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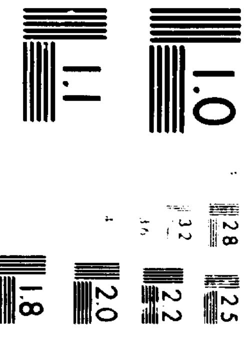
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Third Consultation on the Iron and Steel Industry

Caracas, Venezuela, 13-17 September 1982

1990 SCENARIOS FOR THE IRON AND STEEL INDUSTRY

ADDENDUM

"THE DOSSIERS" */

*/ This document has been translated from an unedited original.

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CONTENTS

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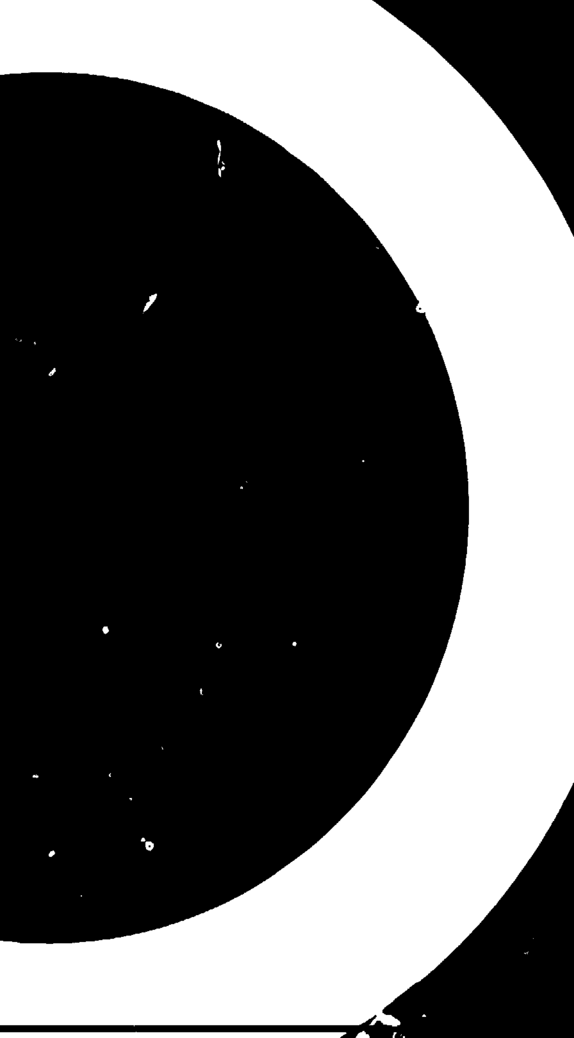
PRESENTATION

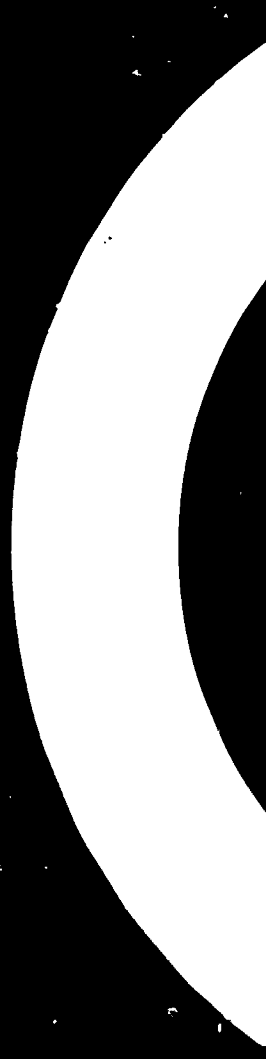
For the drafting of the "1990 scenarios for the iron and steel industry", the Working Group set up after the Second Consultation on the Iron and Steel Industry (New Delhi, 15-19 January 1979) recommended the preparation of "dossiers" summarizing the data and problems relating to the following matters:

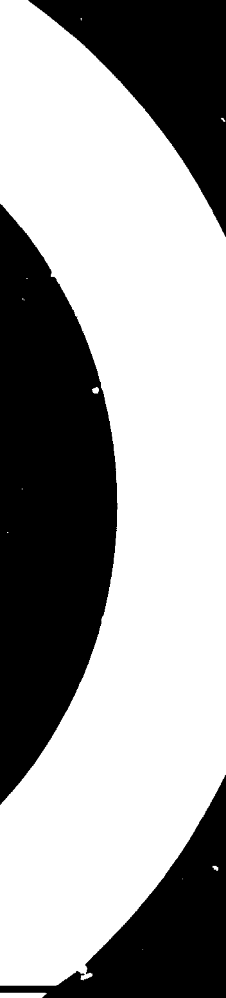
1. Iron and steel projects in the developing countries in 1990;
2. Raw materials and energy;
3. Markets, product ranges and scale economies;
4. Technology and research;
5. Design, construction and commissioning of new units;
6. Development of human resources for the iron and steel industry;
7. Costs and financing.



DOSSIER I

1990 PROJECTS IN THE DEVELOPING COUNTRIES





DOSSIFR - PROJECTS

A. INTRODUCTION

1. The decision was taken, at the end of the Second Consultation Meeting held in New Delhi at the beginning of 1979, to proceed with the construction of alternative scenarios on the growth of the world iron and steel industry up to 1990.

2. The Working Group which was formed for this purpose felt, during the meeting in Algiers in December 1979, that the construction of a 1985 picture of the world iron and steel industry should form the first stage of this work.

3. A "Picture for 1985 of the World Iron and Steel Industry"(1) was proposed and discussed by the Working Group during its meeting in September 1980. The object of this note was "less to put forward a group of quantitative data of high accuracy for 1985 than to identify the most important problems posed by the development of the iron and steel industry, and to highlight the principal components of this industry, with special reference to those developing countries which were preoccupied with achieving the Lima objectives ....".

In particular the 1985 picture showed that the steel deficit in the developing countries, instead of being absorbed, would continue to worsen until it reached a level of about 70 million tonnes.

4. The work which is presented here uses the study on the 1985 picture as the starting point; it extends it up to 1990 on the basis of the collection and analysis of details on all iron and steel projects under construction or being studied. Certainly there is less information available beyond 1985, and it is of a more random nature, whilst the "fluidity" of the projects is such that the situation, as observed at any given moment, may change, sometimes to a considerable extent, within the space of a few weeks. This is why the Working Group took the decision to establish the analysis of the situation regarding projects on the basis of the information available at the end of 1981.

This decision does not in any way diminish the value of the undertaking inasfar as the projects reflect, in all cases, the intentions and strategies of the actors concerned, whilst the evolution of the projects illustrates the problems and difficulties which they encounter.

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(1) UNIDO/ICIS.161/Rev.1 dated 16 July 1980 - Original: French.

B. PROJECTS AND PRODUCTION CAPACITIES FOR 1990

5. The list of the projects identified in the annex to the study of the 1985 picture has been supplemented on the basis of the available information(2).

Projects for extensions or new projects have been classified under three headings:

I. General project concept and pre-feasibility study

II. Projects under study and negotiation

III. Projects under construction or for immediate construction (contract signed and financial backing obtained).

6. One hundred and thirty-eight projects have been identified, the total capacity of these being about 117,000,000 tonnes steel equivalent: of these about 55,6[illegible]0,000 tonnes are in category I and II and 61,250,000 tonnes were in category III.

7. Of the 138 projects:

- 48 are projects for mini-iron and steel works (less than 200,000 tonnes), corresponding to an overall capacity of about 6,100,000 tonnes;
- 32 are projects for units of 200,000 to 500,000 tonnes capacity, corresponding to a total capacity of about 15,430,000 tonnes;
- 17 are projects for units of 500,000 to 1,000,000 tonnes capacity, corresponding to a total capacity of about 13,000,000 tonnes;
- and 41 are projects for units with a capacity exceeding 1,000,000 tonnes, corresponding to a total capacity of about 32,000,000 tonnes (or about 70% of the total capacity of the projects).

8. Geographically speaking these projects can be divided up as follows:

- In Asia 38 projects, including:
  - 6 mini-plants,
  - 10 projects of 200,000 to 500,000 tonnes,
  - 6 projects of 500,000 to 1,000,000 tonnes,
  - 16 projects of more than 1,000,000 tonnes,

  giving a total capacity of about 41,500,000 tonnes.

