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TRANSFER OF KNOW-HOW IN METALLURGY TO AND BETWEEN LATIN AMERICAN COUNTRIES[1]

by

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SUMMARY

This paper is based on some of the results obtained in the course of a more extensive study on the subject prepared under the sponsorship of ILAFA and the Department of Scientific Affairs of the OAS. The final report will be published shortly by ILAFA.

The paper begins by stating the problems of transfer of technology and examining the applicability of some of the concepts to the steel sector. A historical outline follows showing the lag variation in adopting technology in the continent, over time, by comparison with the rest of the world.

The most usual channels for and forms of transfer are described, followed by a description of the results attained in the main stages of steelmaking (blast furnace, steelworks, rolling). Comments are included on the possibilities of intra-regional transfer of technology.

Finally, some considerations are added on results obtained, present prospects open to the industry in this field, and some recommendations, based on the opinions given by technologists and executives active in the regional steel sector.

1.- INTRODUCTION

1. In 1971, realizing the significance of technology in the economic development of countries, the Instituto Latinoamericano del Fierro y el Acero (Latin American Iron and Steel Institute) - ILAFA - together with the Department of Scientific Affairs of the Organization of American States, decided to conduct a study on "Technological Innovation and Transfer of Technology in the Steel Industry of Latin America".

2. The author of the present paper cooperated with Fernando Aguirre Tupper (*) in preparing that study. It was completed in early 1972 and is soon to be published by ILAFA.

3. The main object of the study was to review and examine the technological development accomplished by the Latin American iron and steel industry, in the light of its actual possibilities, and the historical circumstances that led to it, and to compare it with similar processes in the relatively more highly developed countries. Simultaneously, the study was intended to present, as realistically as possible, the role that transfer of technology has played in the process. By canvassing the opinions of executives and officials in the field, some ideas were sought regarding possible inter-enterprise, governmental and multinational action aiming at accelerating technological development in the region.

4. The initial field-work was done personally by the authors and included the major steel companies in the region as well as government agencies and steel industry coordinating organizations in the relatively more developed countries, and the main steel and metal research centres in the region. The direct information collected was then analysed,

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together with valuable supporting bibliographical material that was also collected while visiting the various countries.

5. The interviews held during the field-work stage clearly revealed the interest that was felt in the sector in having a paper that could help to attain maximum utilization of local technical and scientific capabilities for innovating and absorbing technology, as compatible with the efficient and realistic development of steelmaking capacity in the region.

6. The report referred to above covers the following: description of the present status of Latin American steelmaking, its historical development, examination of the present technological level of the sector, listing of research capacity available in the region, the history of technology transfer to and in the iron and steel industry of the region, conclusions and tentative recommendations intended to improve, to the extent possible, the results obtained to date.

7. The present paper contains an updated summary of those results that have to do with the transfer of technology towards and within the region. They are based on information and opinions obtained directly from steel technologists and executives, the authors being responsible for the interpretation given to such material.

2.- STATEMENT OF THE PROBLEM

8. Recent studies on economic development for the most part tend to place technology among the factors determining such development. Through the examination of many countries and sectors of activity it has been found that the traditional production elements - nature, labour, capital - are not enough to guarantee a growth of the Gross National Product such that will enable all the countries of the world to overcome stagnation and underdevelopment.

9. It is increasingly felt that the key to such growth must be sought in the use of more efficient and rational methods to transform natural resources into goods and services that will meet the needs of the community. Such methods are included in the notion of technology as it is so often used - and abused - in the present day.

10. The importance and dimensions of the problem have not failed to draw the attention of international organizations; quite the contrary, to a great extent, through studies, meetings and specific action the true dimensions of the "technological gap" have become better known and concrete measures are being proposed to reduce it.

11. At world international level it is worth stressing, among others, the efforts made in this direction by the Secretary of the United Nations, through the various UN Divisions or "ad-hoc" committees 1/, by the UNCTAD Secretariat 2/, and by the Secretariat of UNIDO whose most recent work will be described at this Seminar.

12. In the Latin American sphere special mention should be made, among some of the most recent efforts in this area, of the work done by the Organization of American States 3/, ECLA 4/, and the Board of the Cartagena Agreement 5/.

1/ See: U.N. "Transfer of Operative Technology at the Enterprise Level". Report of an International Expert Group (E.72.II.A.1). N.York (1972)
U.N. "Appropriate Technology and Research for Industrial Dev." Report of the Advisory Committee on the Application of Science and Technology to Development (E.72.II.A.3). New York, (1972).

2/ See for instance: UNCTAD Secretariat, "Transfer of Technology". Report to the Third Session in Santiago, Chile. TD/106(April, 1972).

3/ See, for instance: papers prepared for the Conference on Application of Science and Technology to the Development of Latin America(CACTAL) held in Brasilia in May 1972.

4/ See, for instance: ECLA, "Transfer of Technology in the Brazilian Steel Industry" (mimeographed, Santiago, 1971).

5/ See, for instance: "Transfer of Technology", a study by the Junta del Acuerdo de Cartagena (Cartagena Agreement Board), (TD/107) Paper prepared for the Third Session of UNCTAD, Santiago, April (1972).

13. These studies reflect the great concern that arose in some countries over the effect that the direct or indirect cost of purchasing technology - as operated in the past few decades - have had on their balance of payments. With their own resources or with the help and support of international organizations they have been conducting a number of studies intended to quantify the cost of the various forms of transferring know-how and to seek possible joint action for improving the bargaining conditions of developing nations. Detailed reference to these studies may be found in the publications mentioned earlier.

14. As a result of such studies laws began to be enforced and organizations to be set up for controlling and participating actively in the technology negotiations conducted by the enterprise, whether public or private.

15. Until a short time ago, the sole part played by governments in those negotiations was restricted, at the utmost, to the Central Banks which were responsible for registering technical assistance contracts with a view to providing the foreign currency required tp pay for it. In other cases the contracts must be registered with the Ministry of Finance or its agencies, for the taxes they generated to be duly collected. Such controls, however, are strictly financial, basically affecting the direct cost of technical assistance or purchase of know-how, and embodying no authority to discriminate as to the type of technology purchased or to require greater participation of local engineering in the projects.

16. Despite its limitations this form of control did lead, however, to some remarkable results and major reductions in royalty payments were achieved in traditional industrial sectors. The results, unfortunately, affected only the direct cost of the transfer, that is, only the visible top of the technological "iceberg".

