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SUMMARY

THE TRANSFER OF TECHNICAL KNOW-HOW IN THE STEEL INDUSTRY IN BRAZIL

prepared by

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Chapter I

EVOLUTION OF THE WORLD TECHNOLOGY OF STEEL PRODUCTION

This chapter makes a detailed review of the most modern technology for steel production in use in world industry and supplies some information concerning the time and circumstances in which the more important innovations were introduced. The review comprises the whole cycle of operations: from raw materials beneficiation to preparation of the burden of the blast furnaces, oxygen steelmaking, continuous and vacuum casting as well as the automation of blast furnaces, oxygen convertors, blooming and rolling mills.

/Chapter II

Chapter II

SHORT DESCRIPTION OF THE BRAZILIAN STEEL INDUSTRY

In 1969, the year in which the field work covering this case study was carried out, the Brazilian steel industry produced a total of 4,810,000 tons of ingot steel. This output was divided into the following figures: a) 79 per cent of the total, in six integrated plants which had been originally planned as integrated units, b) roughly 6 per cent, in five plants which had started as semi-integrated works and had been integrated later and, c) 15 per cent of the total in 18 semi-integrated plants, several of which produce only special steels, while the majority produce common steels.

Taking the total figures, Brazil was self-sufficient in respect of steel in 1969, there having been a net export of some 24,000 tons of finished products. But total imports amounted to 404,000 tons of finished products, consisting mainly of products of chemical composition or dimensions which are not yet made in Brazil, and in addition, minor quantities of common products to cover the demand of remote regions of the country, where transport costs from the steel producing centres would be too high.

Table I lists the plants operating in 1969, stating their output for that year, as well as the technical structure of their installations. The plants marked with a V are those which were visited during the field work for the study.

/Table 1

Table 1

STEEL PLANTS OPERATING IN BRAZIL IN 1969

Plant	Location	Structure	Steel production 1969 in 000 tons
A. Integrated plants originally planned as such			
V. Volta Redonda	Rio de Janeiro	SP - CP - CBF - SM - BM - SCSM - CRM - MPM - TL - GL	1 392
V. Usiminas	Minas Gerais	SP - CP - CBF - LD - BM - SCSM - CRM	791
V. Belgo-Mineira	Minas Gerais	SP - ChBF - LD - SM - BM - MBM - WRM - SSM	585
V. COSIPA	São Paulo	SP - CP - CBF - LD - BM - SCSM - CRM	551
V. Mannesmann	Minas Gerais	CBF - ERF - LD - ESF - BM - MBM - TM	313
V. ACESITA	Minas Gerais	SP - ChBF - ESF - BSF - BM - SCSM - CRM	154
B. Integrated steel plants originally planned as semi-integrated plants			
Barra Mansa	Rio de Janeiro	ChBF - SM - BM - MPM - MBM	111
Aliperti	São Paulo	ChBF - SM - BM - MPM - MBM	112
Usinas Metalúrgicas	Minas Gerais	ChBF - SM - BM - MPM - MBM	27
Pains	Minas Gerais	ChBF - SM - BM - MBM	35
Lafersa	Minas Gerais	ChBF - SM - BM - MBM	20
C. Semi-integrated steel mills			
V. Riograndense	Rio Grande	ESF - CC - BM - MBM - MPM	154
Dedini	São Paulo	ESF - SM - BM - MBM	81
V. Aços Villares	São Paulo	ESF - VC - BM - MBM - P	51
V. Anhanguera	São Paulo	ESF - BM - MBM	70
São José	São Paulo	ESF - BM - MPM - MBM	77
V. Aparecida	São Paulo	ESF - BM - MPM - MBM - FS	31
12 additional small plants, mostly in the Sao Paulo area			255
Total production			4 310

SP - Sinter Plant ; CP - Coke Plant; CBF - Coke Blast Furnace; ChBF - Charcoal Blast Furnace; ERF - Electric Reduction Furnace; BSF - Bessemer Steel Furnace; LD - LD Steel Shop; SM - Siemens Martin Steel Shop; ESF - Electric Steel Furnace; CC - Continuous Casting; VC - Vacuum Casting; BM - Blooming Mill; SCSM - Semi-continuous Strip Mill; SSM - Steckel Sheet Mill; CRM - Cold Rolling Mill; HPM - Heavy Profiles Mill; MPM - Medium Profiles Mill; MBM - Merchant Bar Mill; WRM - Wire Rod Mill; TM - Tube Mill; FS - Forging Shop; P - Presses; TL - Tinning Line; GL - Galvanizing Line.