(2) cf. 1985 Picture

- In <u>Africa south of the Sahara</u> 32 projects, including:
  - 25 mini-plants,
  - 4 projects of 200,000 to 500,000 tonnes,
  - 0 project of 500,000 to 1,000,000 tonnes,
  - 3 projects of more than 1,000,000 tonnes,

  giving a total capacity of 9,200,000 tonnes.

- In <u>North Africa and the Middle East</u>: 26 projects, including:
  - 9 mini-plants,
  - 6 projects of 200,000 to 500,000 tonnes,
  - 4 projects of 500,000 to 1,000,000 tonnes,
  - 7 projects of more than 1,000,000 tonnes,

  giving a total capacity of about 19,300,000 tonnes.

- In <u>Latin America</u>: 42 projects, including:
  - 8 mini-plants,
  - 12 projects of 200,000 to 500,000 tonnes,
  - 7 projects of 500,000 to 1,000,000 tonnes,
  - 15 projects of more than 1,000,000 tonnes,

  giving a total capacity of about 46,900,000 tonnes.

The total announced or estimated cost of all these projects is about $ 172,000 million, divided up as follows:

- $ 6,100 million for the mini-plants
- $ 11,430 million for the projects of 200,000 to 500,000 tonnes,
- $ 15,240 million for the projects of 500,000 to 1,000,000 tonnes,
- $ 135,175 million for the units of more than 1,000,000 tonnes (or <u>78%</u> of the total sum).

These 138 projects are located in 65 countries, of which:

- 12 are in Asia,
- 22 are in Africa south of the Sahara,
- 17 are in North Africa and the Middle East, and
- 14 are in Latin America.

However no project has been identified in 37 developing countries (9 in Asia, 15 in Africa south of the Sahara, 3 in North Africa and the Middle East and 10 in Latin America).

9. It can be seen that, between 1980 and 1990, the following countries should have access to more sophisticated iron and steel production:

- Integrated steel plants (including sponge iron and electric furnace integrated plants)

  Bangladesh,
  Ecuador,
  Libyan Arab Jamahiriya,
  Morocco,
  Nigeria,
  Oman,
  Pakistan,
  Philippines,
  Saudi Arabia,
  Syrian Arab Republic
  Thailand,
  United Arab Emirates (Abu Dhabi)

- Production of flat products:

  Indonesia,
  Iran,
  Libyan Arab Jamahiriya,
  Nigeria
  Pakistan,
  Philippines,
  Syrian Arab Republic,
  Thailand.

- Production of high-grade and special steels:

  (Algeria) ?
  (Colombia) ?
  (Iran) ?
  Nigeria,
  Other Asian countries,
  Pakistan.

whilst 30 countries will still not have any iron and steel production.

The situation regarding the various projects is summarized as an annex at the end of Dossier I.

C. UNEQUAL GROWTH AND DIFFERENTIATION

10. The projected growth of the iron and steel industry is in the hands of countries:

- which have a medium or large population,
- where the gross fixed capital formation is covered by intermediate or high revenues,
- where the projects generally exceed $ 300 millions in the case of a non-integrated unit of small size and $2 to $3 billion in the case of a medium-sized integrated unit (of 1 million tonnes),
- where the per capita consumption of steel is already average or high,
- and, particularly, where hydrocarbons resources are available.

11. This last characteristic can be seen in particular from an examination of the projects with a unit capacity of 1 million tonnes or above. They are located in 20 countries and represent about 86% of the iron and steel capacity under construction or projected in the developing countries.

Table 1 The principal projects in 20 countries

	1978 population, millions	1978 GFCF */ US$b	Per capita revenue US$	1977 steel consumption (kg)	Projected production capacity, millions tonnes	Oil-producing country
Algeria	18	11.0	1,260	110	2.0	X
Argentina	25	12.5	1,910	150	4.4	
Brazil	119	43.1	1,570	100	15.0	
Cuba	14	8.0		n.a	2.9	
Egypt	40	4.4	390	25	1.6	X
India	650	27.6	180	17	11.2	
Indonesia	140	9.6	360	10	3.0	X
Iran	35	25.7	2,160	150	6.9	X
Iraq	12	5.0	1,860	60	2.0	X
Libyan Arab Jamahiriya	2.7	4.5	6,910	250	1.3	X
Mexico	60	21.1	1,290	110	15.0	X
Nigeria	80	13.5	560	20	6.0	X
Other Asian countries	17	6.2	1,400	250	9.0	
Pakistan	77	3.2	230	10	2.5	
Philippines	45	6.9	510	35	1.5	
Republic of Korea	36	13.6	1,160	180	8.1	
Saudi Arabia	8	18.9	7,690	300	1.0	X
Syrian Arab Republic	85	2.4	930	70	1.2	X
Thailand	40	5.55	490	40	2.3	X
Venezuela	15	16.0	2,910	220	4.8	X
Total				about	100.7(3)	

*/ GFCF - Gross fixed capital formation.

It can be seen that, of these 20 countries:

- 13 have more than 20 million inhabitants,
- 15 have an investment capacity (in 1978) of $5 billion per year or higher(4).
- 14 have a per capita revenue of US$ 500 or higher (12 with more than US$ 800),
- 12 countries have a per capita steel consumption (1977) of 50 kg or higher,
- 12 are oil-producing countries.

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(3) 100 million tonnes capacity out of a total of approximately 116 million tonnes

(4) Three others are countries with oil resources (Egypt, Libyan Arab Jamahiriya and Syrian Arab Republic.

Hence the dynamism of the growth of the iron and steel industry is affected by differences in population, availability of raw materials, financial resources (in conjunction with the production of hydrocarbons) and the degree of advancement of the mastery of industrial systems.

12. These factors explain why there are three privileged zones for the development of the iron and steel industry:

- Latin America, with Brazil, Mexico, Argentina and Venezuela, and hence with three oil-producing countries out of four, the fourth being a major producer of iron ore;
- South and South-East Asia with India, the Republic of Korea and the other Asian countries;
- the oil-producing countries of Africa and the Middle East including Nigeria, Iran, Algeria, the Libyan Arab Jamahiriya, Egypt and the Persian Gulf countries.

13. <u>A double division becomes clear</u>:

- firstly between the industrialized countries engaged in implementing increasingly diversified and sophisticated iron and steel production, and the developing countries, where the production is still largely marked by its non-diversified and general product character;
- then between the more dynamic developing countries (the 20 countries listed above) and the developing countries with a low revenue which have no iron and steel production or a very rudimentary production.

It may be asked whether this second differentiation will not become even more marked during the decade, inasfar as several countries in the first group have already entered into the process of diversification and higher quality.

D. THE IMPORTANCE OF THE DIRECT REDUCTION METHOD

14. At the beginning of 1980 several indices suggested that the optimistic forecasts relating to the development of direct reduction processes could be questioned. It seemed in fact that direct reduction had run into:

- technical difficulties in commissioning;
- the rapid rise in the price of energy and, in particular, the rapid rise in the price of natural gas, resulting in the closure of the American Oregon Steel plant, the freezing of the British plant at Hunterston and certain Spanish projects, etc.

15. In fact these hesitations and withdrawals affected the iron and steel industries of the North much more than those of the Third World countries where, on the contrary, there has been a vigorous revival of the direct reduction process in recent months as is shown by the following examples:

- the launching of the improved HYL III process, more economic in energy, adopted since its introduction in Mexico (SICARTSA), in Argentine (the SIDESUR project) and the improved MIDREX processes which were also more economic in energy;
- the increased interest of the major international iron and steel groups in the direct reduction process: SWINDEL DRESSER, DAVY DRAVO Corp., and KAWASAKI HEAVY INDUSTRIES in the case of the HYL process, and KORF, VOEST ALPINE, KOBE STEEL and MITSUI in the case of the NIPPON STEEL MILDREX process.

In this context a listing of the direct reduction projects highlights the following factors:

- Most of the direct reduction projects have been frozen or abandoned in the <u>industrialized countries</u> where only the following projects still remain:

  Australia (Hammersley)
  Bulgaria (Burgas)
  Canada (Alberta)
  USSR (Koursk)

- Direct reduction projects are multiplying in the <u>developing countries</u> (projects under construction or new projects).

