the engineering human resources needed to satisfy this foreseeable demand will influence the evolution of engineering firms. As per some comments I have been able to pick up during my visits to engineering firms, only 20% of the Mexican university graduates seem to have an adequate level for the most creative tasks. On the other hand, the offer of intermediate technical personnel (draftsmen, calculators, technical assistants for construction and assembly work, etc.) seems to be both quantitatively and qualitatively insufficient. Many of these intermediate jobs are fulfilled by low-level engineers*; thus, the ratio engineers/technicians in Mexican engineering and construction firms does not surpass the 1:2 figures, while it may reach 1:5 in other more developed countries.

Organizational patterns represent another intrinsic influential factor in the evolution of engineering firms. The largest enterprises donot quote their shares in the stock market and their capital apparently remains in the hands of their founders and present managers who vouchsafe some shares to a few other board members. In Latin American countries, family enterprises often have a life cycle identified with that of their founders, no matter how much the former have grown or developed. They do not reach the level of permanence of large corporations, in which a few executives administer a large alien capital, made from contributions of many small shareholders, who do not participate in either the operation or the control of the firm. The managers and the few bigger stockholders ruling the board of directors, to whom managers subordinate, may both change and do frequently change in practice, but whoever fills those positions is normally interested in having the firm remain and grow, so as to, in turn, grow and maintain himself in the same. On the contrary, the heirs of family enterprises may easily squander the accumulated wealth or shift the capital to other type of investments more in accordance with their vocations. Besides, who may guarantee that the harmonious relation attained by the founders will last among their inheritors?

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* Even some most capable engineers, who will finally become project or design engineers, go through these intermediate jobs in their training process. However, they do not stay very long.

However, some of these family entrepreneurial groups do outlive their founders by means of adequate agreements among some of the successors, displacement of others if needed and injection of managerial talents external to the group, who are carefully selected and quickly coopted by the ruling alliance.

Another tempting way in Latin America for the founders to insure the permanence of their enterprise, while alleviating charges in their old age, is that of associating with foreign stronger interests.* This is also a way for heirs willing to quickly sell out their capital.

But the Mexican State is also supposed to have something to say. Its Petroleum Institute is growing and may reach a magnitude leading to organize its consulting, research and engineering activities in the form of independent, interrelated enterprises. Nevertheless, it will always need the supplement of strong national consulting and engineering enterprises in its own and related areas.

In this field, like in almost any other economic sector, a healthy balance should be maintained between the initiative of private entrepreneurs who may easily divert from social worries and the public control that easily slips into a cumbersome oppressive bureaucracy.

Anyhow, this is only one of the present Mexican problems and, definitely, not the most critical one: the growth, the permanence and the national control of its engineering may not be disconnected from the development and the stability of the Mexican society nor from the possibilities of an autonomous and participative design of objectives for the same.

We may wonder about the future of many socio-economic factors that have greatly contributed to the boom of Mexican engineering. For instance:

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* An article in the *Mexican-American Review* (Mexico's English language business magazine), August 1974, page 8, mentions moves of foreign enterprises towards joining the biggest Mexican process engineering firm.

- How long will Mexico be able to maintain a currency stability under a growing foreign indebtment?

- How long will political stability be maintained under tensions caused by agricultural and industrial structures based on the existence of pauperized sectors?

- For how long will the members of these sectors repress their desires to enjoy the same standard of living mass media is showing them other Mexicans already enjoy?

C. THE ROLE OF MEXICAN PROCESS ENGINEERING FIRMS IN THE CREATION OF KNOWLEDGE

An interesting fact is that the export programmes of the two main Mexican engineering firms are mostly based on national technological development work, which resulted from agreements made between production enterprises and those engineering firms.

The Mexican engineers who founded the first process engineering firms in the country designed their evolution so as to start with the only activity allowed by the Mexican entrepreneurial reality at that time: serving as auxiliaries to foreign teams in pre-investment work and in the construction of industrial installations. They ended up conquering the whole detailed engineering work and, only now, are starting to think about performing preliminary engineering. They have reached a point in which the accumulation of financial and human resources allows them to face the expenses and risks involved in experimental development and in the further commercialization of the generated technological knowledge.

For instance, local development projects allowing to obtain paper and specially newsprint, from bagasse, are promissing. One of the procedures arose from the iniciative of a Mexican entrepreneur who, associated to a foreign firm, was already producing other types of paper, specially toilet paper. He developed his ideas by himself and outside the production enterprise, thus being able to patent the results of his laboratory work at his sole name both in Mexico and abroad. But it was impossible to sell the process for its application to an industrial undertaking without having a preliminary engineering.

Then, a Mexican process engineering firm helped the inventor in organically perform the experimental development, through a pilot stage. Since Mexico did not do with the adequate equipment, some tons of pulp were prepared and sent to the U.S., where they were transformed into paper, which was later on tested with Mexican newspapers. The process is now being commercialized in several Latin American countries, which try to reduce their newsprint imports by profiting of the wastes of their sugar production.

Another interesting process is that allowing to reduce the content of sulfurous anhydride from stack gasses, transforming it into ammonium sulphate, which may be used as a fertilizer. It was developed in the laboratories of the main process engineering firm and, due to its low installation costs, is becoming a question of attention even for the most industrialized countries in which there are critical problems connected with air pollution.

I have not been able to find examples of processes having been generated at universities or other public research laboratories and then technologically developed by engineering firms for their later marketing among production enterprises. The procedure for obtaining alumina as from alunites, conceived at the University of Guanajuato, is being internally developed by a State-owned Mexican enterprise.

I have heard that a Mexican steel producer developed a process for the direct reduction of iron ores and gave it to a U.S. engineering firm for its commercialization. Since he was not getting any sales from such association, he took the exclusiveness away from the foreign firm. However, he did not think about an agreement with a local engineering firm so as to promote the utilization of the process, but started negociating it on his own.

Local engineering firms have often pointed out the lack of confidence among Mexican entrepreneurs towards the country's engineering forces. A single mistake made by one of them, serves to vanish hundreds of good antecedents.

The lack of hopes on the inside and expectations placed on the outside are often observed within Latin American societies. These attitudes are more frequent among industrial entrepreneurs coming from commercial activities and constituting family enterprises. It is hard for them to duly appraise work performed by engineers and technicians. They are used to negociate things and prefer plants delivered to them as an integrated package with a seal, trademark and warranty of quality. They feel that if these plants are imported, their quality must be much better.

On the contrary, the professionals acting as executives in the largest enterprises do more easily assume the risk involved in the development of indigenous knowledge or in the dissaggregation of the imported technological packages for their adaptation to local conditions. Of course, we may not overlook the fact that small entrepreneurs risks their own capital, while managers risk somebody else's money... and their job at the enterprise.

D. CONSULTANCY IN MEXICO

An overall picture shows a situation similar to that in Argentina, although it looks like no agency in the Mexican public sector has ever intended to organize and coordinate the consulting activities, as it happened in Argentina. What it may again be observed in Mexico is that many people alternate public functions and the management of consulting firms, as well as the fact that Mexican consulting firms do also serve as a shelter to some valuable intellectuals jealously guarding their independence from particular interests or from rigid organizational schemes.

However, these independent consultants seem to have done better than their Argentine colleagues in getting rid of the romantic* elements introduced in their professional formation by the Latin American education. One may perceive that they have internalized the idea that their work is not only a means for procuring adequate satisfactors for their subsistance and self perfecting but also one towards accumulating the capital needed for securing the stability and the development of the activities they perform.

Some consulting firms are highly technical and very specialized. For instance, those dedicated to the organization of projects for infrastructural works, such as bridges, roads, etc. I was told of an engineer who took care of all the projects connected with wheat mills in the country.

Many of these consulting firms are actually engineering firms profiting from the accumulated experience of some of their specialists: they do not organize investment projects through feasibility studies, but only prepare preliminary engineerings that are further developed into detailed ones by production enterprises, by private engineering firms or by State agencies.

The specialized consulting engineering firms do usually quote a global price for their work instead of stating the cost of their services on an hourly basis. Thus, the preliminary engineering of a poultry processing plant would cost about 4,000 dollars. It was estimated that renowned, high level engineers, working

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* I define elements as "romantic" when they estrange professionals from the reality of the industrial and business world and still donot attain the category of a metaphysic enabling those professionals to design ends for the use of the instruments they acquire through education.

under this pattern, would round up monthly incomes of almost 5,000 dollars.