Note: The plants marked with a V were those visited for the preparation of the study.

/Chapter III

Chapter III

PRESENT STATE OF THE TECHNOLOGY OF THE STEELMAKING INDUSTRY IN BRAZIL AND THE DIFFUSION OF THE INNOVATIONS IN THE COUNTRY

The period 1960 to 1969 has not only witnessed a large increase in the capacity of the steel industry of Brazil, but also some changes in the prevailing technology, owing to various different causes. For instance, the relative drop of charcoal pig iron production and the increase of the capacity of coke blast furnaces is due to the partial exhaustion of the natural forests. In 1960, charcoal pig iron represented 56 per cent of the total and coke pig iron 43 per cent. While in 1969 the percentages were 40 and 56, respectively. The other reason for these changes is the appearance in the industry of a new and better technology. The relative increase of the proportion of oxygen blown converter steel is an example of this situation. While in 1960 open hearth steel represented 67.5 per cent of the total, and converter steel 10.5, the percentages in 1969 were 43 and 37 per cent, respectively.

a) Technology applied to the raw materials

Almost immediately after the introduction into two plants in the United States of sizing iron ore within a narrow range of dimensions, the Brazilian industry became interested in this technique. If today there is still some progress to be made in this direction, it is within the plants which are still sizing between 12 and 65 mm.

Sintering, which is the only agglomeration process currently being used in Brazil, was introduced for the first time in 1948, based entirely on research conducted at the Instituto de Pesquisas Tecnológicas at Sao Paulo. Presently, nine of the integrated steel plants use variable proportions of sinter in their burden. Only one modern plant does not sinter the fines, but exports them as part of the ore exported from one mine it owns.

Brazilian coking coal is both expensive and of poor quality, as even after washing it remains with a high ash and sulphur content. The steel industry was compelled in 1969 to use 35 per cent of Brazilian coal in its blends, but the total production of the Brazilian mines has been stabilized and the percentage will drop as total steel production increases.

/b) Technology used

b) Technology used in iron ore reduction

With a view to obtaining a higher productivity and a lower coke rate at the blast furnaces, the industry is applying, in addition to the preparation of the burden, several innovations, such as: fuel injection in the tuyeres, oxygen injection, increase of the blast temperature, etc. The only new technique which has not been applied, so far in Brazil, is the use of increased top pressure. In the majority of the plants, this would mean heavy investment. There is one plant in which the appropriate facilities were built in from the beginning, but although the blast furnace has been operating for some six years, high top pressure has not been applied, apparently because the blast furnace has so far not needed to use its maximum capacity, owing to restriction of the market.

Some of the charcoal blast furnaces operating in Brazil can be included among the most efficient units of this type operating in the world. On the other hand, almost all the small blast furnaces producing pig in the forests are extremely primitive and have never been studied or modernized.

c) Technology applied in the steel shop

The first oxygen blown converter started operating in Brazil in 1957, four years after the initiation of the process in Austria. Since then, with the exception of two open hearth furnaces installed at Volta Redonda, no new open hearth furnace has been commissioned in Brazil, thus explaining the relative growth of converter steel between 1960 and 1969.

The larger open hearth furnaces have been converted to total basic lining. They use oxygen, blown through lances in the degree in which surpluses of oxygen are available at the plant.

d) Technology of pouring and casting

Only one semi-integrated steel plant in Brazil has installed continuous casting machines, although the blooming mill has been kept operating. Only the higher quality steels are cast continuously. Vacuum casting is practised in only one semi-integrated steel plant making high quality special steels. Vacuum is used only for a small proportion of production.

e) Technology of rolling

The technique to increase the capacity of the rolling mills through increasing the speed of the rolls has, so far, not been applied in Brazil. In two plants the adjustment of the rollers through automation has been applied with good results.