Table 2. Direct reduction projects

Country	Project	Capacity million tonnes	State of advancement (*)	Process	Notes
Argentine	SIDERSUR	0.500	III	HYL III	
Bolivia	SIDERSA	0.100	II	?	Uncertain
Brazil	SIDERSUL	0.450	III	From coal	Official approval
	USIBA	0.200	II	From coal	
Colombia	FERROMINEIRA	0.100	II	?	Being studied
Ecuador		0.430	III	Natural gas	Decision taken
Mexico	HYLSA TAMSA SICARTSA SIDERMEX 2 PREMEXA	15.000	III II and I	HYL III	
Peru	CHIMBOTE	0.400	II	From coal	Studies now re-started
Trinidad and Tobago	ISCOTT	0.800	II	(MIDREX?)	Extension project under study
Venezuela	SIDOR	3.600	III	HYL and MIDREX	Plan IV on way to completion
TOTAL LATIN AMERICA	14 projects	21.580 mt			
Angola		?	I	?	Idea of project
Kenya		0.350	II	?	As alternative an integrate project
Liberia		0.500	I	?	
Mozambique		?	I	?	Idea of project
Nigeria	DELTA STEEL	1.300	III	MIDREX	Entry into production start of 1982
TOTAL AFRICA SOUTH OF SAHARA	3 projects + 2 ideas for projects	2.150 mt			

(continued)

Table 2 (continued)

Country	Project	Capacity million tonnes	State of advancement (*)	Process	Notes
Algeria	JIJEL	2.000	III	?	Official approval
Bahrain		0.400	I	?	
Egypt	DEKKEILHA	0.815	III	?	Decision taken
Iran	AHWAZ	2.500	III	HYL, MIDREX and PUROFER	
	ISFAHAN	3.000	II	?	
Iraq	KHOR-EL ZUBEIR or BAGHDAD	2.000	II	?	The first unit opted for HYL
Libyan Arab Jamahiriya	MISURATA	1.300	III	MIDREX	In course of construction
Oman		0.125	II	?	Dastur study
Qatar	QASCO	0.400	II	MIDREX	Project for doubling
Saudi Arabia	JUBAIL	0.850	III	MIDREX	In course of construction
United Arab Emirates (Abu Dhabi)		0.400	I	?	
TOTAL NORTH AFRICA and MIDDLE EAST	12 projects	14.540 mt			
Bangladesh		0.500	II	?	Natural gas
Burma		0.040	III	KINGLOR METOR	Doubling of the first 0.020 unit
India	VIJAYANAGAR	1.000	II	?	This unit could be built on the conventional route
	Three other units	0.660	III and II	From low grade coal	
Indonesia	KRAKATAU	1.000	III	HYL	Completion of the unit

(continued)

Table 2 (continued)

Country	Project	Capacity million tonnes	State of advancement (*)	Process	Notes
Malaysia	LABUAN	0.600	III	MIDREX	
	TRENGANNU	0.600	III	NSC	Doubling of the
	TRENGANNU	0.600	II	"	unit under study
Pakistan		0.500	II	?	Natural gas
Philippines		1.000	II	?	From low grade coal
Thailand		1.400	II	?	From natural gas Under study
TOTAL ASIA	12 projects	7.900 mt			
OVERALL TOTAL	41 projects	46.170 mt			

(*) III = in course of construction or imminent construction
II = at study stage
I = idea of project

16. Forty projects, representing a capacity of about 46 million tonnes, are at the present time being started or are the subject of in-depth studies, representing more than 40% of the capacity of the projects being studied or under construction in the developing countries (about 116 million tonnes).

These projects can be divided up in the following manner:

Table 3

	(1) Number of DR projects	(2) Capacity of DR projects (millions t)	(3) Total projected capacities (millions t)	2/3 %
Latin America	14	21,580	46,900	46.0
Africa south of the Sahara	3	2,150	9,220	23.3
North Africa and the Middle East	12	14,540	19,310	75.3
Asia	12	7,900	41,510	19.0
TOTAL	41	46,170	116,940	39.5

They thus constitute:

- in Latin America: 46% of the projected capacities
- in Africa south of the Sahara: 23% of the projected capacities
- in the Mediterranean and Middle East: 75% of the projected capacities
- in Asia: 19% of the projected capacities.

17. Whilst projects based on direct reduction processes were, until recently, projects of low unit capacity and projects integrated into a production of long products (concrete reinforcing bars), a considerable number of new projects are, on the contrary, characterized by:

- their size, which regularly exceeds 1.0 million tonnes[5] in Algeria, India, Indonesia, Iran, Iraq, the Libyan Arab Jamahiriya, Nigeria and even more in Mexico (SICARTSA, HYLSA, SIDERMEX) and Venezuela (SIDOR);
- their integration into complexes which produce both long and flat products in the case of the projects in Iran, the Libyan Arab Jamahiriya, Mexico, Nigeria or Venezuela (SIDOR).

18. Numerous direct reduction processes are now available, using either natural gas or a solid reducing agent (non-coking coal). In fact at the present time there is a preponderance of reduction processes using natural gas, in particular the MIDREX processes (which has been the subject of successive improvements) and the HYL process (the dynamism of which has now been renewed by the launching of the new HYL III variant) and these at the present time represent more than 90% of the direct reduction projects in the developing countries.

19. It can be seen from this fact that the advance of the direct reduction processes is linked to the availability of hydrocarbons and, in particular, the toxic gases which up to now have remained unused: 90% of the direct reduction projects are in fact located in oil or gas producing countries.

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(5) 12 direct reduction projects are integrated in complexes of which the capacity is 1.0 million tonnes or higher

- 100% of the projects in the oil-producing countries of Africa and the Middle East,
- 90% of the projects in the oil-producing countries of Latin America (Argentina, Colombia, Ecuador, Mexico, Venezuela, etc.),
- 66% of the projects in the oil-producing countries of Asia (Indonesia, Malaysia, etc.)

20. It will be noted that the renewal of interest in oil fields which are deeper and hence more expensive to work will result in the probable discovery of oil resources in many other developing countries, as is the case today in Africa, on the Ivory Coast, in Cameroon, etc.

This opens up new possibilities for the utilization of direct reduction processes in new zones which will in this way have the necessary bases to acquire an iron and steel industry.

E. THE DESTINATION OF PRODUCTION AND THE LOCATION OF PROJECTS

21. A total of 138 projects have been definitively listed. Less than 10% of these are explicitly directed towards exporting: these are in particular projects for the production of iron sponge by direct reduction processes either totally, as is the case with the Mexican-Japanese project intended to supply sponge iron for the Japanese iron and steel industry, or partially, as is the case with the projects in Malaysia (exporting to the Republic of Korea or Japan), in Indonesia (Krakatau Steel), in Thailand, Qatar, the United Arab Emirates (Abu Dhabi) and Trinidad and Tobago (Iscott) and three projects for integrated iron and steel plants as is the case of Tubarao in Brazil and Vizakapatnam and Paradip in India which will have to export part of their production(6). In total they represent 6.4 million tonnes of production capacity out of the 116 projects.

It is obvious that many other projects will contribute towards exports intended to compensate for imports (of equipment, ore, coking coal, etc.) but without being projects specifically directed towards exporting: this is the case, for example, with the iron and steel industries of Brazil, Argentina, Korea, etc.

LOCATION

22. Of the 138 projects identified, and with the proviso of some uncertainty as to the exact location of some of these, about 60% are coastal projects and 40% are inland projects.

23. It will be noted that many inland projects are located in three countries:

- Brazil: extensions at Usiminas, Belgomineira, Mannesmann and Acesita and the Acominas project, etc.,
- India: extensions at Bhilai, Bokaro, and Tisco and the direct reduction projects,
- Mexico: extensions at Ahmsa, FMSA and HYLSA.

(6) The exports forecast from Tubarao seem to be running into difficulties.

24. The installed capacity of the projects belonging to these three countries account for about 90% of the capacity of all the "inland" projects.

25. Most of the countries creating or developing their iron and steel industries have coastal projects. This location of the projects is apparently in contradiction with the priority destination - the domestic market - of practically all the new projects. Examination of the patterns of trade necessitated, in particular, by supplies to the new iron and steel industries, make it possible to provide an explanation of such location.