Another group of consulting firms is dedicated to advising on managerial problems and to auditing. Among the biggest four or five, with about 400 employees each, some are U.S. firms. The rest is a group of smaller firms, most of them national, with an average of about 15 customers each, also advising in accounting and in various organizational aspects, but specially in taxation.

As far as the organization of knowledge for investment projects is concerned, we may find a group of small bureaus performing or evaluating feasibility studies for financial institutions. Four or five of the largest, still paying attention to the micro-economic level as a source of income, specialize and prefer macro-economic studies on regional development, including the introduction of innovations and the formation of enterprises for implementing the designed development objectives. These larger consulting firms do usually have a small dotation of permanent personnel and face the work peaks or the need for specialized knowledge by means of contracts with professionals working for the public sector and not fully-employed by the latter. Apparently, they are all national firms and their work volume would reach an average of 250,000 dollars each per year.

It is interesting to see how these firms support their more ambitious work with income from routine services rendered to small and medium sized enterprises: by means of small computers, a single professional handles operational data for up to 100 firms, telling them (on the phone), once a month, which are their results, how much they differ from the budget and which are the points they must watch or correct. The cost of this service for each enterprise would be about 100 dollars per month.

Finally, we may find the so-called market-consultants, who advise on how to sell, which is the right publicity to be applied, which are the best distribution channels, etc. It looks like most of them are connected with advertising firms, the latter enlarging their customers list by means of the former.

CHAPTER IX

A PROPOSAL
FOR THE DEVELOPMENT OF
ARGENTINE PROCESS ENGINEERING

A. SUMMARY OF THE PRESENT SITUATION

The results of my research work on Argentine process engineering and process industries may be summarized as follows:

1. There is enough installed capacity so as to locally satisfy the present demand for detailed engineering of projects connected with process industries.

2. Part of that capacity is installed within the major chemical enterprises.

3. The demand peaks during the implementation of new projects by those chemical enterprises or by other process industries like the food one are covered by:

   - two national firms: one only providing engineering services was recently founded (1975) as from the engineering department of a national chemical enterprise. The other one, also acting as a contractor, was established 20 years ago by a young chemical engineer.
   - one process engineering and construction enterprise belonging to a transnational corporation.
   - other engineering and construction enterprises, both national and transnational, performing marginal activities in the process industry field without specialization in the same.
   - the engineering departments of local manufacturers of equipment for process industries.

4. The largest Argentine process engineering and construction team (220 professionals and technicians) is far smaller than the largest Mexican one (1,500 professionals and technicians).

5. The demand will exceed the supply as soon as already programmed projects, now held back by the economic and political crisis, get underway.

6. Very little is being done locally as far as experimental development is concerned, that is, in the step in which laboratory basic knowledge is transformed into a usable preliminary engineering.

7. The private production enterprises do little development work, because they usually procure the basic knowledge and the preliminary engineering for their processes abroad. In many cases, they buy "turnkey" installations.

8. A similar policy may be observed at both enterprises and agencies in the public sector, in spite of the fact that YPF has installed capacity in process engineering and in process dynamics within its research and development department.

9. Most of the small enterprises with process industries lack adequate technical assistance for the organization of their new investments and managerial advice for the operation of their facilities.

10. The links between research laboratories and production or engineering firms are very weak and isolated. Therefore, the former do not have customers for their results and may not adequately orient their search.*

11. Except for some branches of the food industry, the National Institute of Industrial Technology has not got into development work for the process industries.

Considering these situations, the State should assume its regulating and control role in the terminal sectors of the economics of knowledge, consulting and engineering, which have been disregarded in the past. In Argentina, the economics of knowledge has started with scientific work and its national control should be regained from the bottom to the top in the utilization chain: Only when pre-investment work, engineering and technological creation in a given sector have been mastered, one may connect science with the production activity in the same.

On 1971, during work performed with Alberto Aráoz for the Ministry of Economic Affairs in Argentina, we supported the need for the State to do with first level technical teams specialized in each one of the branches of the economic activity and able to give advice to the various state agencies and enterprises in their technological decisions. The research work on process engineering in Mexico and Argentina, performed on 1974, lead me to think that those technical teams should also promote and coordinate the organization and development of the engineering and consulting work for their corresponding sectors.**

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* An Argentine entrepreneur indicated he had been in touch with a team in the university that was working on catalysts for hydrogenating styrene into ethyl-benzene, although the reaction that is industrially used is exactly reverse: the dehydrogenation of ethyl benzene into styrene.

** Fore more details on the author's ideas on coordination of pre-investment work in each national economic sector, see Chapter VII of the preceding report *Engineering and Pre-Investment Work.*

B. PROPOSAL FOR THE ORGANIZATION OF A SECTOR COORDINATING GROUP

This proposal was inspired, as a whole and in many of its details, by the antecedents of the National Enterprise for Research and Development in Electricity (Empresa Nacional de Investigación y Desarrollo Eléctrico S.A., ENIDE S.A.), promoted by Jorge A. Sâbato, when he was the president of a large State-owned electrical enterprise. Sabato's idea followed examples found in countries, such as Italy, Holland and France, where similar enterprises in the public sector (Centro Electrottenico Sperimentale Italiano S.p.A., Kema S.A., Laboratoire Centrale des Industries Electriques) were producing and commercializing technologies on electricity.

In order to coordinate the development of process engineering and the chemical and allied industries in Argentina, I propose to set up a stock company, 51% of whose initial capital of 30 million Argentine pesos* would be subscribed by the State, thus forming an Empresa Nacional de Ingeniería de Procesos (ENIP) (National Process Engineering Enterprise). The rest of the capital would be offered for subscription by public and private chemical industries; financial institutions, such as the Banco Nacional de Desarrollo (National Development Bank); labour unions representing the sector, such as the Federación Argentina de Trabajadores de la Industria Química (Argentine Federation of Chemical Industry Workers); engineering and consulting firms; associations of entrepreneurs in the sector, as the Cámara de la Industria Química (Chamber of Chemical Industries) and the Cámara de Industrias de Proceso de la República Argentina (Argentine Chamber of Process Industries)** ; professional associations, such as the Asociación Química Argentina (Argentine Chemical Association) or the Asociación Argentina de Ingenieros Químicos (Argentine Association of Chemical Engineers); research laboratories and public or private technological institutes.

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* Exchange rate at time of proposal: $a 10 to US$ 1.

** In spite of its name, the food industries are not associated to this chamber which unites mainly small entrepreneurs with chemical and chemical related industries. Large national and transnational enterprises are grouped in the Chamber of the Chemical Industry. Some enterprises are members of both organizations.

-The ENIP's field of action would embrace all industries transforming the composition of their inputs at the molecular level or at the level of molecular aggregates (chemical or physico-chemical transformations).

The food industries would be excluded from the ENIP. On account of their importance, size and complexity, they would require an ad hoc coordinating group.

-The following sub-sectors would be included:

- chemical industries proper.
- industries producing fertilizers and pesticides.
- industries based on fossil fuels: petroleum refining, petrochemicals, carbochemicals.
- industries based on forest resources and agricultural products: wood-based chemicals, pulp and paper, agrochemicals.
- industries based on mineral resources: production of ferrous and non-ferrous metals.
- industries that combine different substances to obtain certain formulations or preparations: cosmetics, pharmaceuticals, household products, materials for the building industry.

-The Board of Directors of the ENIP would be composed of eight members. Four of them, representing the State, would be appointed by the Ministry of Economic Affairs and would be in office for not less than five years. One of them should be qualified to take over the general management of the enterprise with full time dedication. As a president and general manager, he would have two votes in case of a tie.

The other four members would represent the minority sector and would be elected by:

- the group of public enterprises, laboratories and institues;
- the group of private member enterprises, laboratories and institutes;
- the member financial institutions;
- the labour unions and professional associations.

These directors would serve for one year in order to allow as many enterprises and organizations as possible to be represented.

49% of the capital would be divided into four series of shares that would be offered to the respective groups of shareholders. The parts not subscribed at the end of the first year in each of these series would be taken up by the State, public enterprises or financial agencies, the last two being given preference.

It would be advisable for the initial working group to be very small. It would suffice for the general manager to be assisted by five other senior professionals: a chemical engineer, an electromechanical engineer, a specialist in process dynamics, an economist and a social psychologist. The rest of the staff would consist of six junior professionals, twelve technicians (documentation specialists, draftsmen, estimators); four people forming a secretarial pool and two auxiliaries for maintenance and messenger services.