17. Most recent laws and institutions take governmental participation

and action by specialized institutions a step further. By way of illustration it is worth mentioning that in September 1971 Argentina issued Law No. 19.231 whereby the national Register of License Contracts and Transfer of Technology was established, under the Ministry of Industry, Trade and Mining.

18. The Andean Area countries have a Common Statute for Foreign Investment (Decision No. 24 of the Cartagena Agreement), which was issued in December 1970 and enforced as from July 1971. It contains a full chapter on common regulations governing technology purchase contracts and patent registers.

19. Brazil reorganized in 1971 the National Institute of Industrial Property, which, together with specialized sectoral agencies - CONSIDER, for the steel industry - participates actively in the study of new contracts for purchasing technology. In Mexico the Law governing the Register of Transfer of Technology and the Use and Operation of Patents and Brands, and creating the National Register of Transfer of Technology, under the Secretary of Industry and Trade, was enacted recently, on January 30, 1973.

20. On the other hand, nearly all the countries in the region have organized - under very similar names - National Councils for Scientific and Technological Research, whose main objectives include coordinating research work within the countries and channeling international technical assistance provided by governments and international organizations. With varying degrees of efficiency and government support, these bodies began work in recent years.

21. Similar lines of action have been followed in the steel sector where coordinating councils, institutes, and trade associations have been set up. In addition to the specific purposes for which they were or are being created, these bodies may play a highly significant role in support of the groups negotiating technology.

22. In Mexico the establishment of the National Steel Research Centre is being considered. In Brazil the National Steel Industry Council (CONSIDER) is operating since 1970. Argentina founded the Iron and Steel Institute in 1972. The Chilean Steel Institute (ICHA) was started in Chile in 1957. These institutions, along different roads and with varying degrees of intensity, all seek to improve the exchange at least of not strictly confidential information. It was found, nevertheless, that none of them, either because of their brief existence so far or because of the direction given to their activities, has endeavoured to organize specialized and stable teams of negotiators able to set out guidelines and advise enterprises on what to buy, how much to pay, how long to use the technical assistance purchased and where to obtain it.

23. It is worth noting that among the steel sector executives interviewed conflicting opinions were given as to the advisability or usefulness of preparing such permanent teams of negotiators, as well as regarding government cooperation in the negotiations. The majority, however, backed by the experience of some of the developed countries - Japan's M.I.T.I. is a case in point - were in favour of such participation feeling that in this matter the accumulation and dissemination of experience and information is essential for future results.

24. The steel industry shows certain peculiarities insofar as it is essential to other industrial branches(fabricating industry, the autombile and transport industries, farming and food processing, construction industry, etc.). Consequently, it does not allow quality to be sacrificed in order to finance the indiscriminate pursuit or use of native technology compatible with the relative local cost of production factors.

25. Steelmaking presents three clearly defined areas for possible technological research. One is the preparation of raw materials and ancillaries, reduction, transformation, and refining processes until the steel is tapped. These transformations are brought about mainly through

physical-chemical processes connected with metallurgy. [illegible] manufacture of steel products by rolling, forging and casting. In this phase mechanical processes predominate, together with materials handling by means of heavy equipment. Lastly, and including the other two, there is the field of plant and equipment planning, production programming, and plant operation. This involves project engineering and management practices including operations research methods, modern computer systems, and plant automation.

26. In all three areas Latin American steelmaking is achieving, in many instances, a level that allows it to employ the most up-to-date practices applied in the more industrialized countries. The greatest regional research activity, however, tends to focus on the first stage, that of materials processing and metallurgical processes, which is also called the "dirty stage" of the industry. In this connexion Latin American steel companies have even made significant contributions to world steel technology.

27. In approaching the choice between transfer or local creativity, a further consideration should be added - that a thorough knowledge of processes currently in operation and available in world steelmaking is a pre-requisite for conducting an adequate technology transfer negotiation, but that it is simultaneously the first step towards starting the creation of local technology. Adaptation of such processes to the peculiarities of local natural resources (coal, iron ore, etc.) and to a cost ratio of labour and capital consistent with conditions prevailing in the region, generates a kind of activity which for some is still included in an efficient transfer of technology, and for others is already part of local creativity 1/.

1/ Concerning this subject and steps to be taken towards stressing metallurgical research in Latin America a paper was prepared for ECLA as early as 1966 by Luiz Corrêa da Silva. In it a list of subjects where research is necessary in Latin America is included. See: "Corrêa da Silva L.: "Problemas que requerem pesquisas [illegible] faculty [illegible] [illegible] to [illegible] [illegible] [illegible] innovation. [illegible] [illegible] with training [illegible] technical staff. It happens that still [illegible] in [illegible], the importance of such staff in [illegible] the executives interviewed [illegible] that the [illegible] training [illegible] pre-requisite for satisfactory [illegible] of technology. The authors of a recent ECLA paper on the steel sector in Brazil 1/, referring to the training of professionals abroad, state that "the specialized training of national professionals is probably the most adequate instrument for transferring technology from abroad, and everything points to the advisability of employing it more and more, as many of the companies are currently doing".

29. Consideration of the objectives pursued by the acquisition of technological knowledge is nearly as important as identifying the kind of activity involved. As extreme cases it is worth mentioning some enterprises in the region that, encouraged by an artificial exchange rate, a tax system favouring remittances abroad and over-equipment, and near-monopoly market conditions, allowed themselves to be carried away by the law of least resistance, imported plants under "turnkey" contracts and keep up contracts for purchase of technology covering processes that are quite familiar to the rest of the experts in the region.

30. There are, too - always in the steel sector -, companies which, under an apparent slogan of "technological self-sufficiency" and

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tecnológicas na industria siderurgica Latino-americana e reflexoes sobre a açao necessaria". Simposio Latinoamericano de Industrialización. ST/ECLA/Conf.23/2.44. Santiago, Chile (1966).

1/ H. Leuschner, Suarez, and Bohomoletz. "Transfer of Technology in the Steel Industry". Published in Portuguese by the Instituto de Pesquisas Economicas. University of Sao Paulo (1971).

protected by tariff and market conditions favourable to their products, keep up an excessively conservative attitude and stick to production and management methods obsolete in the rest of the world and of the continent.