It can be seen from an examination of Table 4 (see the following pages) that:

- with the exception of India most of the largest iron and steel industries in the Third World import coking coal: Algeria, Argentina, Brazil, Egypt, Iran, Mexico, Nigeria, other Asian countries, the Republic of Korea, etc.
- the establishment of direct reduction installations involves the development of major commercial trading, whether it involves the exporting of sponge iron or mainly the importing of high quality iron ore, as is forecast for the following countries: Algeria, Argentina, Bangladesh, Egypt, Indonesia, Iran, Iraq, Libyan Arab Jamajiriya, Malaysia, Mexico, Nigeria, Oman, Qatar, Saudi Arabia, Thailand, Trinidad and Tobago, and United Arab Emirates (Abu Dhabi)(7).

In most of these cases the new iron and steel industries will have recourse to importing either coking coal, high grade iron ore or scrap iron (or billets), even if local resources can cover part or all the necessary supplies (as is the case with the other Asian countries and the Republic of Korea).

The obligation to have recourse to technical assistance from the major international manufacturers again indicates the international character of the growth of national iron and steel industries in the developing countries.

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(7) For example the importing of ore from Guinea into Algeria, of ore from Brazil or Liberia into Nigeria, of Australian or Indian ore into Malaysia, of Indian ore into the United Arab Emirates (Abu Dhabi) and Oman, etc.

The development of the direct reduction route is significant of this process, inasfar as two major processes are being promoted by a small number of major international constructors who share a rapidly expanding market, almost exclusively located in the developing countries.

This means, for the iron and steel industries in the developing countries (except perhaps in Colombia and Venezuela), dependency on and inclusion into an international trading system for raw materials, but also the possibilities of interdependence and more active collaboration between the developing countries themselves.

Table 3. *

Country	Site: C coastal, I inland, ND not determined	Exporting part of the production	Local availabilities: Iron ore	Local availabilities: Energy	Imports required: Iron ore	Imports required: Scrap and billets	Imports required: Coking coal
AFRICA SOUTH OF THE SAHARA							
ANGOLA	C					X	
CAMEROON, Un. Rep. of	C			Petroleum - gas		X	
CENTRAL AFRICAN REPUBLIC	I					X	
GABON	C		X	Oil			
GHANA	C			Oil		X	
IVORY COAST	C		X			X	
KENYA	C			Charcoal			
LIBERIA	C	X	X				
MOZAMBIQUE	C					X	
NIGERIA:							
- Delta Steel	C			Natural gas	X		
- Ajaokuta	ND						X
- Birla	ND						
- Oshoro	ND						
SENEGAL	C		X			X	
TANZANIA, Un.Rep. of	2C					X	
TOGO	C					X	
ZAIRE	I			Hydro-electric power		X	
ZAMBIA	I					X	
ZIMBABWE, Rep. of	I		X	Coal			
MIDDLE EAST and NORTH AFRICA							
ALGERIA:							
- El Hadjar	C		X				X
- Jijel	C			Natural gas	X		
EGYPT:							
- Dekheila	C			Natural gas	X		
- Sadatville	I						
(continued)							

* Not all the projects are shown on these tables, since certain groupings have been carried out within the countries.

Table 3. (continued)

Country	Site: coastal C, inland I, not determined ND	Exporting part of the production	Local availabilities		Imports required		
			Iron ore	Energy	Iron ore	Scrap and billets	Coking coal
IRAN:							
- Isfahan	I		X		X		X
- Ahwaz	I			Natural gas	X		
- Isfahan	I				X		
IRAQ	ND			Natural gas	X		
JORDAN	I					X	
LIBYAN ARAB JAMAHIRIYA	C			Natural gas	X		
MOROCCO	C					X	(X)
OMAN	C			Natural gas	X		
QATAR	C	X		Natural gas	X		
SAUDI ARABIA	C			Natural gas	X		
SYRIAN ARAB REPUBLIC	I		X				X
TUNISIA	C		X	Natural gas	X	X	
UNITED ARAB EMIRATES (Abu Dhabi)	C			Natural gas	X		
<u>ASIA</u>							
BANGLADESH	C			Natural gas	X		
BURMA	C			Natural gas	X		
INDIA	I & C		X	Coking coal			
INDONESIA	C	X		Natural gas	X		
KOREA, Rep. of:							
- Posco	C				X	X	X
- New project	C				X	X	X
MALAYSIA	C		X	Charcoal	X	X	
OTHER ASIAN COUNTRIES	C & I				X	X	X
PAKISTAN	C			Natural gas	X		X
PHILIPPINES	C		X	Charcoal (?)			X
SINGAPORE	C					X	
THAILAND	C	X		Natural gas	X		
	I						

(continued)

Table 3. (continued)

Country	Site coastal C inland I not determined ND	Exporting part of the production	Local availabilities		Imports required		
			Iron ore	Energy	Iron ore	Scrap and billets	Coking coal
<u>LATIN AMERICA</u>							
ARGENTINA - Somisa	C		X		X		X
- Sidinsa	C				X		X
- Zapla	C		X	Charcoal			
- Sidersur	C			Natural gas	X		
BRAZIL	C & I	(X)	X	Charcoal			X
CHILE	C		X	Coking coal			
COLOMBIA	I		X	Coking coal			
CUBA	C				X		X
DOMINICAN REPUBLIC	C					X	
HONDURAS	I			Charcoal			
MEXICO	C & I	X	X	Natural gas Coking coal	X		X
PARAGUAY	I					X	
PERU	C		X	Non-coking coal			X
TRINIDAD AND TOBAGO	C	X		Natural gas	X		
VENEZUELA:							
- Sidor	C	X	X	Natural gas			
- Zulia	I		X	Coking coal			

F. THE PREPONDERANT ROLE OF THE STATE

26. The initiative of the role of the State in the promotion of the iron and steel industry has become preponderant in the developing countries, irrespective of their political systems or their economic and social preferences.

At the present time more than 80% of the projects launched in the developing countries result from the initiative of the State or from State ownership (direct or indirect), in general as a majority shareholder[8]. The contradiction of such phenomena with the increasingly international means of financing of iron and steel projects is only apparent, since the intervention of the State only provides a valid guarantee to the international financing organizations or agents[9].

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(8) Whereas in 1950 23% of the world iron and steel industry was State property by 1980 this percentage had increased to 53%. (See paper by W. Hogan, Xth Congress of the Brazilian Iron and Steel Industry - Rio de Janeiro - April 1980)

(9) See on this subject Dossier VII - "Costs and financing".

Table 4. Role of the State and foreign intervention

	Project status S = State P = Private	Foreign technical or Financial intervention
LATIN AMERICA		
ARGENTINA:		
- Somisa	S	Japanese investment (intervention by the Japanese Government?) Cooperation with FRG?
- Sidinsa	S	Cooperation agreements with Davy (GB)
- Sidersur		HYL III Process (Marubeni Hylsa - Mexico)
BOLIVIA:		
- Mutun	S	Brazilian participation in the project?
BRAZIL:		
- Tubarao	S (51%)	Shareholdings: Kawasaki Steel (Japan) 24.5% and Finsider (Italy) 24.5%
- Belgomineira	P	ARBED (Luxembourg)
- Mannesmann	P	Mannesmann (FRG)
- Cosigua	P	Shareholding: ATH (FRG) S.F.I.
- Acominas	S	Credit from international banking consortium
- Usiminas	S	Shareholding in capital by Japanese group
- Mendes Junior	S/P	Acos Villares Brazilian company)
- CSN	S	International credits World Bank Japan
- Cosipa	S	
- Acesita	S	
CHILE	S	
COLOMBIA	P	DASTUR (India) Study
CUBA	S	USSR cooperation
ECUADOR	S	

(continued)

Table 4 (continued)

	Project status S = State P = Private	Foreign technical or Financial intervention
HONDURAS	S/P	Project for Brazilian shareholding
MEXICO:		
- Hylsa - Furdid.Monterrey* - Tamsa	P	International credits HYL process HYLSA - Swindel Dresser - Dravo.
- Sicartsa - Sidermex II	S	Agreement with DAVY for the 2nd SICARTSA phase. International credits and technical agreements
PARAGUAY:		
- Acepar	S/P	Shareholding by Brazilian groups
PERU:		
- Chimbote	S	DR - German process
- Laminadoras del Pacifico	P	
TRINIDAD AND TOBAGO	S	MIDREX Process Equipment and credit from Japanese suppliers
VENEZUELA:		
- Sidor	S	MIDREX Process - Korf (FRG) HYL Process - Swindel Dresser (USA) - Hylsa (Mexico) International credits
- Zulia	S (minority shareholding envisaged for foreign interests?)	
<u>AFRICA SOUTH OF THE SAHARA</u>		
CAMEROON, Un. Rep. of	S/P	US company shareholding project
KENYA	S	
LIBERIA	S/P	US company shareholding project