The State's selection of the general manager and the subsequent appointment of the rest of the staff by the latter should be guided solely by qualifications for the positions, without intruding any political or ideological considerations. Competitive examinations for filling positions are usually of little value. Ability to compete in an examination does not always go hand-in-hand with excellence in reasoning, common sense and training. Besides, the maneuvers to which competitive examinations can give rise and the inordinate time they take are well known. A direct appointment made with honesty and social concern would be preferable. Without neglecting the risks involved, it is necessary to gradually replace the principle of distrust -which piles paper upon paper and swells the files so much that fraud is made easier- by the principle of confidence which, by leading to more transparency in the actions, permits better social control of public administration.

The staff of the enterprise should have assurance of adequate stability and continually updated remuneration equal to, or better than, that obtainable at similar levels of the private production sector. All the staff would be full time. The requirements to be set and the remuneration for each of the categories of staff could be as shown in Fig. IX.1. in the next page.

The salaries proposed are based on a cost-of-living index of 3,837.3 (January 1975) and should be adjusted every six months in terms of values of that index as fixed by the National Institute of Statistics and Census (INEC).

FIG. IX.1.

Category	Requirements	Salary $a/year
General Manager	To have produced an original technological work, have ability to organize and direct research and development institutions and engineering groups and have implemented productive use of technological research results. Breadth of cultural horizon for a better management of interdisciplinary teams.	300,000
Senior	To have produced important studies and be in a position to do research, engineering or pre-investment work independently.	240,000
Junior	To have shown aptitude for performing research, engineering or pre-investment work under guidance or supervision.	180,000
Technicians and administrative assistants	Completion of secondary education and practical training with proved ability.	60,000 to 90,000
Auxiliaries	Complete primary education.	30,000

In order to encourage the staff to remain with the ENIP, a bonus of 2% per year's service would be paid, up to a maximum of 30%, representing 15 years' continuous service in the enterprise.

The members of the Board of Directors who do not perform executive functions, whatever their ties with other institutions or enterprises, would be paid $a 24,000 a year, adjustable on the same basis as the other salaries, as remuneration for their obligation to devote one full day per month to meetings intended to analyze the ENIP's progress. This would make it possible to select independent professionals as members of the board and to closely follow the progress of the organization with their cooperation.

All the directors appointed by the State should have sound background in research and development, engineering or pre-investment work for process industries. Other shareholders would have to be represented at the president or general manager level in the case of enterprises and financial agencies and at the chairman or secretary general level in the case of labour unions and professional associations.

I estimate:

- Premises needed in 400 m^2
- Investment in equipment, furniture and scientific and technological documentation in \$a 5 miilion.*
- Current operating expenditures in \$a 11.5 million a year, on the basis of the budget shown in Fig. IX.2.
- A supply of 50,000 hours of services a year, excluding the work of the general manager.

If all the available hours were sold, the expenditure budget would be covered, as far as they were charged \$a 250*, a perfectly acceptable price, considering the level of training of the ENIP's manpower. All services, whether rendered to the State or to public or private enterprises and organizations, would be billed at prices that would not only cover costs, but also include an excedent to create a fund for expansion. The ENIP would also be able to obtain profits from the sale or licensing of technology, the development of which it promoted and supervised. Figure IX.3. shows the items that each one of the groups concerned could supply to or require from the ENIP.

The ENIP should set as its general objective the creation, storage, distribution, utilization, organization, exchange, exportation and importation of scientific and technological knowledge in the chemical and allied fields. However, it would initially focus basically on:

- strengthening the installed capacity for preparing sector projects and their detailed engineering;
- promoting the creation of original technologies suited to the scale of the market, the socio-economic conditions of the country and its environmental and anthropological characteristics.
- promoting the disaggregation of the technologies to be transferred from abroad, adapting them to those same local conditions.

In all its activity, the ENIP would avoid duplication of efforts, making a maximum use of resources already invested in fixed assets and in the training of human resources by other enterprises, agencies or institutes. The ENIP would try not to set up research laboratories, experimental development plants,

* Calculated on the basis of an exchange rate of \$a 10 = US\$ 1 and a wholesale price index of 3,163.7 (INEC).

FIG. IX.2. ENIP EXPENDITURE BUDGET (FIRST YEAR)

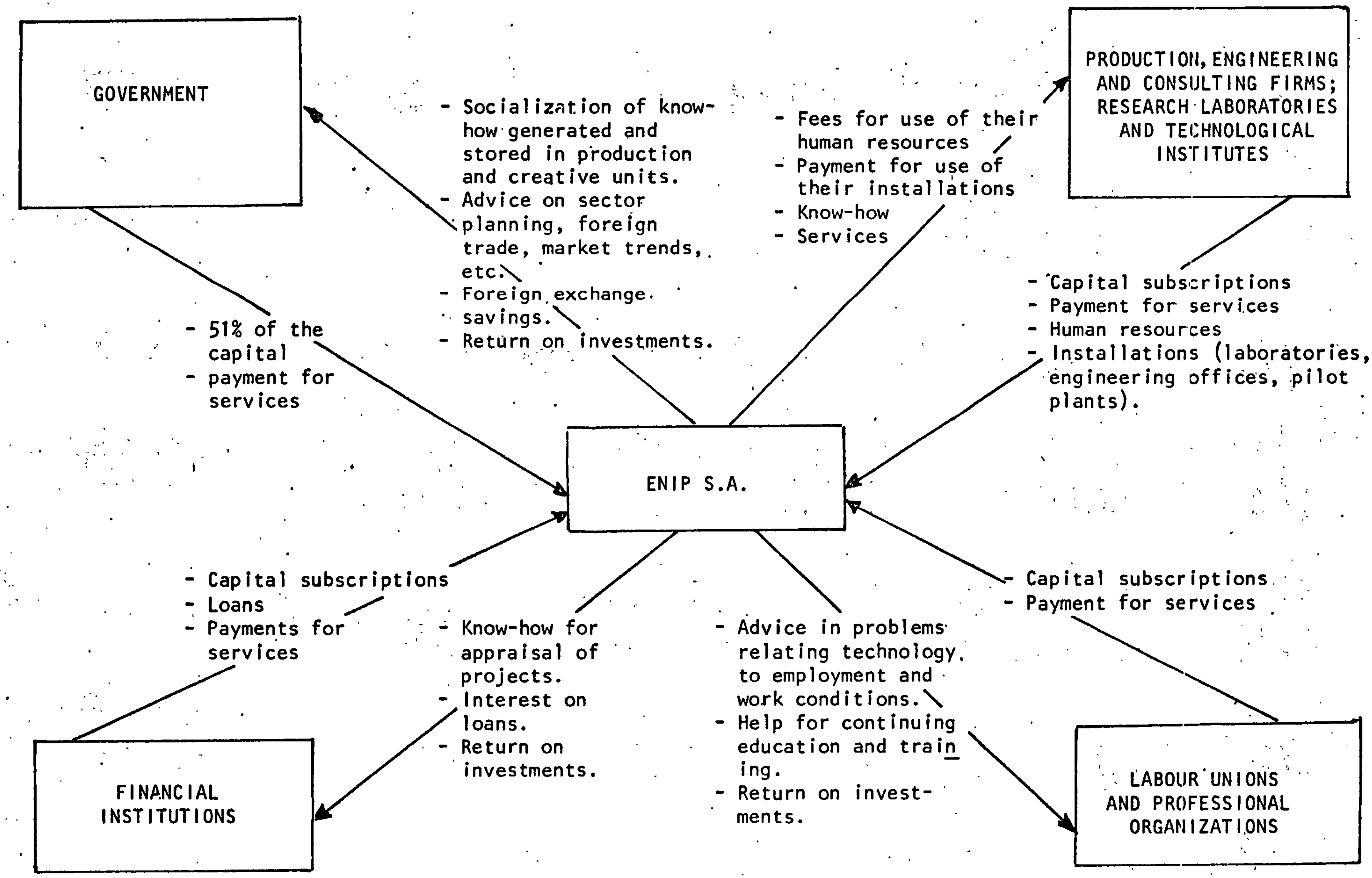
			$a
1.	Salaries		4,008,000
	General Manager	300,000	
	5 senior professionals	1,200,000	
	6 junior professionals	1,080,000	
	16 technicians and administrative staff	1,200,000	
	2 auxiliaries	60,000	
	7 directors	168,000	
2.	Social charges* 60% of salaries		2,404,800
3.	Rental of premises 400 m^2 x 100 $a/m^2/month x 12 months		480,000
4.	Miscellaneous expenditures Stationery, light, telephone, trips, etc.		500,000
5.	Contracts with third parties**		3,750,000
6.	Contingency allowance		357,200
		TOTAL	11,500,000

Basis of calculation: Exchange rate $a 10 per US$ 1
Wholesale price index: 3,163.7

* Includes complete medical assistance and insurance in accordance with the remunerations, plus the payments provided for by law.