31. At the other extreme companies are found whose attitude to purchasing technology is openly aggressive : they are permanently up to date on world developments in the sector, and maintain a team of professionals enabling them to be highly selective in their purchase of technology, and to apply the criteria of profitability and competitiveness in national and world markets.

3.- TRANSFER OF TECHNOLOGY TOWARDS THE REGION - STEEL SECTOR

3.1 Historical background

32. Chart 1 describing the invention of steel processes or plant and their adoption in Latin America, over time, endeavours to present in graphic form and chronological order, the lead-time between processes, plant items or systems as they were adopted in the region, by comparison with the initial adoption on an industrial scale in the countries of the world where they originated.

33. This chart is not intended to be exhaustive. It refers only to the invention and adoption of the major processes that have enjoyed world-wide industrial application. The historical background of Latin American steelmaking - quite vague at certain times and in certain countries - leaves the way open for contributions from experts in the field who might help to improve these charts by possible additions.

34. The age of modern steelmaking in the world begins about 1830, with the first charcoal-fired blast furnaces and coke-fired metal-shaft

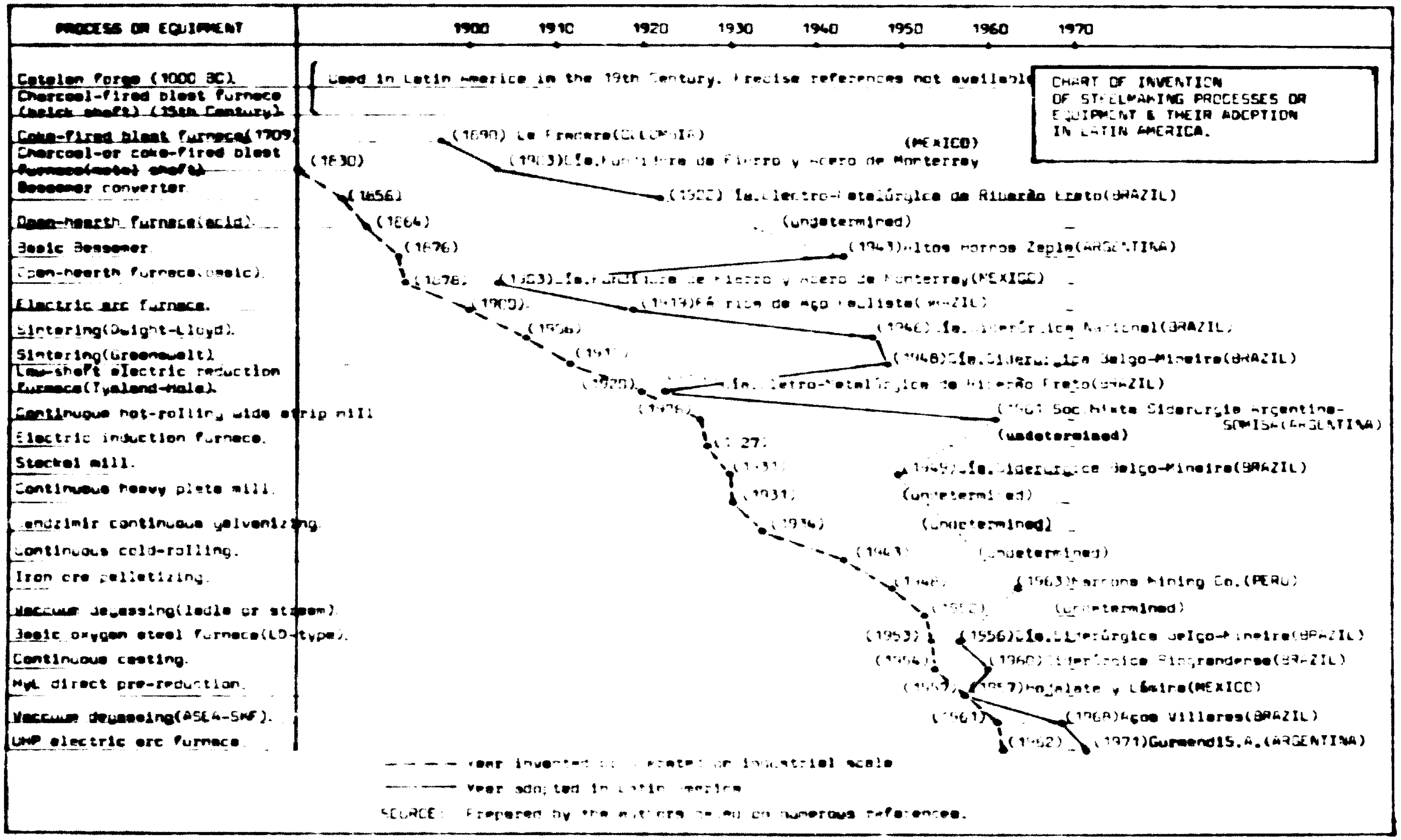
CHART OF INVENTION OF STEELMAKING PROCESSES OR EQUIPMENT & THEIR ADOPTION IN LATIN AMERICA.
PROCESS OR EQUIPMENT
1900
1910
1920
1930
1940
1950
1960
1970
Catalan forge (1000 BC)
Charcoal-fired blast furnace (brick shaft) (15th Century)
Coke-fired blast furnace (1709)
Charcoal-or coke-fired blast furnace (metal shaft)
Bessemer converter
Open-hearth furnace (acid)
Basic Bessemer
Open-hearth furnace (basic)
Electric arc furnace
Sintering (Dwight-Lloyd)
Sintering (Greenawelt)
Low-shaft electric reduction furnace (Tysland-Hole)
Continuous hot-rolling wide strip mill
Electric induction furnace
Steckel mill
Continuous heavy plate mill
Sendzimir continuous galvanizing
Continuous cold-rolling
Iron ore pelletizing
Vacuum degassing (ladle or stream)
Basic oxygen steel furnace (LD-type)
Continuous casting
HyL direct pre-reduction
Vacuum degassing (ASEA-SKF)
UHP electric arc furnace
Used in Latin America in the 19th Century. Precise references not available
(1830)
(1856)
(1864)
(1876)
(1878)
(1900)
(1906)
(1927)
(1943)
(1952)
(1953)
(1954)
(1957)
(1961)
(1962)
(undetermined)
(1943) Altos Hornos Zapla (ARGENTINA)
(1963) Marcona Mining Co. (PERU)
(1957) Hojalata y Lámina (MEXICO)
(1968) Aços Villares (BRAZIL)
(1971) Gurmendi S.A. (ARGENTINA)
Year invented or operated on industrial scale
Year adopted in Latin America
SOURCE: Prepared by the authors based on numerous references.