(continued)

* Shareholding by a Japanese group and technical assistance from Nippon Steel

Table 5 (continued)

	Project status S = State P = Private	Foreign technical or Financial intervention
NIGERIA:		
- Ajaokuta	S	Cooperation with the USSR and French companies for the construction (International credits)
- Delta Steel	S	MIDREX - cooperation with German companies
- Special Steels	S/P	Shareholding (40%) by BIRLA Company (India)
- Small unit	P	Joint venture project with a company from other Asian countries.
SENEGAL	S	Project studied by DASTUR (India)
ZAMBIA	S	Project with Yugoslavia dropped New project
<u>NORTH AFRICA and MIDDLE EAST</u>		
ALGERIA:		
- El Hadjar	S	Extension - USSR cooperation - Japanese cooperation - European group (with suppliers' and bank credits)
- Jijel	S	Study by Tractionel (Bel) then agreement with Nippon Steel
SAUDI ARABIA	S + shareholding FRG group	MIDREX - KORF (FRG) 80% SABIC 20% KORF/DEG
EGYPT:		
- Helouan	S	Extension completed with USSR cooperation
- Dekkheila	S = 87% Shareholdings : Japanese group 10% SFI* 3%	Japanese credits

* SFI = Société Financière Internationale World Bank group

Table 4. (continued)

	Project status S = State P = Private	Foreign technical or Financial intervention
UNITED ARAB EMIRATES (Abu Dhabi)	S	DASTUR (Indian) study
IRAN:		
- Isfahan	S	Cooperation with USSR
- Ahwaz	S	DR processes - MIDREX - HYL
- Bandar Khomeini (then Isfahan)	S	Construction entrusted to Finsider (Italy)
IRAQ	S	Supplier: Creusot Loire (Fr) Process: HYL (Mex & USA)
LIBYAN ARAB JAMAHIRIYA	S	DASTUR: engineering services and principal consultant (India) Suppliers: Japan, no credit (cash)
MOROCCO	S	Contract with Davy (GB) with British and international credits
OMAN	S	DASTUR (India) study
QATAR	S + Kobe Steel shareholding	Kobe Steel and Japanese interests 30%
TUNISIA	S	Study of extension entrusted to Atkins (GB) and consultation agreements with SOFRESID (France)
ASIA		
OTHER COUNTRIES OF ASIA	S/P	Japanese and European equipment
KOREA, Republic of	S	Japanese and European equipment (France, FRG, Austria)
INDIA:		
- Bokaro extension	S	Cooperation with USSR
- Vizakapatnam	S	Cooperation with USSR (Discussion on partial buy-back)

(continued)

Table 4 (continued)

	Project status S = State P = Private	Foreign technical or technical intervention
INDIA (continued)		
- Paradip	S	Letter of intent in favour of a consortium led by Davy (GB) was cencelled, May 1932
- Mangalore	S	Western Europe and Romania was in the wings
- Vijayanagar	S	Firstly ELRED process (Sweden) (??) but now new project
INDONESIA	S (and P)	HYL process (Mexico and USA) German cooperation Japanese cooperation
MALAYSIA	S + P national and foreign capital	With Nippon Steel (Japan) With Klockner (FRG) etc.
PAKISTAN:		
- Pipri	S	Cooperation with USSR
PHILIPPINES	S (and P)	New Mindanao project
THAILAND	S (and P)	Studies carried out by Japan and Austria (Austro Plan)

27. This table shows that:

- in the 69 cases considered the State intervenes in all but seven of these;
- practically all the projects call on international cooperation, in general from the industrialized countries and, in some cases, from countries of the South.

G. CONCLUSION

Nearly 140 projects, representing a capacity of about 116 million tonnes: this is the significant fact in the growth of the iron and steel industries in the developing countries. Numerous countries will enter into the mastery of integrated iron and steel production during the eighties; others will pass from the production of long products to the production of flat products; others, again, will acquire the mastery of the more or less diversified production of special and high grade steels.

Part of these projects are the subject of firm agreements; certain of them are already being built. On the other hand some projects are still in various stages of progress, from imminent agreement to the first pre-feasibility study and the first concept of the project. Part of these projects are therefore affected by uncertainty: their realization will depend on various conditions which it is the precise intention of the scenarios to list. It is certain that the growth of the demand will constitute an important factor which will operate either to accelerate or to hold back the realization of the projects.

The dynamism reflected by the capacity of the projects in the developing countries is thus confirmed in a fairly surprising manner in a world context which is depressed by the crisis and where most of the advanced iron and steel industries are concerned with fewer new projects than with restructuring and sometimes in drastic reductions in activity.

A new equilibrium must therefore be sought:

- on the basis of the replies given to the questions posed on the succession of the entries of the new arrivals into the iron and steel world, on the ranges of products involved, etc.;
- on the basis also of negotiations on the best possible adjustment regarding not only interference and competition but also of complementarities.

Care must be taken not to forget that realization of the many iron and steel projects listed here will in fact only make a modest contribution to the essential catching up within the framework of the objectives defined by the Lima Conference whilst, on the other hand, dozens of countries, in particular in Africa and Asia, still possess neither an iron and steel industry nor the smallest project in this field.

ANNEX
to Dossier I

SUMMARY OF THE PROJECTS

Tableau 5 Distribution des projets par niveaux de capacités

Table Distribution of projects by capacity levels

Capacité Capacity (m.t.)	Amérique Latine Latin America		Afrique au Sud du Sahara Africa South of the Sahara		Afrique du Nord et Moyen-Orient North Africa and the Middle East		Asie Asia		Total pays en développement Total developing countries	
	Capacité totale Total capacity (m.t.)	%	Capacité totale Total capacity (m.t.)	%	Capacité totale Total capacity (m.t.)	%	Capacité totale Total capacity (m.t.)	%	Capacité totale Total capacity (m.t.)	%
0.0 à /to 0.200	3,400	7.2	2,470	26.8	830	4.3	3,680*	8.9	10,380	8.9
0.200 à /to 0.500	4,540	9.7	1,450	15.7	2,115	10.9	3,305	8.0	11,410	9.8
0.500 à /to 1.000	5,200	11.1			3,165	16.4	4,700	11.3	13,065	11.2
> 1.000	33,760	72.0	5,300	67.5	13,200	68.4	29,825	71.8	82,085	70.1
TOTAL	46,900	100	9,200	100	19,310	100	41,510	100	116,940	100

Tableau 6 Distribution des projets par niveaux d'avancement

Table 6 Distribution of the projects by levels of progress

	Amérique Latine Latin America		Afrique au Sud du Sahara Africa South of the Sahara		Afrique du Nord et Moyen-Orient North Africa and the Middle East		Asie Asia		Total pays en développement Total developing countries	
	Capacités Capacities (10^6 t)	%	Capacités Capacities (10^6 t)	%	Capacités Capacities (10^6 t)	%	Capacités Capacities (10^6 t)	%	Capacités Capacities (10^6 t)	%
Niveau **Level** III	28,120	59.95	3,270	35.5	9,690	50.2	22,400	54.0	63,480	54.28
Niveaux **Levels** II - I	18,780	40.05	5,950	64.5	9,620	49.8	19,110	46.0	53,460	45.72
TOTAL	46,900	100	9,220	100	19,310	100	41,510	100	116,940	100

Tableau 7 Pays les moins avancés ayant des projets sidérurgiques d'ici 1990
Table 7 Least developed countries with iron and steel projects up to 1990