** These contracts would be for intrinsic purposes such as setting up the card index of sector costs. Contracts that might be required for work requested by third parties would be covered out of funds obtained from the respective requesters for that purpose. In other words, every client of the ENIP would pay, on the one hand, for the services rendered by the ENIP and, on the other, for those which the ENIP has to subcontract with third parties at the cost to be negociated with each such third party.

FIG. IX.3. FLOW OF RESOURCES AND RESULTS BETWEEN THE ENIP AND ITS MEMBERS



consulting offices or engineering groups, of its own but would allocate the work arising from its initiative, or requested of it by member enterprises or third parties, among the existing enterprises, organizations or institutes, or those whose formation it promotes, giving preference to laboratories, pilot plants or consulting and engineering services of the shareholding enterprises, agencies or institutes.

For instance:

- The ENIP would not create a new Argentine Petroleum Institute: it would try to make the present one something else than a library and a meeting place.
- The ENIP would not set up new petrochemical or petroleum laboratories: it would seek to movilize and perfect the installed capacity of the State Petroleum enterprise (YPF), which has more than 20,000 m^2 of laboratories, shops and pilot plants and almost 200 people working in its research and development department.
- The ENIP would use the capable personnel now dispersed among various consulting firms, none of which has been able to organize a critical mass of professionals and technicians to meet the specific demands of the sector.
- The ENIP would advise the production enterprises, specially the smallest ones, on:
  - (i) purchase, rental or creation of appropriate technologies.
  - (ii) sale or licensing of technologies they might generate.
  - (iii) procurement of their main inputs.
  - (iv) opening of new markets for their products.
- The ENIP would maintain an up-to-date card index of the cost of capital goods, raw materials, intermediate inputs, end products and technologies that the sector uses or produces.

C. COMMENTS ON THE PROPOSAL

The ENIP and unionism

I feel it is really important that representative unions within the sector participate as stockholders in the administration of the enterprise. The Secretary of the Argentine Federation of Chemical Industry Workers admitted* that the subject of the influence of technological choices on the social and economic development of the country seldom appears in labour union meetings and that urgencies resulting from extrinsic political activities and from intrinsic union ones were hindering a careful study of the problem.

Unionism appears as disregarding the growing importance of technology as a production factor in its analysis of national problems. Unionists keep considering economics exclussively in terms of capital and labour, among other things because, undoubtedly, these two factors are the ones strongly influencing their every-day activities. However, they should start thinking on how the selection, generation and use of appropriate technologies are connected with the quality of life, equity in income distribution and full employment.

Their participation in enterprises such as the one I am proposing would allow unionists to learn by doing, working together with professionals, technicians and entrepreneurs in those subjects.

The ENIP and technology transfers

As it is indicated in the Linowitz's report**, "the market for technology might be improved if better information about terms and prices of technology were recorded and shared".

One of the ENIP's tasks would be precisely this one: recording cost data and making it available to Argentine private and public production enterprises and

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* Personal interview, June 1974.

** Report prepared by a Commission of 23 members presided by Sol Linowitz, former Ambassador of the U.S. to the Organization of American States. It was delivered in Washington on October 1974, under the title "The Americas in a changing world - Report of a Commission on United States-Latin American relations". The quotation was made from page 51 of a xerographic copy obtained from the U.S.I.S. of the U.S. embassy in Buenos Aires.

consulting and engineering firms.

The same report sustains that "technology transfer takes many forms" and that "the institutional and organizational ability to use it is as important as access to the technology itself". Regarding that access, it reckons that "most transfers (...) result from private decisions of corporations, tipically in the form of equity investments" and that "the market place, because of the monopoly elements inevitably present, will not always yield equitable solutions". In order to partially relieve this situation, it recommends* that "The U.S. Government should cooperate with Latin American countries to collate and diseminate information relating to the terms of licensing agreements, royalty payments, etc. Similarly, one function of the new public science foundation recommended previously should be to provide a clear house of information on technological services potentially available from middle and small sized firms in the United States".

On this respect, I have been able to find that there is a source of technology that could be profited by Latin American countries as soon as these develop their capacity for the local organization of their investment projects and for performing the engineering of the same: ideas generated within the teaching and research units in the universities of the most developed countries sometimes remain at a laboratory stage because inventors do not find financial support in their own countries so as to perform the experimental development of the same. Peripheral countries might benefit from picking up that basic knowledge and build the preliminary engineering and, then, the detailed engineering around the same, for a new investment project. The inventor would collaborate with his advice in the experimental development and engineering work performed in the developing country and would attain growing retributions for his idea to the extent in which the development would demonstrate the validity and industrial feasibility of the knowledge.

I was personally involved in an agreement of this type, by which a U.S. professor received a first small payment for delivering the necessary knowledge for an Argentine enterprise to reproduce in its laboratories a procedure that the former had finished at a laboratory scale and that, as far as he reported could: a) reduce energy consumption to a third of the amount spent in the

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* Recommendation No. 33 of the Linowitz Report, *op.cit.*, page 52.

process being used by the Argentine enterprise; b) employ only 25% of one of the very expensive intermediate inputs involved in the process; c) increase the yield of the raw material; and d) improve the quality of the final product.

If the procedures showed no difficulties at a laboratory scale when applied to Argentine raw materials and if the laboratory tests confirmed the advertised advantages, the enterprise would make a second payment, ten times as big as the former, and start experimental development, always with technical assistance from the knowledge supplier. If, in turn, the results at the pilot plant showed coherence with those at the laboratory scale and demonstrated the feasibility to be transferred to the desired industrial scale, the inventor would receive a third payment, three times as big as the second one, and continue advising the argentine team during the plant implementation stage. With this third payment, the Argentine enterprise would become the only owner and possessor of the developed technology. It would then be able to use the developed knowledge as many times as it decided, without any further payments. Only when licensing third parties would the Argentine enterprise share one third of the collected royalties with the inventor.

That was how an actual sale-purchase contract was attained, with a minimum risk for the buyer, which did not know, at the time the negociation was made, whether a technological feasibility or a scientific illusion was being purchased, and conveniently and gradually retributing the inventor as the knowledge was developed, its possession strengthened and its use extended. The knowledge would gradually be transformed from potentially usable (laboratory) into usable (pilot plant) and, finally, into used (industrial plants).

The presence of a high level technical team, such as the one that would integrate the ENIP, would ease the access to similar or even more original technological sources, as alternatives to present ones, where large production and engineering groups predominate.

The ENIP would also allow the small firms in the sector to more easily procure the technological inputs they need in order to attain an efficient activity, since these enterprises do normally lack the necessary human resources for negociating and making adequate decisions as far as their production and managerial technologies are concerned.

The ENIP and standardization

A strong dependence on foreign technologies obliges a country to defend itself at least from the introduction of equipment and fittings with different construction patterns that do later increase spare part stock costs, complicate the replacement of capital goods and hinder an efficient maintenance work.

H. F. Rase* says:

-"the mass production genius of America is based, in part, on the standardization program of the American Standards Association, for without standardization of structural components every job would be a custom one".

-"Many progressive design and operating firms in the process industries have realized the benefits of standardization and have prepared standards for equipment and design procedures. Though valuable, each set of company standards suffers from the myopic vision of the limited experience of that company. This is analogous to the frog in the well who knows nothing of the ocean. How much better it would be if these standards could be developed through cooperation of all industry".

-"To those who might suggest that this would hurt competition, they need only be reminded that freeing employees' minds for creative work would surely increase the type of enlightened competition that benefits all. It is an inexcusable waste of time to guard with great care and cunning some routine design method. An aura of authenticity is cast on the method that encourages the mediocre to seek these company 'secrets' as key to competence, and mediocrity is advanced in a dizzy spiral as the 'secrets' are discussed and traded but never analyzed in the forum of general professional debate".

The ENIP, being a State-controlled enterprise but transparent to the private sector by the latter's direct participation in its administration, would be in an excellent position to promote these aspects, mobilizing private and public production enterprises and engineering firms towards a more efficient and harmonic development of Argentine chemical and related industries.

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* H. F. Rase, *The philosophy and logic of Chemical Engineering*, Gulf Publishing Co., Houston, 1961, page 136 and fol.