/f) Quality control

f) Quality control

Owing to the demand from the market and the internal competition from the producers, there is general concern about quality control.

g) Technology of the production of special steels

The Brazilian steel industry is, in general, making a considerable effort to place itself in a position to deliver to the local market a large variety of special steels, within the strictest standards of quality.

h) Technological research in the industry

In many of the plants some research is being carried out for immediate application, usually by the staff in charge of quality control, but in some instances, problems of bigger importance are entrusted to separate groups formed within the plant. Of the major steel producers, two are organizing or strengthening a research organization within the industry and a third has entered into a contract with the Instituto de Pesquisas Tecnológicas at São Paulo, who will undertake research on whatever problem may arise in the plant.

/Chapter IV

Chapter IV

TECHNOLOGY TRANSFER PATTERNS AND CLASSIFICATION OF THE TYPES OF KNOW-HOW

The construction of a new steel plant in a developing country requires the investment of a large amount of scarce capital resources. In order to achieve a high technological level and efficiency, it is necessary to receive considerable technical and financial assistance from abroad.

On the other hand, the construction of a plant, accompanied by the necessary infrastructure, takes a long time. During this period, the market for steel is subject to changes. Therefore, planning of the industry should be carried out to cover a long period. If the country is a large one, as is the case of Brazil, it is necessary for best results to draw up a general development plan for the whole steel industry.

The pattern of assistance for the initial project of a plant depends to a great extent on how the initiative to build it came up in the first place. If we consider the six integrated steel plants, planned initially as such, which operate in Brazil we find:

a) Foreign investments.

The most representative of this group is the Mannesmann plant. The idea of building it stemmed from the head office in Germany which carried out all the planning. The largest plant corresponding to this group is Belgo-Mineira which began in 1923 with the purchase of a small plant at Sabará, built by Brazilian metallurgists. The new plant at Monlevade was originally planned entirely by the head office in Luxembourg.

b) Government initiative

Volta Redonda belongs to this group. In 1939 the government decided to build the plant and appointed a technical committee to take charge of the initial studies. They secured the services of a North American consulting firm but, because of the planning taking place during the war, the Brazilian group had to perform a much larger share of the task than is customary. Another plant created on government initiative is USIMINAS, promoted by the Government of the State of Minas Gerais. In this case, the technical group organized by the Government associated with a Japanese firm which did most of the planning.

/c) Private initiative

c) Private initiative

To this group belong COSIPA and ACESITA. In both cases, the planning and construction, carried out with the help of consultants, took a long time mainly because of difficulties experienced by the originators to secure capital, not only to construct the plant but also to pay for the projects.

Planning, feasibility study, construction and start of operations of a new steel plant

In this type of work, the collaboration of a great number of professionals and specialists in different technical fields is indispensable. As it is an advantage if this group is accustomed to team work, the usual procedure is to retain the services of a reliable foreign consulting firm. The local enterprise, in its turn, should take advantage of organizing a local technical group to collaborate with the consultants from the very beginning of the work in order to gain knowledge and experience once the latter leave the country.

i) Planning, general studies and feasibility. These items include: study of the market and projections for 7 to 10 years; possible manufacturing programme in view of the expected market development; sources of raw materials; location of plant and selection of productive processes, taking the available raw materials into account; general study; necessary investment and, finally, feasibility study.

ii) General project. Once the financing of the plan is insured, the consultant has to prepare the general project. It should contain: details of the process and list of equipment; location and layout of the buildings and plant; forecast of the labour requirements as well as the necessary skills; final estimate of investment and operation costs; final evaluation of the project; and finally, work plan.

iii) Execution of the project. The steps to be taken are: erection of the buildings and the auxiliary systems; purchase and testing of the equipment; start of operations. As all these activities have a considerable local component, the new enterprise has to assume an important role in its management. In this paper, the various ways in which this part of the action can be organized are examined and discussed.

/iv) Training of

iv) Training of personnel. The plan for the training of the personnel is one of the most important elements in the general plan. In many cases, some of the trainees have to be sent abroad, but generally they can be trained within other plants operating in the country. Usually, training courses are organized for the more intelligent labour working in the construction.

Technical assistance for expansion and modernization

In Latin America, owing to the small size of the markets, combined with their rapid growth, the plants are always built by steps, establishing from the beginning a plan for successive expansion. Even when the plan for each expansion has been set up at the beginning, it is of advantage before carrying it out to make a new study of the proposed investments in order to take account of the eventual changes of the market, as well as of possible technological innovations which might be adopted to advantage.