Pays Country	Description du projet Project description	Capacités prévues Planned capacities (m.t.)	Côut approximatif Approximate cost (billion US$)	Avancée des études ou des travaux Stage of development
Bangladesh	Extension de l'unité de Chittagong Extension of Chittagong works	0.100	0.100	II
	Projet de réduction directe Direct reduction project	0.500	0.500 (?)	I
République centrafricaine Central African Republic	Projet de mini-usine Mini plant project	0.010	0.020	I
Yemen démocratique Democratic Yemen	Projet de mini-usine (idee de projet ONUDI) Mini plant project (UNIDO project)	0.100	0.200	II
République-Unie de Tanzanie United Republic of Tanzania	Projet de TANGA (projet de mini-usine) TANGA project (mini plant project)	0.090	0.150	II
	Projet intégré de l'ONUDI Integrated UNIDO project	0.300	0.600	II
Ethiopie Ethiopia	Projet ECA/MULPOC ECA/MULPOC project	0.300	0.450	I
Malawi	Projet de mini-usine Mini plant project	0.120	0.180	I
Somalie Somalia	Projet de mini-usine Mini plant project	0.050	0.100	I
Ouganda Uganda	Projet de mini-usine Mini plant project	0.055	0.100	I
TOTAL		1.625	2.400	

Tableau 8 Distribution des projets par zones et par capacités
Table Distribution of the projects by regions and capacities

	Amérique Latine Latin America			Afrique au Sud du Sahara Africa South of the Sahara			Afrique du Nord et Moyen-Orient North Africa and the Middle East			Asie Asia			Total pays en développement Total developing countries		
Capacité Capacity (m.t.)	No. de/of proje(c)ts	Capacité totale Total capacity (m.t.)	Total coûts/costs (bill.US$)	No. de / of proje(c)ts	Capacité totale Total capacity (m.t.)	Total coûts/costs (bill.US$)	No. de/of proje(c)ts	Capacité totale Total capacity (m.t.)	Total coûts/costs (bill.US$)	No. de/of proje(c)ts	Capacité totale Total capacity (m.t.)	Total coûts/costs (bill.US$)	Projets Projects	Capacité Capacity	Coûts Costs
0.0 à /to 0.100	6	0.550	0.830	15	0.755	1.200	6	0.375	0.550	2	0.140	0.160	29	1.820	2.740
0.100 à /to 0.200	2	0.350	0.250	10	1.715	2.190	3	0.455	0.430	4	0.540	0.490	19	3.060	3.360
0.200 à /to 0.500	12	4.540	4.750	4	1.450	2.000	6	2.115	1.550	10	3.305	3.130	32	11.410	11.430
0.500 à /to 1.000	7	5.200	5.650	-	-	-	4	3.165	3.300	6	4.700	6.290	17	13.065	15.240
> 1.000	15	33.760	65.100	3	5.300	11.500	7	13.200	26.500	16	29.825	32.800	41	82.085	135.900
TOTAL	42	46.900	79.080	32	9.220	16.890	26	19.310	32.330	38	41.510	44.370	138	116.940	172.670

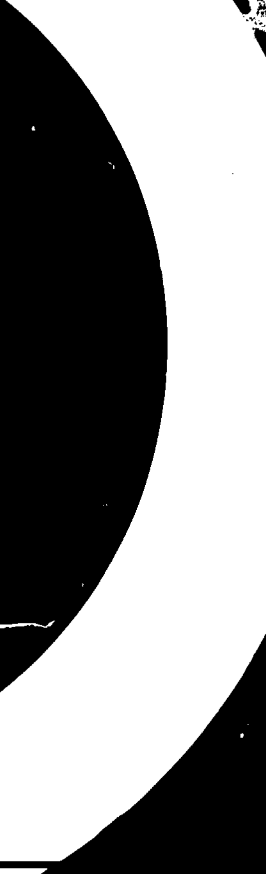
Tableau 9 Nombre de projets de mini-usines (capacité 0 à 0.200 millions de tonnes)

Table 9 Number of mini plant projects (capacity 0 to 0.200 million tons)

Amérique Latine Latin America	Afriqu au Sud du Sahara Africa South of the Sahara	Afrique du Nord et Moyen-Orient North Africa and the Middle East	Asie Asia	Total
8	25	9	6	48

DOSSIER II

RAW MATERIALS AND ENERGY



1. The iron and steel industry is a converter of raw materials and a major consumer of energy: in an integrated plant the production of 1 million tonnes of steel requires the conversion of approximately 3 million tonnes of iron ore, coking coal, limestone, refractory products, alloying metals, etc. Raw materials and energy therefore constitute a key factor in the development of the steel industry, and the restrictions which they impose over successive periods must be evaluated.

A. RAW MATERIALS AND ENERGY AVAILABILITY AS A CONSTRAINT

2. Historically the production of iron, and then cast iron and steel, has been linked to the proximity of iron ore and reducing agents; charcoal (forests), then coke (coking coal). Less than thirty years have passed since six Western European States linked iron, coal and steel in the same organization (the ECSC), whilst the typology of developing countries proposed in the first UNIDO study on the world iron and steel industry was based on the existence (or absence) of iron ore and reducing agents (coking coal, forests, hydroelectric power, hydrocarbons, etc.)[1]

3. The widespread "redeployment" announced in 1974-1975[2] also comes under the same heading, to the extent that the projects specified were located in regions rich in:

- iron ore: Australia and Brazil;
- hydrocarbons (natural gas): the Libyan Arab Jamahiriya, Saudi Arabia, Trinidad and Tobago and Tunisia;
- coking coal: Australia, South Africa, etc.

History shows that, for two centuries, world steelmaking has been dominated by iron and coal bearing countries, the leading roles being played in succession as follows:

(1) "World-wide Study of the Iron and Steel Industry: 1975-2000" - UNIDO/ICIS/25, 15 December 1976

(2) Cf. on this subject "The World Iron and Steel Industry" (2nd study) prepared by the Sectorial Studies Section - UNIDO/ICIS.89 - 20 November 1978

- by Great Britain, supplying more than 50% of the world production before 1850;
- by Western Europe (Belgium, France, Germany, Great Britain and Luxembourg), supplying 68% of the world production in 1870;
- by the United States, producing 60% of the steel in 1920 and 63% in 1945;
- by the USSR, whose steel production exceeded that of the United States in 1971.

4. The general ebb and flow of the redeployment movement has shown that the existence of natural resources does not necessarily constitute a decisive variable on which to base the vitality of the iron and steel industry.

5. More than fifteen years ago, the appearance of the "waterside" iron and steel industries introduced a separation between iron and steel production on the one hand and coal basins (natural resources) on the other.

6. The recent emergence of the Japanese iron and steel industry has introduced a new element to this historical sequence. The Japanese iron and steel industry is currently the most modern in the world; between 1956 and 1976 it created a new production capacity of 137 million tonnes of crude steel - four times more than in the EEC - yet at a lower total investment price. More than 99% of Japanese steel is produced using oxygen converters (LD) and electric furnaces; approximately 60% of this steel is continuous cast, whilst automation of production has made rapid progress. Today, the whole world tends to refer to Japanese consumption standards (coke, for example) or to Japanese steel industry productivity. Unlike Great Britain, continental Western Europe, the United States and the USSR, the Japanese steel industry does not have its own iron ore or coking coal resources (or at least only to a very small extent), and it is forced to import from Australia, Brazil, Canada, India, etc.

7. The Japanese iron and steel industry is not an exceptional case, since its ideas have been copied in the Republic of Korea and other Asian countries - the Korean and Asiatic iron and steel industries are precisely

the two industries where, during the 70's, the highest growth rates of production (and of consumption) have been recorded:

+ 300% in the Republic of Korea between 1974 and 1979,
+ 400% in another Asian country between 1974 and 1979.

8. On the contrary we find that the existence of abundant local resources of iron ore or reducing agents is not sufficient to trigger off a rapid development in the iron and steel industry: Colombia, which possesses the largest coking coal reserves in Latin America, produces less than 500,000 tonnes of steel, whilst in the oil producing countries, from Saudi Arabia to Venezuela, iron and steel production is developing more slowly than was forecast a few years ago.

9. These examples show that nothing is automatic, that the energy constraint exists but that it can be more easily overcome if one is able to operate on other variables, whether technical mastery and high productivity (energy economies) or reductions in transport costs.

10. The relative reduction in supply costs to the steel industry is the consequence of the reduction in maritime transport costs. From the end of the fifties the reduction in costs of transoceanic transport, resulting from the increasing size of ore-carrying vessels, was coupled with the fall in the market price of raw materials, particularly of iron ore. These changes have made possible a spatial separation between supplies on the one hand and iron and steel production on the other.