CHAPTER X

COOPERATION AMONG LATIN AMERICAN CONSULTING AND ENGINEERING TEAMS

A. THE LATIN AMERICAN MARKET

The Latin American geography shows:

- -tropical plateaus
- -large forests
- -inmense cultivable plains
- -long mountain ranges, with peaks up to 7,000 meters high
- -giant rivers
- -panoramic views varying from the moonscapes of some deserts to feasts of Nature where, through vegetation, water and skies, Creation seems willing to court the Goddess of Beauty.

While the leaders of the Latin American independence supported the romantic idea of a unified Spanish American country, history and reality were retouching political divisions based on social differences carved out since long ago by some of those colossal geographical obstacles hindering communication.

Considering that Europe, with 10 million square kilometers, extensively mingled by wars and conquistadors of many different origins, ended up in a 32-State division, we should not be amazed by the fact that Continental South and Central America plus Mexico, with more than 20 million square kilometers, be divided into 19 independent nations plus 2 small territories still dependent from outside-the-continent powers. The history of the United States of North America is different, they are not born to independent life with their almost 10 million square kilometers: this large space was gradually occupied through conquests, colonizations and negociations.

I have already analyzed some of the differences between two Latin American countries, Mexico and Argentina, and I may point out some other examples of how Latin American countries differ from each other, both socially and economically.

-Costa Rica is small (50,000 square kilometers and approximately 2 million inhabitants on 1974), modest (645-dollar gross product per capita on 1973 in 1970 dollars), non very equitable (the richest 5% of its inhabitants absorbed 35% of the income in 1967), and highly literate (85.7% on 1963), has no armed forces and was spending almost 19 dollars per capita in educa tion during 1972/73 in dollars of 1970.*

-Brazil, instead, is rich in land (8.5 million square kilometers), rich in population (104 million inhabitants on 1974) and rich in poors (20% of the popularion shared only 4.2% of the income in 1967) and was scarcely spending 3 dollars per capita in education during 1972/73 in dollars of 1970, although growing at such a pace (more than 10% yearly increase in the gross product between 1971 and 1973, inclusive) that cement and steel are muffling the song and the rythm bubbling up from its people's veins.*

-In Peru, the "sierra", asleep since the times of Machu Picchu, separates the primitiveness of the Eastern forests from the modern world piercing the coastal region. Taking the average gross product per capita in the forest region as 1, figures are 2.7 times higher for the sierra and 5.2 times higher for the coastal area.**

-Uruguay, open to the four winds, collects the fall-out of the latest fashions exploding abroad and contemplates how its ancient wealth is eroded. The percent of its population enrolled in high studies (0.7% in 1968), the number of inhabitants per medical doctor (1,040 in 1967), the newsprint consumption (5.4 kilos per capita in 1968), the number of seats in cinemas (71 for every thousand inhabitants in 1973), the number of radio sets in use (379 for every thousand inhabitants in 1969) and the number of inhabitants per car (13 in 1971) are all figures comparable to those in more developed countries; but it's retail prices increased 220 times between 1950 and 1971 and its foreign trade in the period 1968-1970 was a half of what it was in the period 1928-1930.***

Under this context, we may realize why the utopia of a Latin American common

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* Data collected from the following sources:
- -BID, *Progreso Socio-Económico en América Latina*, Yearly Report, Washington, 197
- -CEPAL, *Estudios sobre la Distribución del Ingreso en América Latina*, 1967.
- -CEPAL, *Estudio Económico de América Latina en 1973*, Sgo. de Chile, 1974.
- -BID, *Sinopsis Estadística de América Latina.*

**H. Harms, *Geografía Universal*, Ateneo, Buenos Aires, 1969, Vol. 5, page 461. As per statistics of the Interamerican Development Bank, the gross product per capita for the whole country in 1973 was 533 dollars of 1970.

***OECEI, Argentina Económica y Social, Buenos Aires, 1973, Vol. I.

market diluted in its very beginning and is demanding to be replaced by a more easily attainable objective.

The programme outlined in Montevideo on 1960, tried to reach a free exchange among the regional markets in twelve years and finally end up in an actual common market with common economic policies, a single supra-national Central Bank and a single currency. However, on 1972, the Latin American Free Trade Association (LAFTA) was not even able to finish negociating the withdrawal of customs restrictions for a first product list and only 36% of almost 11,000 minor import duty concessions granted had generated some regional trade.*

The initial member countries (Argentina, Brazil, Chile, Mexico, Paraguay, Peru and Uruguay) may have perhaps passed over the fact that a region is not only an economic space but also an ecological space, a social space and a cultural space, involving complex interactions among its national infra-structural elements and among these and their respective political and juridical superstructures. The integration of this set of units into a single functional system requires at least that previously designed objectives be internalized by each one of them.

The difficulties that were and still are encountered by the European Economic Community, due to their lack of political integration, become more critical in Latin America because of the larger economic disparities among the various countries and because of their different degrees of subordination to foreign interests.

However, the LAFTA example shows that, even under those conditions of a heterogeneous set trying to become a single operational system, the pursuit of an utopia, as carelessly as it may have been designed, mobilizes unexpected energies, arises new motivations and allows to partially attain some objectives.

In the case of the LAFTA, the evolution gave way to something possitive: an increase in the regional trade. Dependence among Latin American nations from the European and U.S. market was so intense before the Montevideo Treaty that,

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* Data obtained from a series of articles by Miguel Angel García, published under the name of "El Contradictorio Destino de la ALALC", in the Buenos Aires newspaper *La Opinión,* in its issues dated May 31 and June 1, 2, 3 and 4, 1972.

even advantages resulting from vicinity and complementary endowments of resources were disregarded. During the first ten years, trade among the LAFTA members moved from 1,000 million dollars to 2,700 million, although, even so, it only represented a 12.8% of their total foreign trade. As opposed to this, when the European community was born, 42% of the trade performed by the member countries was already regional.* Fig. X.1. shows the evolution of general trading and that of chemical products in particular, for the LAFTA member countries.

On the other hand, an intrinsic risk of this type of associations is that of allowing for the creation of a center and a periphery within the region. In Europe, the geographical center of the community, the old "Lotharingie"**, did also become its economic center, extending up to the South of England and of the Scandinavian countries, while the non-comunist part of the circle around that center, from Greece to Laponia, covering the Italian "mezzogiorno", Spain, Portugal and Ireland, constitutes a periphery with much less income, employment and equity, serving as a reservoir of cheap labour for the center.

A Latin American association with loose non-systemic objectives could lead to similar situations, although the center of the system here would possibly be other than the geographical one. The power would keep growing as from the coastal areas, where the trading ports are located, while the large interior space would keep emptying.

Argentina is still trading with Peru by means of ships that go around the Southern coasts through the Magallanes strait. Thus, products from Salta and Jujuy, in the North-West of Argentina, travel almost 2,000 kilometers in order to be embarked at the port of Buenos Aires, are sailed for more than 10,000 kilometers to reach the Peruvian port El Callao and, again on the road, travel almost 1,000 kilometers to finally arrive at the SouthernPeruvian city of Cuzco, which is only about 2,000 kilometers from Salta on a flight line.

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* M. A. García, *op.cit.*

** Expression used by Paul Hanappe in his article *Strategies spatiales des firmes multinationales*, Metra, Vol. XIII, No. 1, Paris, 1974, pages 17 and fol., from which the main ideas of this paragraph have been taken. Lotharingie was the name given to the kingdom of Lorraine, formed on 855 after the death of Lothair I, in favour of his son Lothair II.