Chart No. 1

furnaces. The first industrial application of this process in Latin America was No. 1 blast furnace at Cía. Fundidora de Fierro y Acero de Monterrey (Mexico), built in 1903, that is seventy-three years later. The Bessemer furnace took 66 years to appear in Brazil, basic Bessemer was used in Zapla, Argentina, after sixty-nine years, whereas the first basic open-hearth furnace was adopted only twenty-five years after it was invented.

35. One of the developments most quickly assimilated for the period was the low-shaft electric reduction furnace, of the Tysland-Hole type, which was first erected by Cía. Electro Metalúrgica Riberão Preto, Brazil, in 1922, only two years after its initial adoption in the world.

36. In the second half of the century the chronological gap in the adoption of inventions was considerably shortened. Marcona Mining Co. erected in Peru the first iron-ore pelletizing plant, with a lag of fifteen years; Cia. Siderúrgica Belgo Mineira built its first LD-type BOS furnace in 1956, three years after it was invented on an industrial scale. The so-called continuous casting process took only six years to come to Latin America, vacuum degassing (ASEA-SKF) appeared after seven years. The first UHP electric arc furnace was operated by Gurmendi S.A., in Argentina, in 1971, nine years behind the first industrial application.

37. A major event for the region took place in 1957, with the starting of a direct-reduction process for producing sponge iron, developed by Hojalata y Lámina S.A. in Monterrey, Mexico. This fact is marked on Chart 1 as the sole point of contacts between the lines indicating the lead-time.

38. Events in the past few years show that the possibilities of innovation and adaptation are greater than ever today. This points to a better knowledge of world technology on the part of Latin American engineers and technologists, as well as greater management capability to absorb new technologies and even to support the development of local

innovations.

39. The opinions canvassed agree that the main obstacles so far encountered by the Latin American iron and steel industry in the process of adoption of new technologies have been the size of regional markets and the alternative cost of the use of capital for the region. It is not therefore a matter of lack of scientific or technical knowledge of the researchers and engineers working with the Latin American steel companies.

3.2 Most usual forms of purchasing technology in the steel sector

40. Several studies published recently, in some of which the authors of this paper have participated, give a detailed analysis of the various channels currently in use for the transfer of technology and the type of know-how involved in the transfer 1/. We need not therefore duplicate that analysis here.

41. Suffice it to recall that there is a functional classification making a distinction between the categories of transferable knowledge (i.e. feasibility studies, design of new facilities, plant construction, marketing assistance, technical assistance in plant operation, etc.)

42. Another form of classification is based on a contractual criterion, according to which several transfer mechanisms or channels are identified (i.e., agreements on design and construction, license agreements, technical assistance agreements, management contracts, etc.)

1/ See, for instance: U.N. "Transfer of Operative Technology at the Enterprise Level". Report of an Interegional Expert Group (E,72.II.A.1) New York (1972).
Cooper Ch. and Sercovitch F. "The Mechanisms for Transfer of Technology from Advance to Developing Countries". University of Sussex (1970, mimeographed).

43. Lastly, may it be noted that side by side with the mechanisms mentioned above that govern the transmission of "proprietary knowledge", there are the freely accessible forms of transmission channeling freely available technical knowledge. This category covers technical publications, scientific conferences, training courses, and others.

44. Apart from some variations in the form adopted in the different countries, the picture of regional steelmaking reveals a set of common features that are described below.

45. The freely available channels or mechanisms are well known and easily accessible. Some, like the exchange of technical documentation, organization of seminars and technical meetings, and personnel training, have developed significantly. Frequently quoted is the work done in this respect by ILAFA and the ABM (Associação Brasileira de Metais) - the Brazilian Metals Association -, both of which, through their meetings and technical publications have become efficient channels for exchanging information among technologists in the region and between them and their colleagues in more developed countries.

46. As regards the use of mechanisms subject to contractual arrangements, the most frequent refer to contracts for plant design and construction, and for technical assistance to operate the plant. In both cases the most usual form is that of contracts for general technical assistance operating with a local counterpart; their object and operation vary according to cases.

47. Owing mainly to the size of the companies and to the fact of State participation in most of them, considerable resources have been devoted to training and keeping up their own engineering teams, as an essential condition for assimilating technical knowledge and generating native plant design and operation capabilities. This does not happen in the smaller companies.

48. Similar evolution in the process of acquiring technology was

observed in most of the plants visited: a first plant is erected with a significant degree of foreign technical assistance for plant design, choice of equipment and starting period; the assistance decreases rapidly in the operation sector, when expansion is contemplated it is carried out with a major participation of local engineering, particularly for managing the works and selecting equipment; plants arriving at the stage of second or third expansion have achieved considerable participation by local engineering and employ foreign firms only for specific parts of the project.

49. Discontinuous activity in the various specialities involved in a steel project was quoted as a limiting factor in making greater progress towards substituting foreign engineering. Only in a very few cases, as will be explained later, has it been possible to set up local consulting firms specializing in specific areas and ensuring continuity by serving several steel companies in succession.

50. The degree of participation of local engineering in plant design is of primary importance because of the multiplying effect arising from designing in accordance with local or regional production possibilities, thus encouraging the local capital goods industry. Satisfactory utilization of engineering capabilities available in the region is still far off. Design possibilities are very different when the design originates with the local company and is checked by some foreign firm, and when the reverse happens. In the latter case the cost involved in possible modifications to a finished project designed for foreign equipment weigh too heavily on the executive responsible for taking decisions, whose first duty is to answer for the economic results of his company.

51. Very little is known about the actual cost of the contracts for purchase of technology that the individual companies sign. Such information is usually considered confidential and the sole answers given in this connexion refer only to general figures or qualify the cost as "reasonable" or "excessive, but essential". In very few

instances the idea was accepted that appropriate and responsible dissemination of this information among the companies of the continent would improve substantially the bargaining conditions of each one, as it would permit the utilization of precedents of lower cost and of some equivalent to the most favoured nation clause.