"At the beginning of the sixties practically all countries with deep-water ports were able to obtain basic raw materials at costs which were competitive with the costs obtaining in the United States or Western Europe, that is to say by the traditional producers of those materials. The most striking example of this development took place in the second half of the fifties in the case of Japan which was able to profit from the fall in the cost of raw materials and where, for this reason, the cost of producing steel fell throughout the whole of the succeeding period[3]. The cost of raw materials

(3) Dr. Robert W. Crandall "Analysis of the current crisis in the iron and steel industries of the OECD member countries". Paper to the OECD Symposium, Paris, February 1980, pages 1 and 2.

per tonne of finished steel has varied, in Japan and in the United States, in the following manner:

Table 1

	Japan in US Dollars	United States in US Dollars	Ratio Japan/United States
1956	93.17	56.17	1.66
1966	51.18	47.28	1.08
1976	112.29	151.10	0.74

Source: Federal Trade Commission - USA
Staff Report on the U.S. Steel industry and its international competitiveness. November 1977. Table 3-1.

11. This development could be radically modified as a result of:

- an increase in the price of energy and a recovery in the price of iron ore,
- an increase in maritime freight rates, which would transform the conditions of transport of heavy products.

Such new data could operate in favour of the major producer of raw materials and energy, that is to say: Algeria, Argentine, Australia, Brazil, Canada, Mexico, Poland, Saudi Arabia, South Africa, the USSR, and Venezuela.

In this respect certain Australian authorities have forcefully emphasized the value and "need" for such a return(4).

12. However those projects being constructed, or which are envisaged up to 1990 (see Dossier I), do not seem to be influenced by these new factors. They are a continuation of past trends, and are characterized by:

(4) Statement by Sir C. Court, IISI, 13th Annual Conference, Sydney, October 15-17, 1979. Report of Proceedings, pp. 32-35.

- mainly coastal installations, in particular in Africa, Asia and the Middle East;
- supplies remaining broadly dependent on imports, even if the iron and steel production has an essentially domestic (national) destination;
- imports of coking coal: projects in Algeria, Argentina, Brazil, Iran, Nigeria, Pakistan and Syria;
- imports of high-grade iron ore: projects in Algeria, Egypt, Iraq, Libya, Mexico, Nigeria, Oman, Qatar and Saudi Arabia, etc.
- imports of scrap: projects for medium-sized or small semi-integrated units in Africa and in East and South-East Asia;
- imports of coking coal and iron ore: projects in Asia and Korea.

13. The realization of an increasing contradiction between the national usage of production and the largely international character of supplies leads to an assumption that the "return" of iron and steel production towards the sources of supply, as recommended by the Australians, for example, will not form a marked characteristic of the eighties.

In fact, it must be remembered that increases in transport costs will affect the transportation of finished or semi-finished "piece-goods" products as much as, if not more than, bulk items and that, in addition, iron and steel production based on obtaining increasingly specific qualities (linked with specific markets) will not be at all adaptable to the importation of rolled products and, even less, of semi-finished products with properties which are not under direct control and which are hence uncertain.

However it is not impossible that the "return" may occur during the following decade, after 1990. It is significant that, after several years of silence, the matter of the Australian Jumbo project has again been raised in 1980. Its implementation depends on the Japanese companies who are recipients, but who will make no actual undertaking "until the time is ripe"[5]. It seems that the time may well not be ripe before the end of the eighties.

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(5) Metal Bulletin, 1 July 1980.

B. RAW MATERIALS

Iron ore constitutes the bulk supply of the iron and steel industry

14. In spite of its bulky nature, international trading in iron ore has not ceased to develop since the first imports of haematites from Algeria and Spain were needed when the Bessemer process was introduced into Western Europe.

International trading in iron ore has undergone an increase which is more than proportional to the development of world iron and steel production, due to the cumulative effect of the following:

- the development of the Japanese steel industry, which is 100% supplied by imports,
- from the sixties, the accelerated shift of the European steel industry from locally obtained ores to high-grade imported ores (79% of the EEC supply in 1977),(6)
- the lesser movement of the American steel industry towards importing (33% of supplies in 1977, 29.1% in 1979).(7)

15. During the eighties, international trade will again increase as a result of increased participation by the developing countries.

Known and listed deposits of high-grade ores are numerous, in particular in America and Africa. It has sometimes been stated that the slow rate of entry into working has been due to the difficulties of directing capital towards this type of investment: it must be noted, however, that this reticence operates more to the detriment of certain zones in the Third World rather than rich mining deposits of the western world(8). The relatively optimistic forecasts made in 1976 estimated that by 1990 there would almost be a balance between the international supply and demand of iron ore (+0.850 million tonnes iron content in 1980 to -7.350 million tonnes in 1990). A slower increase in the demand, which corresponds to the existing

(6) "Acier Arabe" No. 3, 1980

(7) Ditto and "Revue de Métallurgie", May 1980

(8) 4 countries (Australia, Brazil, Canada and Sweden) would supply 60% of exported ore and 8 countries (the above plus India, Liberia, South Africa and the USSR) would supply 85%.

forecasts, should thus theoretically result in an approximate balance between supply and demand. In fact this slowing-down of the demand may result - in the absence of guarantees of sales and the availability of capital - in holding back the opening of several mines: this could eventually result in shortfalls, together with a loss of profit for the economies affected in this way: most of these, such as Guinea and the Ivory Coast, are in Africa.

16. The development of international trading in iron ore is accompanied by a constant increase in the quality of imported ores; their average iron content rose from 40% in 1940 to 57% in 1971[9]. The trend towards a demand for high-grade ores and a high level of purity should increase during the eighties due to combined pressure from the following:

- the need for maximum economy in materials and energy in the predominant standard process (blast furnace, LD steelworks);
- the need to supply new direct reduction plants with high-grade and pure ores.

17. This could cause an increasing devaluation of local deposits, either because the content or composition of the ore does not meet international standards, or because the capacity is insufficient to interest those with the necessary capital to exploit them. The weight of "the international imperative" thus risks slowing down the investigation and construction of iron and steel plants adapted to local resources, resulting from a preconceived favourable opinion of plants included in an international supply trade in accordance with the "standards".

18. This highlights those discretionary guiding factors which can be used by the main actors when importing raw materials or developing iron and steel techniques. This is one aspect of the "return" constraint which the iron and steel industry exerts upstream on the mines, in accordance with the impulses which it receives from downstream.

(9) See J. Astier, C.I.T. No. 10, 1975.

19. In this respect, it is significant that the opening of several iron ore mines in Africa or in Latin America comes into competition with European, American and, in particular, Japanese steel producers who are both suppliers of capital and purchasers of ore. Whilst the Wologisi project seems to be slumbering in Liberia, the Brazilian project at Carajas is coming back to life: here and there we find the same iron and steel industrialists. Furthermore the rapid implementation of the Guelb project in Mauretania depends on both the sustained interest of the European iron and steel producers and the solidarity of Arab capital.

20. At the beginning of 1980, the actual increase of 34% in iron ore prices recorded in January of that year was termed an "irresistible increase".(10) In fact it was a limited adjustment which occurred following a long erosion of ore prices in constant terms; it is estimated that this adjustment should be accelerated in order to achieve a level which will make new mining investments more attractive.

The evolution of iron ore prices has been unfavourable when compared not only with the evolution of oil and coking coal, but also with the average price of steel products(11).

Table 2

	1968	1979
Iron ore	100	189
Average for exported Japanese steel products	100	321

21. The weak negotiating power of iron ore suppliers may also be gauged from the fact that the CIF price of ore does not differ with the source of the ore: where imports to Japan are concerned, this leads to

(10) "Usine Nouvelle" No. 6, 7 February 1980

(11) Cf. Source Acier Arabe, No. 3, 1980.
The price of oil was multiplied by 6.5 and the price of coking coal by 5 during the same period (ending April 1979). Cf. also Voest Alpine: "Contribution to the world iron and steel 1990 scenarios" by G. Meindl - July 1980, p. 72. In Japan the CIF price of iron ore increased on average 89% between 1970 and 1979, whilst during the same period the price of steel products increased by 221%.

an FOB Chile price which is 20% less than the FOB Australia price. Under these conditions the relative cost of the iron ore required for producing one tonne of steel tends to fall, since it only represents 10% (or less) of the cost of standard steel and even about 1% of the cost of certain high-grade steels[12].