FIG. X.I. TRADE AMONG COUNTRIES OF THE LATIN AMERICAN FREE TRADE ASSOCIATION (LAFTA)

(In million U.S. dollars)

COUNTRY	YEAR	1 TOTAL TRADE (a) IMPORTS	1 TOTAL TRADE (b) EXPORTS	2 TRADE WITHIN LAFTA (a) IMPORTS	2 TRADE WITHIN LAFTA (b) EXPORTS	$\frac{2(a)+2(b)}{1(a)+1(b)}$ %	3 TOTAL TRADE OF CHEMICALS (a) IMPORTS	3 TOTAL TRADE OF CHEMICALS (b) EXPORTS	4 TRADE OF CHEMICALS WITHIN LAFTA (a) IMPORTS	4 TRADE OF CHEMICALS WITHIN LAFTA (b) EXPORTS	$\frac{4(a)+4(b)}{3(a)+3(b)}$ %
Argentina	62	1,356.5	1,216.0	103.2	141.4	9.5	81.2	127.9	2.7	5.2	3.8
	72	1,904.7	1,941.1	373.1	484.1	22.3	285.7	72.0	13.3	33.3	13.0
Bolivia	67	151.0	166.3	17.6	9.6	8.6	12.5	4.4	1.5	0.01	8.9
	69	165.0	198.2	26.1	17.5	12.0	12.8	6.0	1.5	0.04	8.2
Brasil	62	1,486.8	1,214.0	128.6	75.8	7.6	162.5	13.7	5.9	0.8	3.8
	72	4,723.0	3,990.0	392.4	407.8	9.2	738.2	65.5	54.9[1]	23.7[1]	9.8
Colombia	62	540.3	463.4	12.5	7.3	2.0	84.0	1.2	2.1	0.6	3.2
	69	685.3	607.5	48.2	54.7	8.0	103.1	8.1	6.2	5.5	10.5
Chile	62	571.3	530.1	80.5	39.4	10.9	14.6	36.2[2]	2.3	4.5[2]	13.4
	69	907.1	1,075.6	217.1	114.1	16.7	91.9	29.2	10.1	5.7	13.0
Ecuador	62	97.1	117.4	3.9	6.1	4.7	3.0	1.4	-.-	0.9	20.5
	71	340.1	199.1	50.5	25.5	14.1	37.4	1.9	4.2	1.6	14.7
Mexico	62	1,143.0	891.5	6.1	16.7	1.1	175.2	32.8	3.0	2.8	2.8
	72	2,900.0	1,825.0	119.8	147.5	5.7	408.3	113.4	14.1	28.7	8.2
Paraguay	62	40.0	33.5	6.1	10.9	23.1	1.6	3.6	1.0	0.1	21.1
	72	69.8	86.2	23.5	20.6	28.3	3.6	2.4	1.1	0.1	20.0
Peru	62	536.9	540.0	45.2	48.8	8.7	52.5	2.7	0.9	0.6	2.7
	70	621.8	1,047.8	105.6	63.5	10.1	74.8	3.3	4.3	1.6	7.6
Uruguay	62	230.5	153.4	34.0	8.0	10.9	6.0	0.07	2.1	0.01	34.8
	72	187.0	214.0	70.4	26.6	24.2					
Venezuela	67	1,343.1	3,112.0	35.0	145.0	4.0	131.0	6.5	2.7	0.1	2.0
	69	1,754.0	3,112.6	61.4	167.7	4.7	156.7	4.3	4.4	0.9	3.3

Sources: -Statistics of LAFTA, OAS and U.N. -CEPAL, *La Industria química latinoamericana*, 1966. -Papers filed with the VI Latin American Congress of Chemical Engineering, Buenos Aires, 1969.

[1] Data corresponding to 1973.
[2] Includes exports of nitre.

NOTE: The figures under 1 and 2 are more trust-worthy than those under 3 and 4. Many of the latter are really estimations and the classification of chemicals does not follow the Brussels Customs Nomenclature in every case.

This roundabout puts Argentine products as far from Peru as North American products leaving the Port of San Francisco. The problem may be solved by building or improving roads and railroads, but, if the intermediate empty areas are not "filled" and an international hinterland trade implemented, those means of conveyance and travel will be under utilized.*

On the other hand, by enlarging the markets, at least for a few products, the LAFTA should have verified the postulates of the economies of scale. Up to now, it has only and modestly proved that, while maintaining their former production scales, the Latin American countries may benefit from an increased regional trade and that in the very few cases in which a larger scale technology was needed it has favoured the activities of large transnational corporations with great mobility in their financial and technological capitals.

In the LAFTA, most of the regional trade of non-traditional products** is in the hands of transnational corporations, whose headquarters are outside the area. Three of the six agreements signed until 1968 for complementing industrial activities among member countries served to benefit one transnational group each, by allowing them to organize their various branches in the area so as to satisfy the demand of the whole Latin American market.*** Similarly, the EEC did neither promote European multinational firms, while investments from U.S. corporations increased from 637 million dollars in 1950 to 11,695 million dollars in 1970.****

The transnational organizations, when operating in common markets, prefer multiple plants, each one of them specialized in a series of particular operations.***** The assumption that large spaces make a better use of the economies of scale is thus partially counteracted, but the risks for nationalization are decreased: each one of the countries keeps only a piece of technology that is worthless by itself. Decisions on where to locate each partial operation are based mainly on the sensitiveness of national economies to key factors in the economy of the corresponding operation. Thus, for

* Statements by Miguel A. García, *op.cit.*, are closely followed.
** Mainly manufactured products, as opposed to the primary commodities that are still the fundamental exports of less developed countries.
*** D.C. Lambert and J.M. Martin, *L'Amerique Latine: economies et sociétés*, Armand Colin, Paris, 1971, page 366.
**** P. Hanappe, *op.cit.*
***** *ibid.*

certain assembly lines, a region with cheap labour will be preferred, the qualifications of the personnel and the distance from communication centers having little incidence. On the other hand, the operations sensitive to transportation costs and requiring relatively less labour will be preferentially performed in these communication centers.*

This type of production organization, profiting from previous local economic patterns, does very little towards "the diversification and improvement of the local industrial fabrics".** If an area is selected because it provides cheap, unskilled labour, most of the employment created will be of the same type and the favourable effects for the region resulting from the improvement of the ability to locally organize and use knowledge will be few and weak.

Larger markets have also disregarded psycho-social and cultural factors. For a country to integrate with another, it must be formerly integrated in itself: only then may it give and receive. It is hard for a Nation to join another country's space, when it is still empty of its own people, its own culture and its own management.

The lack of integration with themselves in Latin American countries increases difficulties in their relations with the North of the continent, where the biggest military, industrial, commercial and financial power of the world has developed.

As regards to other continents, the United States have oscillated between an archaic introversion and a thundering extroversion, but concerning the American continent, they have always tried to be the pater familias of a clan united around the father's totems.

This allowed the patriarchal house to largely benefit from the work force and from the resources of the subordinated families, exchanged for "aid" to their development and for "protection" against foreign evils.

On their side, the subordinated members of the clan, due to the lack of a mature self-identity, did not intend their own, gradual and diversified search for satisfaction of their needs, with their own resources, through

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* I keep closely following P. Hanappe's ideas.
** P. Hanappe, *op.cit.*, page 28.

their own efforts and in an open play with the whole world.

The young Latin American nations expect "Daddy" to give without demanding and sink into oedipal relations, each one wanting to monopolize the father's favours and distrusting the other. The father, inmature in himself, encourages this type of dependent relations, which will end up becoming a load for his own home and benefiting only those for whom the economic space does not identify with any political or cultural space... nor with affection.

When the father wants to protect his most intimate family, his decisions often affect the peripheral dependent groups and these shout and protest; but, in turn, any attempt by the latter towards more assertive independent attitudes are blocked or repressed. Thus, the possibilities for a mature relation between heterogeneous peers, who should for no reason be even in wealth so as to be equals- dilute once and again.

The Linowitz Report* has clearly reckoned this situation. It is worth while reproducing some of its "directions for the future":

> We must base our actions in the future on the recognition that the countries of Latin America and the Caribbean are not our "sphere of influence", to be insulated from extra-hemispheric relationships. Nor are they marginal to international politics. Rather, they are increasingly active participants on the world scene, nations whose friendship and cooperation are of growing value as we confront the realities of global interdependence.
>
> We must also recognize that the nations of the region are not homogeneous. They are diverse, with varying goals and characteristics, at different levels of development. They are not and need not be, replicas of our country, nor do they require our tutelage. They are sovèreign nations, able and willing to act independently, but whose interests in forging constructive solutions to regional problems will often coincide with ours.
>
> Our mutual concerns in the hemisphere center not on military security, but rather on the critical issues of economic and political security in an uncertain world. The growth of our economies, the well-being of our citizens, the coherence of our societies, and the protection of our individual liberties: these are the goals we share, and which we now recognize cannot be attained in isolation for -or at the expense of- our neighbours.
>
> ...
>
> The approach we suggest is based on the proposition that the United States cannot neglect, exploit or patronize its hemispheric neighbours. It is based, too, on the proposition that justice and decency, not disparities of power and wealth, should be the guiding forces in hemis

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* *op.cit.*, page 53.

> pheric relations. Both self-interest and our fundamental values require that we nurture our common interests and historic ties in the Americas, and that we cooperate in helping to build a more equitable and mutually beneficial structure of international relations.