52. In arrangements for general technical assistance, payment usually takes the form of a fixed annual sum which entitles the recipient company to consult the foreign company on specific topics, have their experts travel to the plant of the advisory firm and vice versa (the direct cost involved in such travel is, however, extra and payable by the recipient of the assistance). This form of arrangement was favourably commented on by the executives interviewed, who pointed out that the benefit derived from them is due to the energy and ability of the recipient rather than to the goodwill of the supplier. Some companies fail to utilize fully the possibilities of these arrangements because they are unaware of their own problems and of the type of information they should request. The greatest benefit arises from trips to the plant of the supplier company, which generally behaves quite openly towards the staff of the recipient company. Payment for such contracts through a royalty per ton produced is very seldom found; it is growing less and less frequent, and should disappear soon.

53. Contracts involving licenses are infrequent and restricted to the field of fine and special steels. As regards common steels and certain special steels in general use, this form of contract is non-existent because there are standardized steels made by fairly well-known processes. License contracts in force for the production of fine and alloy steels refer in any case to the right to employ patented processes and do not entail payment for use of brand names. The clearest cases of payment on patents for use of a process refer to direct-reduction (HyL process) and continuous-casting plants. The form of payment for this type of contract is calculated as a percentage of the sales price or

as a fixed amount per ton produced.

54. Almost all the plants visited [illegible] at one [illegible] times under contracts for <u>technical assistance in management</u>. These arrangements involve a fixed amount and, as their name implies, are intended to supply assistance in management, accounting, organization, and production programming for the entire plant or part of it. Certain companies have resorted lately to consultants on operations research and information systematization, which is covered by this form of arrangement, though it sometimes refers to specific stages in the technical process of the plant.

55. Just as the "technological gap" is often mentioned, the existence of a "<u>management gap</u>" is also recognized. To discuss it would be beyond the scope of this paper; on this subject some think that it is more difficult to fill than the technological gap, inasmuch as it entails transferring and absorbing attitudes more difficult to transmit than objective technical knowledge.

56. One channel for transfer that is very seldom mentioned, although it is employed quite frequently, is that of <u>hiring free-lance foreign personnel</u>. Two opinions are current among industrialists in this connexion. Some feel that the system is unreliable as regards the level of the experts available, and that the advisory services of a company, if more expensive, are more trustworthy and up to date. On the other hand, most of the executives interviewed have resorted to hiring free-lance experts, either personally or through ad-hoc organizati[ons] (among them the International Executive Service Corp., IESC). The advantages of this system include, in addition to lower cost, a more open attitude regarding transfer of information, as well as a greater degree of identification of the free-lance expert with the success of the company hiring him. Furthermore, if results are satisfactory there is the possibility of having him join the staff permanently.

57. <u>Equipment purchase</u> is usually a form of transferring process

technology through the starting period and operator training services supplied by the manufacturers. The effectiveness of this transfer, as in other cases, depends to a greater extent upon the technical ability of the recipient enterprise than on the level of the supplier company. In such cases it is difficult to determine the actual cost of the transfer, for a significant percentage and sometimes all of it, is included in the price of the equipment. In the case of items of general use (engines, presses, certain types of furnace, etc.) competition among suppliers worldwide is extremely strong and the sales volume quite substantial, so that surcharges for research and development cannot be too high because they are spread over a large number of units.

58. In the case of plant for specialized use (converters, certain types of mill rolls, parts of blast furnace, etc.) the number of suppliers and consumers is considerably reduced. The cost of research and development must be financed by a few customers and the selection is not made primarily in terms of equipment cost, which leads to higher surcharges on initial prices, but rather through capitalized royalties or other forms of payment for that technology.

59. Recent studies on contracts for transfer of technology in different countries have revealed the existence of clauses governing restrictions on export possibilities, purchase of parts of raw materials from the licenser, marketing policies, advertising expenses, or specific brand names or processes. Clauses of this type were not found in the contracts examined in the steel sector.

3.3 Quantification of know-how received by beneficiaries

60. The evaluations often attempted on the results of the technology transfer process give as the objective function the self-sufficiency

attained in design, operation, and management of the plant. Steel technologists in the region feel that self-sufficiency is already possible in several portions of the process, but that for reasons of economic efficiency it is not advisable. Blast-furnace design was given as a case in point: there are several engineering groups in diverse companies of the region that are fully capable of designing a blast furnace; nevertheless, if an optimum design is desired, including special performance features, it may turn out more efficient and economic to resort to some of the specialized firms operating in the world. This in turn requires a very good local engineering team to act as counterpart for the specialized foreign groups and permits resorting to the latter only as and when conditions require it. Needless resort to the expedient of turnkey contracts is thus avoided.

61. In those countries of the region where several plants are operating and continually expanding (Brazil, Mexico, and - in certain processes - Argentina) specialized local engineering firms have been set up ensuring continuous workload by serving a number of companies in succession. Infrastructure projects involving civil works for the plants should be examined as a separate area, insofar as local engineering capabilities can usually ensure full self-sufficiency in this sector.

62. The degree of modernization or updating in the various processes cannot be taken as a measure in the process of transfer of technology, the volume of investments committed for erecting a steel plant, and the repayment periods restricting speedy replacement by new processes, however renowned. By way of illustration we may quote an ECLA report of 1968, as follows: 1/

1/ ECLA. "The Steel Industry". Information Document No. 6 of the Thirteenth Session. Lima, April 1969.

63. "Unfortunately some U.S. consulting firms induced their clients in Latin America to invest in open-hearth steelworks at the end of the fifties, when basic oxygen steelmaking had already conquered the market, except in the U.S.A. For this reason several Latin American companies failed to take the opportunity of starting production with up-to-date facilities. The general scarcity of capital prevailing in the region prevents Latin American steel plants from following the example of the U.S.A., where OH furnaces - even the newly-built - are being replaced by BOF steelworks".

64. Regarding transfer of technology in enterprises incorporating foreign capital, there is as a rule active exchange of information between the parent company and its subsidiary. It is difficult, however, to estimate the cost of transfer as such, as there are many financial channels for contact between them. Foreign capital participation is quite low in the sector, if the number of companies involved is considered. Most of them are semi-integrated and operate in the field of alloy steels or tube production. Of the integrated plants operating in the region only four have foreign participation (three in Brazil, one in Mexico).