Technical assistance to introduce innovations which require very little or no investment

Most of the changes in the manner of operating the equipment fall among this group of activities. In most cases, they can be carried out by the technical staff of the plant. On the other hand, most of the plants have retained the standing services of a consultant firm abroad and the advice of this firm is usually sought before introducing any changes.

Technical assistance in the manufacture of new products

If it is intended to introduce a new product into the production plan of the plant, the safest procedure and the one most employed in Brazil is to enter into an agreement for technical assistance with a firm manufacturing the product abroad. The simple purchase of patent rights or of a recipe, although much cheaper, seldom gives satisfactory results.

Technical assistance for the improvement of quality

With this purpose in mind, either of two procedures is generally applied: (a) to request a team of specialists, usually from a plant abroad, to establish the system and train the staff in the plant; (b) to send a team from the plant to a plant abroad for training.

/Chapter V

Chapter V

MEANS OF TRANSFERRING TECHNOLOGY AND THEIR RELATIVE EFFICIENCY

1. Foreign technical assistance for creating new plants

This section begins with a detailed description of the many steps taken for the planning and construction of two major Brazilian plants: Volta Redonda and USIMINAS. Most of the information available comes from these two plants. Table 2 shows the agencies responsible for the planning and execution of the major steps necessary for the erection of the plants.

Analyzing the way in which these tasks were performed in practice, it appears that except in the origination of the project, there is a great similarity in the organization of the planning and construction of both plants. One of the differences concerns the selection of the plant site. While in Volta Redonda eight possible locations were evaluated by the consultant, McKee, in COSIPA the selection was made by the group of promoters (Paulista Group in the table). It is probable that if Kaiser had intervened at this step, some of the disadvantages inherent to the location, which was probably selected for political reasons, might have been avoided.

COSIPA, in contracting the whole layout with Kaiser, chose probably the best possible solution. It should be borne in mind that Volta Redonda could not adopt this procedure because at that time McKee was tied up with the U.S. war effort. In both cases, the Brazilian participation in the purchase of equipment was quite marked which is how it should be, because the new enterprise is in the best position to know the commitments it can accept for future payments.

Erection and testing of the equipment, as well as the beginning of operations were mainly the responsibility of technicians supplied by the respective manufacturers. In these cases, the local staff tends to refrain from taking over full responsibility, even when capable of doing so, in order not to interfere with the rated performance which the manufacturer of equipment has to guarantee.

/Table 2

Table 2

AGENCIES WHICH SUPPLIED THE TECHNICAL CO-OPERATION AND TOOK DECISIONS CONCERNING PLANNING, CONSTRUCTION AND START OF OPERATIONS IN SOME BRAZILIAN STEEL PLANTS

Items	Volta Redonda (CSN)	COSIPA
Preliminary idea of the project	Federal Government	Paulista Group
Production Programme	Fed. Government & CSN	Paulista Group
Raw Materials		
Iron ore	CSN & McKee[a/]	Paulista Group
Coking coal	Federal law	Federal law
Location	McKee & CSN	Paulista Group
Processes		
Reduction	Federal law	Federal law
Steel shop	McKee & CSN	Kaiser & Paulista Group
Rolling mill	McKee & CSN	Kaiser & Paulista Group
Auxiliary equipment	McKee & CSN	Kaiser & Paulista Group
Budget & investment plan	McKee & CSN	Kaiser & Paulista Group
Layout of the plant	McKee & CSN	Kaiser
Sizing of equipment	McKee & CSN	Kaiser
Purchasing contracts (equipment)	CSN & McKee	Paulista Group & Kaiser
Construction and detail plans	CSN & McKee	COBRAPI & Kaiser
Equipment erection	CSN & technicians of manufacturers	COBRAPI & technicians of manufacturers
Tests of equipment	CSN, technicians of manufacturers & McKee	COBRAPI, technicians of manufacturers, COSIPA & Kaiser
Start of operations	CSN, technicians of manufacturers & McKee	COBRAPI, technicians of manufacturers, COSIPA & Kaiser

a/ The selection of the iron ore depended on the location of the plant and the steel making process selected.