The report's formula seems to be "independence with interrelationship". However, paternalism has so deeply penetrated the U.S. political environment that, even this report, rebelling against that paternalism, lets it slip in. For instance: it recomends that the United States should complaisantly vouchsafe preferential custom tariffs to the Latin American countries even if they may affect the internal economy of the U.S. and oblige this country to issue extraordinary aid policies for the enterprises that may see their activities impaired and for the U.S. citizens who may lose their jobs.*

Delicate equilibria are involved in an independent and still interrelated life based on a country's particular endowment and on stimulus coming from its inside and from its outside. It seems that, for social bodies, as well as for individuals, the inward perception needed to mature and to assert objectives is blurred by excessive exchange flows with the outside.

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* See statements on tariff preferences and domestic adjustment assistance, in Chapter VI, "Economic Relations" of the Linowitz report.

B. COOPERATION IN THE CONSULTING AND ENGINEERING FIELD

The main features in the development of process industries in Latin American countries have been:

i) Installations have had little effect upon the local manufacture of capital goods, because most of them have been purchased under turnkey operations, all or the most important pieces of equipment being imported.

ii) The evolution of the process industries manufacturing basic and intermediate products has not been coordinated with that of the production of consumer goods and, therefore, many of the former had and have to work under their nominal capacity for long periods of time.

iii) The knowledge on the processes and their preliminary engineering were mostly imported, while in many projects the detailed engineering and the construction work were locally performed.

This sector has an important share of the Latin American industrial production, principally due to its industries transforming agricultural products. If only rubber, chemical and petrochemical products are considered, such share is smaller, specially among the least developed countries in the region (see Fig. X.2.). Therefore, the Latin American industrialization is generating a considerable demand for process engineering services.

A survey made in 1972 for the Cartagena Agreement Committee estimated the total demand for engineering services in the Andean region at that time in 53 million dollars per year and expected it to reach 100 millions by 1975 and to surpass 150 million by 1980.

Other sources indicated that Venezuela, by itself, was planning to invest about 1,000 million dollars in petrochemical projects between 1975 and 1980, which would mean an equivalent demand for engineering services ranging around 100 million dollars for the same period.*

The above surveys showed that the overall participation of the different

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* We must remember that every 10 million dollars demanded for engineering per year result in the work of approximately 500 people (200 engineers and 300 technicians). The calculation is based on the sales price of 10 dollars per hour, on 2,000 men-hours available per person and per year, and on working teams organized as per a ratio of 1.5 technicians for each engineer.

FIG. X.2. PARTICIPATION OF THE PROCESS INDUSTRIES IN THE LATIN AMERICAN INDUSTRIAL PRODUCTION

COUNTRIES	WHOLE SECTOR[1] %	RUBBER, CHEMICALS AND PETROCHEMICALS, ONLY %
Argentina	37.2	15.7
Bolivia	61.0[2]	4.8
Brasil	40.1	20.1
Colombia	54.1	16.2
Chile	36.6	12.2
Ecuador	61.9	8.1
Paraguay	61.1	12.7
Peru	42.7	6.0
Uruguay	57.5	15.5
Venezuela	62.1	23.0
Costa Rica	76.7	8.0
Republica Dominicana	83.5	5.1
Guatemala	64.4	6.3
Haiti	56.6	1.1
Nicaragua	68.8	13.0
Mexico	54.9	21.2

Source: D. C. Lambert and J. M. Martin, *L'Amerique Latine: Economies et Sociétés*, Colin, Paris, 1971, page 318, table 35.

[1] Includes: food, beverages, tobacco, paper, furs and leather, rubber, chemicals and petrochemicals. Metals have not been included because most statistics unite their production with metal working.

[2] Does not include paper, whose production in this country is considered together with printing.

branches of local engineering in the various industrial projects performed in the area of the Andean Pact was very low as far as detailed engineering is concerned and still lower for preliminary engineering. The participation in detailed engineering hardly reached 10% in Peru and 20% in Ecuador, while in Chile it went up to 50% because, at that time, its State agencies and enterprises preferred to perform it by themselves, within their own engineering departments.

Vicious circles, similar to those shown when studying Mexico and Argentina, may be found at the regional level:

i) Technology is not developed in the area because investment resources are scarce and, in turn, capital accumulation is slow, among other things, due to a low level of technological innovation.
ii) National engineering does not develop into large firms because the demand is low and, on the other hand, every new large project is contracted abroad because local engineering services have not yet been efficiently organized.

Regarding capital accumulation, it should be borne in mind that a good portion of the Latin American financial surplus migrates from the region on account of political, economic and psychological reasons. Between 1952 and 1961, the total amount of private capital sent abroad from Latin America has been publicly recorded as 576 million dollars. If this is added to capital that was secretly transferred, a figure around 3,000 million dollars is obtained.*

Besides, a survey performed for the whole Latin American area on 1969 reported that, if the amount of new loans remained at the same level as on 1965/67, services, that reached 87% of the amounts yearly borrowed in that period, would reach 130% by 1977.**

Regarding dependence from foreign engineering, consideration should be given to the fact that the detailed engineering of a large number of the regional projects is performed by foreign firms, for reasons connected with direct dependence (branch-headquarters), with indirect dependence (tied-up loans),

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* From a report of the International Monetary Fund and from the comments on the same published by the newspaper *Le Monde*, Paris, March 19, 1964, page 20.

** *Le Monde Hebdomadaire*, Paris, No. 1101, page 11.

with cultural dependence or with psychological problems related with risk assumption.

Evidently, Latin America needs to install its own capacity in engineering and consultancy and, considering the probable future demand and the experience accumulated in some countries of the area, we may wonder about the convenience of organizing multinational Latin American engineering and consulting firms, for the process industries sector.

Somehow, the problem appears as an option between work at a large scale and smaller national service units. The former is apparently more economic, while the latter are supposed to be more capable of thoroughly considering the political, economic, social and cultural aspects involved in each project.

In the case of consulting services programmed as multinational instruments, they would have problems in getting rid of the imitative tendency, which would take up whatever may have previously developed in the area as a model.

The objectives of consulting services are quite different from other production activities: while a multinational merchant fleet, for instance, could be a commercial instrument aiming to serve predefined and predetermined activities in each member country, a multinational consulting firm should be an instrument aiming to define and to determine what to do and how to do it under the conditions of each country.

Besides, the barriers that are still opposing to quick communications and exchange flows among Latin American countries would hinder the consolidation of a multinational enterprise. The Latin American countries still cling to physical formal borders, instead of limiting their national activities within clear cut functional boundaries. Frontiers confine and asphixiate; on the contrary, functional boundaries, helping to concentrate energies and to assert objectives, produce self-confidence and allow for people to open up to the world, without fear of loosing their identity.

Each country should strengthen its personality, while interconnecting itself with all the rest, so as to take up whatever is necessary and some of the apetizing elements the others may offer, and, at the same time, offering the surplus of its own autochthonous elements, needed or desired by the others. The exploitation and/or transformation of those autochthonous elements may sometimes call for the design of technologies ten or one hundred times smaller than those currently used in other countries or, reversely, for the crea tion of technologies for much larger scales.

Let us see a few examples:

i) Bolivia needs to solve its own gas-petroleum equation. Although it could lean on Argentine, Brazilian or Mexican experiences, it is for the Bolivians to decide by themselves what to do with their gas and with their petroleum. Do they want to replace candles, kerosene lanterns, twilight and stars in all their territory by lighting obtained from thermically generated electricity? Do they also want to have fire everywhere by only tapping a gas pipe, while keeping their wood for other usage? Do they want to export the wealth of their subsoil as raw materials, to receive foreign currency for the same and with that foreign currency purchase other satisfactors? Or do they prefer to generate those currencies by competing with products resulting from petrochemical plants that would perform the transformation of their petroleum and gas resources within their territory? Could they sell their fossil fuel wealth and still not compromise the future, by replacing the energetic reserves for monetary reserves that might later be applied to purchase fision, or perhaps, fusion, nuclear plants?

ii) Just before the start of large hydroelectrical works, such as Corpus and Yacireta, which are going to increase the supply of electricity, the flowered and small Asunción del Paraguay was replacing its streetcars, that do not contaminate the air and that do not make much noise when well-maintained, by "gasoline-swallowing" and "gas -when not soot- vomiting" busses. Wouldn't it have been better for them to develop their own design for the streetcars, for instance, making them more open or reversely air conditioning them towards more comfort in a hot climate? Wouldn't the maintenance and construction of street cars promote other Paraguayan electromechanic industries?

iii) The empirical knowledge of the old women selling medicinal plants in many Latin American market places is waiting to be developed and converted into the basis of an industry that may draw the virtues of *poleo, yaguarete-caa, marcela, zarzaparrilla, etc.* to the drugstores' shelves. New rich elements might so be incorporated to a now unidimensional medicine that often mistakes the biological reactor with a laboratory apparatus, disregarding whatever cannot be quantified in the former.

iv) In Peru, a soft-drink based on indigenous herbs is not only conquering the local market, but started to be demanded by neighbour countries.