65. One element that has occasionally discouraged innovations in some processes is the imbalance in the size of the various plant departments. Such imbalances arise because, when a steel plant is planned in a developing country, rapid market growth requires foreseeing a number of steps that will allow future expansions to be made at the lowest cost. The usual thing is therefore to build as oversized units those which are the most expensive or whose place in the production cycle does not allow them to be stopped while expansion is under way. The result of this is that - at least in the initial stages of operation - part of the plant works at a fraction of capacity, increasing costs and checking possible measures for improving productivity.

REDUCTION PROCESS

66. Both in the blast furnace and in direct reduction a satisfactory degree of knowledge and handling of the process has been accomplished, the results obtained being on a par with those achieved in the rest of the world, taking into account the size of the plants that the markets of the region will allow. In those countries of the area where the markets justify large-scale or highly-specialized plants, production figures and quality are competitive by international standards, and the participating technical staff is mostly if not wholly local.

67. The direct reduction process developed by Hojalata y Lámina S.A. of Mexico, currently in use at several plants in Latin America, is the most noteworthy result attained in the region in the area of local technological innovation. There are also cases of specialization arising from the resources available in a given spot, such as the charcoal-fired blast furnaces operated by some Brazilian plants, where the world's best results for this type of furnace have been obtained (Monlevade plant, operated by Cia. Siderúrgica Belgo Mineira), as well as figures that make the process a successful competitor to the coke-fired blast furnace.

68. The process of transfer of technology in this branch of steelmaking may be considered successful. Most plants began with foreign technical assistance and foreign staff to operate the blast furnaces. The foreign staff was replaced after fairly brief periods and technical assistance was either entirely dispensed with or restricted to ad hoc contracts for resolving specific problems.

69. For expansion projects mixed teams are hired, composed of specialized firms for designing the blast furnace proper, and local consultants or company staff for handling infrastructure design, ancillaries (cowpers, gas-cleaning systems, conveyor belts, bins for raw materials, etc.) and plant layout.

70. In constructing plant units the countries of greater relative development in steelmaking (Brazil and Mexico) have reached a degree of local composition equal to 60% in weight of all the elements employed in erecting a blast furnace.

71. At this point it is worth mentioning the interest felt in the region for developing or adapting new ore-preparation processes. The object of this pursuit is not solely to improve blast-furnace efficiency, but also, in some cases, to permit the use of local iron ores that are not always suitable for direct use in the conventional blast furnace. Joint action has been undertaken by steel companies and iron-ore mining operations. Several pellet plants are already operating in the region and as many projects are well advanced. In addition to supplying the extra-regional export market, they deliver increasing amounts of raw materials to steel plants in the region.

72. Almost all steel plants in the region operate regular sinter and self-fluxing sinter plants in order to utilize ore and coal fines and improve the overall efficiency of the process by recycling even waste materials.

73. Work on pelletizing plants has been done jointly with foreign firms specializing in plant design and operation, successful results being obtained both in production and local assimilation of technology. For sinter plants, which require processes and equipment of more universal design and construction features, a greater degree of local engineering and materials has been utilized.

STEELWORKS

74. Latin America has followed fairly closely the world trend towards replacing the conventional open-hearth furnace (Siemens Martin) by oxygen-blown converters (such as the LD type). The reasons given at

the beginning of this paper (i.e. cost of equipment and repayment periods) have conspired, however, against a speedier replacement date, as a good number of plants erected in the late fifties and early sixties were based on OH furnaces. All new plants projected or expansions under way include BOF furnaces.

75. The first BOF in Latin America was erected in Monlevade, Brazil, in 1957. By 1970 oxygen steelmaking in the region amounted to 2,031,000 ingot tons.

76. In view of the expansions and new projects under way, the technical staff of leading companies have displayed a significant effort to update their knowledge of the oxygen steelmaking process. The predominant idea among the technologists interviewed can be summarized by saying that the first plants to operate oxygen-blown furnaces have reached technical self-sufficiency; that in more recent facilities the contracts for general technical assistance held by those companies suffice to resolve operation problems; and that in the case of furnaces currently under construction or in project, save rare exceptions, mixed teams of local and foreign engineering have been set up to utilize foreign designs adapted to local conditions and possibilities.

77. By way of illustration, the case of the BOF plant recently erected in Mexico is worth quoting. The Mexican company involved introduced modifications to the original design, retaining the vessel and modifying the general layout of the works as regards the cooling system, travelling cranes, structures, and other items. The result was a 40% saving in construction costs and use of Mexican materials and equipment equal to 70% in weight of the total steelworks.

BLOOMING, CONTINUOUS CASTING, AND ROLLING

78. The most significant event in the past few decades, as regards

this stage of the steelmaking process, is the development of continuous casting for billets and slabs which in turn go to feed the rolling mills. From the standpoint of transfer of technology, both stages of the process present clearly distinct characteristics. Rolling is based on a comparatively well known technology employing mechanical equipment designed to be built in repeated and standardized units. Continuous casting is based on processes whose patents are still in force, and equipment built by a reduced group of manufacturers who simultaneously own the process know-how. These suppliers provide technology to the developing as well as the highly developed countries. The distinction mentioned above affects the respective process of absorption of technology and its dissemination to the suppliers of equipment.

79. In the area of rolling mills, Brazil is building light rolling mill trains with practically 100% local integration. This is not surprising if we recall that for some time companies in Brazil, Argentina, and Mexico produce mill rolls that are exported to international markets.

80. As to the end-products of the process, the consumer market has been gradually imposing increasingly higher quality requirements (the automobile industry, for instance) to which the leading companies of the region, at least, have responded satisfactorily. This quality improvement has not required continuing technical assistance or the use of special licenses. At most, arrangements have been made under general technical assistance contracts.

81. In continuous casting, owing to the existence of patented processes, as stated above, it has been necessary to resort to the suppliers both for technology and for equipment. The most frequently used is Concast, of Switzerland. Their license contracts include the right to frequent technical assistance, attendance at seminars on the subject organized by the supplier firm, periodical information on new technical developments arising from research conducted by Concast or any of the licensee

companies. Payment for this assistance is made in the form of a fixed amount payable upon purchasing the equipment.

82. There is increasing bibliographical information on the subject and numerous relevant papers presented to the congresses. It is likely that this technological development will take some time to spread through the integrated steel plants of the region, but that will not be due to lack of information as much as to financial reasons derived from the existence of conventional blooming trains built fairly recently.