/In view of the

In view of the important role played by COBRAPI, a consulting firm created by Volta Redonda in the erection of COSIPA, it seems certain that by pooling talent from the various steel plants in the country, there would be no obstacle to a new modern plant planned entirely by Brazilians. Even in such a case, foreign technical assistance would be of great advantage for the following steps: (a) selection of the location in order to nullify possible political pressures instead of following a technico-economic criterion, and (b) selection of equipment, because an active and alert consultancy firm is usually in a better position to know the possible alternatives available.

2. Technical assistance for expansion and for important equipment changes

Although generally, at the time when the original plan is set up, definite plans for the successive expansions are also prepared, it is highly advisable to study each successive project again at the time of carrying out the expansions, because of possible changes in the market as well as in the available technologies.

This part of the paper is devoted to examining the means of obtaining know-how in these cases, which is limited to considering the possible changes in technology. If these are not important, the assistance required would follow similar lines to that required by a new plant, though on a more limited scale. For the purpose of this analysis, the five main productive departments of a steel plant are examined in Table 3, on the light of the relative dependency on foreign technical aid to decide and carry out modifications.

The key to the contents is the following:

Dependence on foreign aid	Definition in the table
100%	Complete dependency
70 to 90%	High "
40 to 70%	Limited "
20 to 40%	Little "
under 20%	Very little "
0%	Complete autonomy

Concerning the means by which such aid is usually transferred, the following definitions have been used:

Suppliers of foreign assistance	Key
Consulting firms	Consultants
Individual experts	Experts
Equipment manufacturers	Manufacturers
Licencers of processes or equipment	Licencers

/Table 3

Table 3

DEGREE IN WHICH THE BRAZILIAN INDUSTRY DEPENDS ON FOREIGN TECHNICAL ASSISTANCE FOR EXPANSION OF EXISTING CAPACITY AND IMPORTANT CHANGES IN THE EQUIPMENT

Productive department	Selection of process	Sizing of equipment	Civil construction	Erection of equipment	Tests and running in
Coking and agglomeration	Complete autonomy	Complete autonomy	Complete autonomy	Complete dependency from manufacturer a/	Complete dependency from manufacturer a/
Reduction	Complete autonomy	Complete autonomy	Complete autonomy	Complete dependency from manufacturer a/	Complete dependency from manufacturer a/
Steel shop	High dependency: consultants and licencers b/	Complete autonomy	Complete autonomy	Complete dependency: manufacturers, consultants, licencers a/ b/	Complete dependency: manufacturers, consultants, licencers a/ b/
Casting	High dependency: consultants & licencers b/	High dependency: consultants & licencers c/	Complete autonomy	Complete dependency: manufacturers, consultants, experts, licencers c/ a/	Complete dependency: manufacturers, consultants, experts, licencers c/ a/
Rolling	High dependency: consultants, experts, manufacturers d/	High dependency: manufacturers d/	Complete autonomy	Complete dependency: manufacturers d/	Complete dependency: manufacturers d/

a/ The general rule is that the plants request the manufacturers to assume full responsibility for the erection, tests and running in of the equipment, even if these tasks could be fulfilled by plant staff in most cases.

b/ In the expansion of steel shops of the classical type, there is a marked autonomy. The foreign contribution concerns the use of oxygen, be it for the transformation of existing furnaces or for construction of new ones and, in the latter case, it is considerable.

c/ There is plenty of autonomy in the handling and expansion of pouring and casting of ingots of the classical type. The external aid is necessary to design and put into operation continuous casting strands or vacuum casting.

d/ Most of the rolling problems can be solved locally. External aid is necessary for electronic control of the process (automation).

/Obviously, at

Obviously, at the very general level at which this table has been drawn up, it cannot cover all possible situations. On the other hand, it has to be borne in mind that almost all the plants retain standing consultants' services with some well-known foreign firm and that, even if it should not be deemed necessary, this firm would be consulted out of courtesy at least.

Coking plant and agglomeration. With reference to the coke plant, all indications are that as long as the present blends of coals are used, there will be complete autonomy for the design, planning and civil construction, while for the erection of the new equipment, the assistance of the manufacturers would be sought as usual. The same situation exists regarding sintering, except that changes in the inputs in this section would not affect the technological autonomy.