Bearing the preceeding considerations and examples in mind, I propose cooperation among Latin American countries for performing pre-investment work to be based on the formation and strengthening of national consulting teams able to:

- analyze the local reality and its relations with the foreign context;
- perceive the limits of their own intrinsic capacity beyond which they should apply for help; and
- identify themselves with their social, cultural and physical environment.

Nobody could feel local problems better than nationals honestly worried about the evolution of their country. They should organize their projects by selecting the most appropriate technologies. For the preliminary engineering, which should support the feasibility studies, and for the detailed engineering when implementing the projects, they could recur to foreign engineering services if a projection of the demand for engineering services does not justify the creation of local teams, so as to satisfy the peak loads resulting from those projects.

These foreign engineering services could evidently be performed, among others, by Latin American multinational firms. However, thorough studies should be made in order to assess the potential utility and efficiency of Latin American multinational engineering enterprises that would be lead to manage very large technical teams, even if only part of the foreseen demand in the area is to be faced.

My experience makes me fear the vertical mechanistic dependent links arising when very large personnel dotations must be managed as from a central brain (where located?).

Communication channels are then rapidly stuffed, because they are run over by even minor decisions and messages do soon become confuse and slow.

I prefer horizontal organic exchange flows that may be established among autonomous national teams for joint work as needed. Communication channels would thus only be utilized for major decisions, for those messages really needing to trespass the local functional limits.

If, after pre-investment work performed by local consulting groups, aided or not by foreing enterprises, Bolivia decided to contract the detailed engineering of its petroleum refineries, petrochemical plants or gas distribution systems abroad, firms from other Latin American countries with experience in these fields could compete. They could bid either isolatedly or under temporary ententes among themselves or with enterprises from outside the region.

Even so, some engineers and technicians of the receiving country should always participate in the work performed by the firm or group of firms from abroad, be they exclusively Latin American or not. The problem of national participation cannot be disregarded in attempts towards Latin American technical cooperation. Foreign and local people can be better integrated when working in small decentralized units than for large across-the-countries vertical business organizations.

In order to attain an effective participation of local people and a fluent transfer of skills, each national team working for another country should have the professionals and/or technicians to be sent abroad adequately trained in the language and customs of the host country.* This training should not be merely anecdotic and formal. It should get deep into the social, anthropological, cultural and psychological levels of analysis. One thing is telling somebody that many people in India refuse to eat beef and a different thing is analyzing the evolution of the modes of production and of social and cultural patterns that generated the custom and its supporting beliefs.

Formation courses should be in charge of very well trained natives from the place where the work or the study are going to be performed, or of those foreigners who often devote their lives to study and research on social, cultural and economic problems of countries other than their own.

In some cases, knowing the host country's official language is not enough. For instance, professionals or technicians aimed to work at the Peruvian

* A transnational enterprise operating in Mexico declared to have performed this type of training as a normal practice for all its projects. See: *Memoria del I. Congreso de la Asociación Nacional de Firmas de Ingeniería,* Mexico, 1971, page 177.

"Sierra" region should acquire the rudiments of Quechua.

The presence of psychologists in the engineering teams could also enhance cooperation among countries. They could assess the psycho-cultural climate in which foreign personnel and their families would have to live and could help in selecting the most suitable personnel. The most experienced technician is not always the best technology transferor under conditions different from those to which he is accustomed. The problem of selection is complex because both the individual's psychological and physical conditions and the extent to which these are supported -or hindered- by particular family equations must be taken into account.

The presence of psychologists among host-country teams could, in turn:

- encourage integration between foreigners and local staffs, avoiding the development of ghettos.
- bring to light and iron out conflicts of interests among the individuals making up a working group or between individual ends and the objectives of the project.
- increase the efficiency of the groups by counteracting the tendencies towards dispersion and use of wrong levels of analysis during discussions on the work progress.
- increase the creativeness of the groups, helping individuals to remove inhibitions that prevent them from freely expressing their feelings and ideas.

The manager of a British engineering and construction group, involved in a large siderurgical project in Mexico, told me that, based on his Mexican experience, he was proposing his company that, before undertaking similar jobs in the future, it should send a mission to the host country, consisting of a physician, a business manager, a psychologist and the engineering professional who would later head the foreign team.

In addition to what the psychologist would assess, the physician would:

- determine the health measures that the foreigners would need to take in the light of the local sanitary conditions.
- work out ways to avoid the tensions that develop in foreign families when faced with the need to use a different system of health care, involving communication in a language other than their own.

In Mexico, a British nurse who knew both languages was hired to act as an intermediary between British patients and the local medical professionals. In addition to this, a British physician visits the Mexican works twice a year for ten days of consultation. The interviewed manager recognized that both measures were more a form of psychological reassurance than responses to a real need.

The business manager would help to organize all the aspects relating to housing, education and transportation of expatriate families; their communication with relatives back home, etc. In the case I am commenting, a special weekly service connecting London, Mexico City and the worksite was organized to pick up and deliver correspondence in both directions.

Among most of the Latin American countries a common language simplifies some aspects, but does not allow for omitting psychological aid in overcoming obstacles to the flow of knowledge and skills arising from individuals and from their different cultures and degrees of development.

On the other hand, training of human resources for engineering and consulting work in the receiving countries should be supported by:

a) Universities that store and transmit the whole universal spectrum of knowledge. Nevertheless, educational systems should reinforce those fields from which professionals are likely to tap more elements for solving local problems. This should be done by increasing the number of units of information in those particular fields and by performing local research work on the same. For instance, Bolivia may have enough with a single chair on Roman Law, but may need several chairs on petroleum processing and on its related physico-chemical sciences.

b) a set of "seed" centers* organized as per the main national economic sectors and serving:

-as an aid for government agencies and public and private enterprises in the organization of investment projects.

-as promoters for the development of national engineering and consulting services.

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* See Chapter VII of the author's previous report *Engineering and Pre-Investment Work*.

as banks of technical and economic data.

c) a general education system encouraging creativity, deepening local roots, opening to the outside world and getting rid of taboos and prejudices.

Taking into account:

-that skilled Latin American human resources are either scarce, being misused or put to flight by regrettable policies.
-that the formation of those human resources is a very slow process; and
-that the supply of foreign engineering may become scarce*,

the Latin American countries must urgently start forming and expanding engineering and consulting teams. However, instead of thinking about multinational giant structures, they should promote the development of national groups and speed communications and exchange flows among them** and between them and the various Latin American societies.

The national consulting and engineering services should constitute a link between the local, regional and universal creation of knowledge and the local production of goods and services. For such purpose, consulting and engineering enterprises need to be national and, at the same time, interrelate with those in other national systems of the Latin American area and also with similar teams in the most industrialized countries and in those belonging to other developing areas.

Up to now, most of the projects, organized and implemented from outside the boundaries of a national system, involved, either directly or surreptitiously, unconsciously or willingly, superiority and domination, in the form of mental positions, assuming that:

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* Basil Achilladelis, *Emerging changes in the petrochemical industry: an overview*, OECD Development Center, Paris, November 1974, page 14, mentions that oil refineries and gas liquification and petrochemical plants, whose construction is being faced by the Middle East petroleum countries, would be enough to fill the order books of all chemical plant contractors well into the 1980s. The foreseen investments would range around 15,000 million dollars.

** I was a witness of a case in which communications between two technological research institutes in neighbour Latin American countries had to be established through the headquarters of an international organization at the other end of the continent, in order to perform a programme for exchanging research workers.

-the social, cultural and economic patterns of those who prepare the project are always better than those in the receiving countries.

-the organization of the project should lead, at the implementation stage, to the procurement of capital goods and engineering services from the country where the project has been prepared.

-people in less developed countries do not have the same human needs as those in the countries where the projects are organized, being nevertheless susceptible to be engrafted with the same cultural desires motivating those foreign societies.

The scheme of independent and yet interdependent national groups looks forward replacing relationships involving either submission of one side and domination from the other or paternalistic attitudes from the more developed towards the least ones for an assertive interrelation between heterogeneous peers.