4.- POSSIBILITIES OF TECHNOLOGY TRANSFER WITHIN THE REGION

83. In the past few years considerable efforts have been made by regional organizations and entrepreneur groups seeking ways to increase technological exchange among the countries of Latin America, and improv their overall relative position vis-à-vis the more developed nations. These efforts are based on the fact that there is knowledge to be exchanged, interest in exchanging it, and common channels of action must be found to improve bargaining conditions in the region as a whole when purchasing extra-regional technology.

84. The opinions given by steel industrialists and officials responsible for operating and programming the steel sector show that in practice - at least in the near future - certain safeguards should be introduced in the good intentions mentioned above, in order to make them fully operational.

85. It was observed that in all steel companies - whether public or private - the entrepreneurial, competitive attitude prevails. Any company in the region or even in the country is placed in a competitive position similar to that of any extra-regional enterprise. These

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companies are in fact competitors in the world markets as regards some of their products (i.e. semis, heavy plate, reinforcement bars). Such opposition has positive effects by encouraging improved productivity although they hinder all overly ambitious plans for free and detailed exchange of information.

86. The foregoing limitation has not prevented steelmen from maintaining permanent contact through visits to plants and by means of an organization such as ILAFA, which has been instrumental in achieving personal and inter-enterprise contacts favourable for exchanging technical and economic information on the operation of the various plants and processes.

87. At the level of basic and theoretical information on the various processes the exchange has been most active. At the Annual Assembly of ILAFA there is high attendance of technologists from the region and the developed countries. Several seminars a year are conducted on specialized topics. There are at least two regular publications of satisfactory technical level: the monthly journals edited by ILAFA and IBS, and Metalurgia, edited by the Associação Brasileira de Metais, as well as a number of national publications or company journals on the subject.

88. As to personnel training, international courses are organized in the region each year on specialized subjects, and experts from the region visit other plants in the area and in the country, where interesting technological developments have taken place.

89. In certain cases, too, engineers from a plant undergoing expansion have resorted to other plants in the region for studying new processes and equipment before designing or selecting new plant for their own operations.

90. The foregoing, however, does not justify the assumption that the exchange of information is at all complete. As the contacts are mostly

of a personal nature and based on mutual goodwill, it is often the case that companies operating in the same country have little if any contact or mutual exchange of information, while each keeps up a separate exchange of information with extra-regional consulting firms.

91. The situation changes when it is a matter of disseminating technical knowledge to smaller non-competitive companies or to suppliers or users of steel products. There are several instances of technical assistance to mining companies for joint development of iron-ore preparation processes, or to fabricating industries for jointly developing designs that will encourage steel consumption in the grades produced by a specific steel company.

92. In conclusion, regarding the possibility of intra-regional transfer of technology, it may be said that there are channels and organizations capable of facilitating such transfer but that - at least for the present - spectacular results cannot be expected unless there is decided governmental policy and a minimum safeguard of the economic interest of the companies.

8.- SOME FINAL COMMENTS

93. The study on which this paper is based included a set of conclusions and recommendations, some of which are summarized in the present chapter insofar as they are connected with the subject dealt with here.

94. The iron and steel industry of Latin America is at the head of industrial development as a whole and has responded efficiently to the growing quality requirements that import substitution at steel consumer level has imposed on it. In the entire group of steel industrialists (whether public or private) there was great interest and understanding shown towards the problem of creating transfer of technology. There is awareness of the fact that the demand for and cost of technology in the sector are such that they require and allow envisaging solutions on a continental scale.

95. Economic evaluation consistent with financial facts in our countries has checked speedier adoption of world developments in processes and equipment. Present facilities will require several years for economic and technological amortization. Partial improvements, however, have been introduced (oil injection in the blast furnace, oxygen injections in OH furnaces, etc.) that permit obtaining yields comparable to those of more modern plants throughout the world.

96. In the relatively more developed countries of the region, at least, there is good local ability to study, design, and erect plants, that can be further improved if a continuing work load is assured and the use of local engineering is insisted on whenever long- and medium-term conditions allow. In the operation stage there is the general feeling that, at least for units already built, foreign assistance could well be dispensed with, without affecting present production rates.

97. Almost all the large steel companies in the area hold contracts for general technical assistance, a few because they are distrustful

of their own capabilities, the majority because they find there a means for ensuring permanent access to technical developments and the answer to specific and empirical problems arising in their plants. It was repeatedly stressed that the benefit derived from these general contracts depends increasingly upon the ability and vigour of the recipient rather than on the attitude - usually far more open than what is expected - of the supplier.

98. There is very little effective contact, sometimes none at all, between the scientists active in universities and autonomous institutions, and executive and operation engineers with the steel companies. In the few instances of such contacts it appears to be the result of a personal relationship rather than an institutional link between companies and universities or autonomous institutions.

99. Good contact, however, is kept up through ILAFA among the enterprises of the region. The research centres appear to have felt out of place at the meetings organized by this Institute and, for lack of other ad hoc mechanisms, remain to a great extent isolated. There is much room for improvement in this area.

100. Despite the fact that demand for technology is at present met mainly from abroad, the leading companies in each country are in a position to provide technical assistance to more conservative enterprises or to smaller plants whose size precludes financing a permanent engineering team to absorb and adapt technology. The latter variety of companies are not always aware of their backwardness and the possibilities of adopting new technologies.

101. Although there is clear interest shown towards technological problems, the general feeling is that for some time yet the countries of the region must continue to be purchasers of technology. According to those who share this feeling, much still remains to be done in the field of assimilating and adapting foreign technology.

102. This attitude leads to insufficient allocation of funds for research

and development at company level. Such funds are concentrated in quality control laboratories and certain chemical and metallurgical services, and in a hesitating staff-training policy, on the grounds that "it will not do to remain behind, but not too much should be risked on experiments".

103. Two of the most noteworthy exceptions to this rule are Hojalata y Lámina S.A., of Mexico, which developed its own direct-reduction process that is patented all over the world, and Usinas Siderúrgicas de Minas Gerais (USIMINAS), Brazil. The latter is carrying out a technological development plan that includes intensive personnel training and operation of a laboratory for applied research involving an expenditure of about one dollar per ton produced, as is done in the U.S.A., Japan, and other developed countries.

104. The text of the report to which this paper refers includes an estimate of investments required to carry forward the expansion programs planned by the various Latin American countries in the next decade. The volume of such investments is, of course, subject to variations according to projects and countries; the overall cost, however, will be approximately ten billion dollars, averaging nearly one billion dollars per year. A simplified though realistic calculation leads to estimating about two billion dollars for engineering, about 40% - or four billion dollars - for construction work, and another four billion dollars for equipment, over the total ten-year period.