Reduction. The situation prevailing in regard to coke or charcoal blast furnaces is very much the same as in coking and agglomeration. If a direct reduction process is selected, however, the foreign dependency would be complete, as Brazil has no experience of these processes.

Steel shop. It is highly improbable that a new open hearth furnace should be built in Brazil. Concerning oxygen blown converters, there would be a small dependency regarding the method of using the oxygen and, in the case of electric steel furnaces, the dependency is probably restricted to the design of furnaces of a much larger size than those operating in Brazil.

Pouring. Dependency on foreign technology would be very high with reference to continuous casting and to vacuum casting.

Rolling mills. Most of the rolling problems can be solved in Brazil. Foreign technical assistance would be indispensable for automation of a part or all of the process.

The above illustrates the high level attained by the steel technology in Brazil. On the light of the contents of the table it can be said that the design and construction of a new conventional plant can be carried out in the country without any foreign aid, if talents from several of the existing plants are pooled. On the other hand, if it is intended that the new venture make use of patented or little known processes, it would be necessary to lean heavily on assistance from abroad.

/3. Foreign technical

3. Foreign technical assistance for changes involving little or no investment and for the making of new products

Both the management and the technical staff in Brazil are strongly motivated to introduce, at as early a stage as possible, any innovation which proves valuable in other countries. While examining those which can be carried out with little or no investment, two situations have to be considered: (a) whether the innovation concerns only one of the productive departments; or (b) whether it concerns several of them.

(a) Innovations concerning only one productive department

Coking and agglomeration. Although the technology in this department is advanced in Brazil, research is being conducted to introduce further improvements.

Reduction. Past performance of the Brazilian technicians in this field is remarkable. For instance, in Monlevade, the original daily capacity of the existing charcoal blast furnaces was 360 tons of pig iron. It has been raised to 1,600. Research is being done in some special fields. For instance, ACESITA is experimenting on the injection of mixtures of oil and fine charcoal through the tuyeres. The biggest difficulty is the tendency of the potassium of the charcoal to accumulate in the fines.

Steelmaking. A limited dependency on foreign technology exists concerning the use of oxygen in steelmaking. For the balance, there exists full autonomy.

Pouring. The dependency is limited to newly patented processes.

Rolling. There is almost full autonomy including the speeding up of the rolls. Dependency is limited to automation.

New Products. In order to illustrate what is meant under this heading, it can be mentioned that USIMINAS, in addition to common steels, produces welding steels, high resistance steels, corrosion resistant steels and sheet for deep drawing. ACESITA, in its turn, produces stainless steel sheets, chromium nickel tool steels, non-oriented grain silicon steel sheets, etc. When the chemical or the physical characteristic of the new product differs from the steels currently being made at the plant, the same foreign expert who advises the steel shop on its manufacture is also expected to solve any problem which might arise in the rolling mill with the new material.

/(b) Improvements

(b) Improvements of various departments

The most important problems falling under this heading are quality control and administrative organization and productivity.

Quality control. The usual procedure is to send a team of the local staff, generally selected by the consultant, for training abroad to supplement or substitute for the foreign experts retained at the beginning of operations. In the plants visited in Brazil, the staff engaged in quality control ranged between 50 and 90 persons in total. Although in theory, the staff should be ready to operate at the start of operations, most plants have found it necessary to overhaul the organization of this department after a short time.

Administrative organization and productivity. Administrative sciences have progressed a great deal and the management of the steel industry in developed countries has reached a high level of efficiency. As consultants with broad experience in this field practically do not exist in the developing countries, it would be advisable to retain the services of an experienced foreign consulting firm, if it is intended to take full advantage of the possibilities offered by these improvements.

4. Methods used for securing technical assistance for the industry

Planning construction and start of operations. Several procedures can be followed with respect to the distribution of the planning and construction work and the directors of the visited plants were, in general, satisfied with the services they had received.

Assistance for expansion and changes in processes. It is generally agreed that if the foreign co-operation is restricted to the visit of an expert for a limited time to solve the problem, little more than a recipe is obtained, which may go wrong at the slightest change in working conditions. The best procedure is to send one of the technical staff abroad to study the problem.

Manufacture of new products. One of the firms, making a great variety of special steels, states that training its staff in order to allow it to develop the necessary technology would result extremely expensive. It is cheaper to buy the technology, preferably from some industry actually making the product. The higher the technological capability of the purchaser, the lower the price the firm has to pay for the technology.

/Technological research

<u>Technological research</u>. There is a general feeling in the industry that in each plant there should be sufficient technological capability to study and improve on the daily routine problems arising in the plant, but that major problems should be entrusted to a research institute. Even if much progress is attained in this, there will always be a need for foreign assistance, especially for the manufacture of new products and the application of newly developed processes.

/Chapter VI

Chapter VI

OTHER PROBLEMS

1. Purchase of foreign technology versus creation of local capability

There are no legal restrictions for the purchase of foreign technology by the steel industry of Brazil. Therefore, the decision on the choice rests fully on the industry.

The technological knowledge existing in the country is not centred in one institution, but is disseminated in many plants where intensively trained specialists work. For several reasons, the existing technological institutes have contributed very little during the last few years to the progress of the industry and in order to change this situation, a considerable strengthening of their human resources would be indispensable.

2. Factors influencing the tendency to innovate

During the field work, ten plants were selected to evaluate their reactions towards innovations. Given the composition of the Brazilian steel industry, they cannot constitute a homogeneous sample. Some of the plants included are old, others very new; some make common flat steels, others alloy steels for tools, etc. Under these conditions, it was decided to make a general subjective appraisal of the problem. As the sample includes plants in which one or two departments are very up to date while others lag far behind, the average situation in the plant was taken into account.

/Table 9

Table 9

CLASSIFICATION OF THE TEN PLANTS CONTAINED IN THE SAMPLE REGARDING THEIR TENDENCY TO INNOVATE

Type of enterprise and plant	Very aggressive a/	Progressive b/	Conservative c/
Enterprises with foreign capital			
Making common steels	2	-	-
Making special steels	2	-	-
Enterprises with Brazilian capital			
Making common steels	-	3	1
Making special steels	2	-	-

a/ Plants which continually study the innovations introduced in the world steel industry and apply them soonest;

b/ Plants which study the innovations introduced in the steel industry of the most advanced countries but apply them with a certain time-lag;

c/ Plants which maintain a conservative attitude viz. innovations and wait until they have been generalized to a certain extent, in order to avoid possible difficulties or failures.

As shown in Table 4, the plants were classified within one of the three following categories: (a) plants in which world technological progress is kept constantly under review and applied as soon as feasible. They are here called technologically "very aggressive"; (b) plants in which knowledge concerning the technological progress in the world is kept up to date, but where there is a time-lag between the acquisition of the knowledge and its application. They have been classified as "progressive" and (c) plants which maintain a conservative attitude and do not undertake innovations until their benefit has been demonstrated in other plants. These are called "conservative".

Various factors influence the tendency to innovate. In the following, some of them will be analyzed.

/3. Influence of

3. Influence of foreign investments

Although foreign capital still existing is generally in a very small minority, except in one of the plants listed, the table indicates the technological alertness of the managements of this sort of venture.

4. Influence of competition on the market

The growth of the Brazilian steel production during the last ten years transformed the country from a net importer into a net exporter. Consequently, the competition for the internal market was serious at the time the study was carried out. The composition of the sample does not permit us to measure the effect of competition on the tendency to innovate within the plants. The only thing which became evident during the survey is that the competition became an important factor in improving the quality control in all the plants.

5. Influence of the technical staff of the plants

In general, the technical staff of the Brazilian steel industry is up to date on the evolution of technology in the most modern industries of the world. The operative personnel, on the whole takes pride when the operations under its control show a high degree of efficiency. Nevertheless, in some cases it is possible to find technicians who are afraid to make mistakes and, therefore, take a reticent attitude towards innovation. In such cases, management would do well to engage the services of an expert.

6. Influence of the board of directors

The fact that the Brazilian steel industry had been operating at a loss[1/] for several consecutive years at the time when this study was carried out, is probably to a great extent responsible for the generally conservative attitude of the members of the board of directors. This reluctance was, of course, more marked when the innovation in question demanded investment. In general, it was felt that the attitude of the board of directors as a body concerning innovations, is more receptive if among the members there are one or two enterprising men with progressive minds.

1/ Mostly owing to the low selling prices established by the Government.