105. Assuming that construction expenditures will be made in any case in the countries of the area, the magnitude of the challenge may be pictured as follows: to be capable of organizing production capacity and engineering ability to obtain that the investment in equipment and expenditures on engineering (between five and six billion dollars in total) remain for the most part to benefit the region.

106. For this calculation it was estimated that average annual production for the decade in Latin America would be the steel ingot equivalent of

20 million tons. In 1980 annual production will rise to 36 million tons. If Latin American steel companies were to allocate to research only fifty U.S. cents yearly, still much less than the developed countries do, a total fund averaging ten million dollars per year for the decade would be available for research.

5.1 Preliminary recommendations derived from the study

107. Below are given proposed courses of action affecting four types of institutions in the field of steel: companies, specialized institutions (ILAFA, ABM, IBS, CIS, CNIHA, ICHA, etc.), international organizations (OAS, ECLA, UNIDO, etc.), and universities or autonomous research centres. Action on the part of all of them should be closely interwoven, consequently only possible courses of action are listed without suggesting, except in very obvious cases, which institutions should undertake them.

108. At national level it was possible to identify suggestions regarding organizational schemes designed to increase the research and assimilation effort, including among others the following features:

109. -Establishment of supporting and applied research centres in the larger plants, participation of research workers in resolving operation problems, and of plant engineers in orienting research, in addition to basic research conducted by universities and autonomous specialized institutions with financial support and encouragement from steel companies;

110. -Medium- and small-scale companies can resort to autonomous applied research centres serving several plants. The centre carries out the research, either at any of the plants when industrial scale is required, or at the centre's facilities. The companies, however, keep up engineering teams for quality control and possible design of special

products. Certain areas of applied metallurgical research in more universal use may be studied by the autonomous centres at their own initiative or at the request of the companies. The companies take active part in financing research projects.

111. From the standpoint of organization, these centres could belong to a university, be of a private nature and self-financing, or set up as cooperative organizations managed jointly by the associated companies.

112. The possibility of multinational action is still open and arouses great interest in the sector. The feeling is that it would not be operational, for the present at least, to concentrate research in a multinational centre, but that some form of multinational coordination is required for steel research, managed through an Executive Secretariat and Regional Secretariats, for example, whose basic duties would include the following:

- Training of high-level specialized staff by means of courses conducted in different countries of the continent, and coordinating training programmes in other countries of the world;

- Coordinating academic curricula in the disciplines necessary for steelmaking development and taught at the universities of the region;

- Coordinating, through exchange of information and application of special funds, the steelmaking research carried out by some universities and autonomous centres in the region;

- Coordinating specialized documentation centres and channeling exchanges of documentation with other similar centres all over the world;

- Promoting exchange of information on contracts for technology and evaluating them.

113. To finance the establishment and operation of national centres

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and multinational action, the support of governments and international institutions will surely be available, as all have for some time shown interest in the field. The basic contribution, nevertheless, must be made by the steel making companies, not only in the form of ideas and management of the institutions set up for the purpose, but mainly by financing such institutions by means of a far more substantial investment than is currently spent on research and development.

114. It was stated above that a mere fifty cents per ton spent on research and development would suffice to make up a research fund regionally averaging ten million dollars per year for the next decade. This amount is still considerably below the average spent along similar lines in the developed countries, and also below the amount spent by leading companies in the region. Very few others even come near that amount and the great majority make no specific allocation for this purpose. It is suggested that the topic be brought up and discussed with high priority at some of the forthcoming meetings of steel industrialists, including specific proposals for starting joint financing of the activities described in the preceding paragraphs.

115. In the region there are engineering teams working with the steel companies or specialized consulting firms that have reached a satisfactory technical level, both in plant and equipment design and in construction. In many cases, however, a vicious circle arises from the fact that local engineering is not hired because it lacks experience whereas it cannot acquire experience because it is not usually called in on major projects.

116. Only in a very few cases, all of them taking place in the past two or three years, has any form of restriction been invoked against the indiscriminate and often obvicusly unnecessary use of foreign engineering. While it is true that very often the use of consultants from the developed countries stems from conditions imposed by the international financial institutions, unless there is a clear governmental policy in this regard it will be difficult for individual

companies to alter these rules of the game. In certain cases, even, the tax or exchange regulations enforced by the Latin American governments themselves encourage the employment of foreign instead of local consultants.

117. In connexion with the insufficient employment of local engineering and lack of specialization owing to discontinuous activities of the regional consulting firms, two courses of action are suggested. One would be to make known the engineering potential available in the Latin American area. The other, to encourage intensive use of this professional ability, thus leading to its future consolidation and development. A directory should be prepared listing engineering firms capable of providing services to the steel sector, as well as individual experts classified by specific areas, who may be called upon by the companies of the continent.

118. For the second course of action it appears advisable to recommend that regulations be issued to restrict the indiscriminate employment of foreign consultants. Such regulations should be neither rigid nor static, for they would risk becoming artificial obstacles to industrial development; they should rather be the result of concerted action and submitted to continuing revision by governments and companies.

119. It is recommended that ways be sought to disseminate the terms under which foreign technology contracts are negotiated so that such information may be utilized for future contracts. This subject has recently been receiving especial attention from divers international organizations (UNCTAD, UN Secretary General, UNIDO, OAS, JUNAC, etc.) Their advice would help to find new ways to conclude technology contracts that will be more favourable to our countries.

120. Finally, in this field spectacular or very rapid results cannot be expected; decision and courage are required but the work done is for the long term and results are very indirectly measurable. If an appropriate policy for assimilating and creating technology is to be

pursued, nothing will substitute direct and decided action on the part of the very countries interested in it, and of the companies active in the sector. The amount of resources that the development of iron- and steel-making in Latin America will demand in the near future allow thinking very seriously on the long-term development of regional engineering and technology. The challenge faced by governments, companies and international organizations is to be capable of agreeing among themselves and making steel producers and users agree, in order to capitalize these benefits in favour of the region, and lay the foundations for a truly Latin American long-term development of steelmaking. It seems difficult to conceive that facing the magnitude of such a challenge at least some points of agreement may not be found that will permit designing and implementing concrete programmes and projects for national and multinational action in the short and medium term.

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