22. Supplies of iron ore have given rise to concern for the future because of the slowing-down or halting of the opening up of new mines.

Six or seven years ago it was estimated that the opening up of new mines with a production capacity of 200,000 tonnes was in hand, whilst an additional 300,000 tonnes of capacity was envisaged.

These prospects are now considerably reduced. In June 1982 the projects in hand amounted to only 85 million tonnes (excluding China, the Popular Democratic Republic of Korea and the USSR). Projects at concept and feasibility study stage amounted to 280 million tonnes[13]. Ignoring problems of the quality and type of iron ores and their price it seems that there will not be any shortfall in actual supplies needed to realise the productions of iron and steel projected in the normative and, a fortiori, the low growth scenarios.

However constant surveillance is necessary as a function of changes in the iron and steel economic climate. It is also necessary not to lose sight of the fact that an adjustment in the ore supply and demand, in the event of a massive iron and steel recovery, would necessitate investments in the mining sector which would have to be added to the financing needs of the iron and steel sector.

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(12) Very special steels over US$ 2500 per tonne.

(13) Estimate of the Association of Iron Ore Producers and Exporters (APEF) - 29 June 1982.

Scrap

23. Scrap constitutes an important raw material for the iron and steel industry, providing approximately 40% to 45% of its iron supplies (of which 25% is bought from outside[14].

24. Scrap is used as a raw material, in particular by three types of iron and steel industries:

- steel industries in the older industrial countries where the size of the steel stock ensures an abundant supply: the United States, West Germany and the USSR;
- the more recent and dynamic iron and steel industries with poor iron ore and coking coal supplies: Italy, the Republic of Korea and the other Asiatic countries;
- small iron and steel industries in countries with a low level of industrialization, where the supply is frequently insufficient to meet even limited requirements.

Scrap makes up 56% of the Italian iron and steel industry supplies, and 100% in the case of Uruguay and Angola. It will account for 60% to 70% when the Tunisian steel industry is extended.

25. Scrap, a product with a high energy content, is a future asset in the original industrialized countries where the steel stock is so extensive that it guarantees a continuously increasing supply[15].

Table 3

	Consumption of scrap in kg per tonne of crude steel	Exports of scrap (thousands tonnes)
F.R. of Germany	397	1,028
Great Britain	550	837
USA	512	5,033
USSR	555	1,800

(14) Paper from W. Philips to the AIME Congress, New Orleans, 1979. With regard to scrap, see also the numerous works from the EEC, Geneva.

(15) Source Stahl und Eisen No. 10, 19 March 1980, page 512, quoted by Voest Alpine, doc. cit. page 64.

Some go so far as to estimate that the world is on its way, in the very distant future, towards a steel industry founded 80% on the conversion of scrap. Meanwhile the supply of scrap available in the Federal Republic of Germany from 1990 onwards will very likely cover 50 to 60% of its steel production(16).

26. The price of scrap undergoes extreme fluctuations; at a time of crisis it is at its lowest, but it rises in price sharply when circumstances return to normal:

	US$/t(17)
April 1974	111
Peak 1974	144
October 1977	< 45
July 1978	70
February-March 1980	130, then 150 (170?)

Whenever prices flare up many projects relating to sponge iron production (as a replacement for scrap) reappear, in the industrialized countries, only to be "frozen" again when prices fall. The prospects for the eighties show that 2 to 3 million tonnes of sponge iron will be required by the Japanese iron and steel industry to supplement its scrap supply; the Eurofer estimate for the same period (1985 - 1990) gives the same order of magnitude; it is also probable that neither the United States nor Europe will take a decisive interest in this route during the eighties because of the abundant availability of scrap and also because of changes in the price of energy.

27. Developing countries are, generally, short or very short of scrap; when they are hydrocarbon producers direct reduction processes allow them to substitute sponge iron for scrap. Others have to import the required scrap directly or indirectly in the form of old vessels delivered for scrap to Pakistan, the Republic of Korea and another Asian country.

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(16) 30 to 38% comes from the collection of old scrap. Source "Stahl und Eisen" page 513 (Voest Alpine, doc. cit. page 55).

(17) See Usine Nouvelle, 13.7.1977, 22.9.1977 and 17.11.1977. Revue de Métallurgie, July 1978, Metal Bulletin 26 February 1980, etc.

Ferro-alloys

28. The component metals in these alloys represent only a small percentage in steel production.

In 1976 United States steel production was made up as follows[18]:

- For 128,000,000 short tons of crude steel:

Manganese	:	900,000 (short tons)
Chromium	:	410,000
Silicon	:	347,000
Aluminium	:	200,000
Nickel	:	19,000
Vanadium	:	6,800
Colombium	:	1,466
Tungsten	:	754
Cobalt	:	314

29. Future requirements for ferro-alloys will be affected by two contradictory trends: economies in costly materials on the one hand and production of steels of ever-increasing quality on the other; the resultant of these trends is probably in favour of the second.

30. Until recent times their production was largely in the hands of the more advanced countries. Today numerous developing countries are engaged in their production (see Table 4 below).

31. Ferro-alloy production is being redeployed towards alloying-metal producing countries with good supplies of energy, or towards basic metal producers[19], but the new plants require massive investments (US$ 400/tonne for ferro-manganese). American, European and Japanese steel producers, with close control over production techniques, are moving carefully in this direction, taking account of supply security criteria as well as production costs[20]. In this respect the exploitation of sea-bed nodules will be a

(18) Iron and Steel - Bureau of Mines - July 1978, page 15

(19) See Metal Bulletin, 12 October 1979.

(20) Cf. the recent closure of Ugine Aciers' plant in the Ardoise.

factor to be taken into account during the period 1990-95, but certain estimates put forward for 1985 seem already to be somewhat premature[21].

Table 4

Country	Production
Argentina	Fe/Si Fe/Mn
Brazil	Fe/Mn (5) [a] Fe/Si (5) Fe/V (2) Fe/W (2) Fe/Cr (1) Fe/Mg (1) Fe/Mo (1) Fe/Ti (2) Fe/Cb (1) Fe/Ni (1)
Chile	Fe/Mn Fe/Si
Egypt	Fe/Si
India	Fe/Mn (5) Fe/Si (1) Fe/Cr (1) Fe/Mo (1) Fe/Ti (1) Fe/W (1)
Mexico	Fe/Mn (2)
Nigeria	Ferro-mobium
Philippines	Fe/Cr Fe/Si
Republic of Korea	Fe/Mn Fe/W
South Africa	Fe/Cr
Turkey	Fe/Cr Fe/Si
Venezuela	Fe/Si Fe/Mn
Zimbabwe, Republic of	Fe/Cr (2)

Source: Metal Monthly Bulletin, September 1977, C.I.D. - May 1979

(a) The number of plants producing ferro-alloys is shown in brackets.

(21) General report to the President of the United States for the year 2000, according to which the exploitation of deposits will guarantee the United States the following from 1985 onwards: 14% of their nickel requirements, 2% of their copper requirements, 62% of their cobalt requirements and 28% of their manganese requirements.

C. ENERGY

32. A consensus can be seen on the major importance of energy to the steel industry during the eighties.

The iron and steel industry is, in fact, a major energy consumer: in the advanced countries it is the main industrial energy consumer.

3.8% of the domestic consumption in the United States,
7 to 8% of the domestic consumption in France,
16 to 17% of the consumption in Japan(22).

The iron and steel industry alone consumes more energy than is used in the production of all other metals.

33. The iron and steel industry is thus affected by the energy crisis, and this has led firstly to large-scale measures designed to economise on energy: the performance of Japanese companies is well known in this field, and secondly to attempt to diversify usable energy sources, such as coking coal, charcoal, natural gas, etc.

34. However, the industry is also interested in the development of a new energy source which is capable of providing new outlets which are both quantitative and qualitative. The application of new energy sources will be reflected in investments which will use steel(23). The Voest Alpine report estimates that the magnitude of these steel requirements will allow the recovery of world steel production(24). However it will be seen below that these prospects are far from being obvious.

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(22) Nippon Steel News, December 1979, and "Actualités Industrielles Lorraines", November 1980, page 225.

(23) Munich Conference, September 1980 - where the required annual investment was estimated as US$ 500 billion.

(24) Voest Alpine - doc. cit.

Coking coal

35. The use of coking coal is linked with the standard route of blast furnace/oxygen-type steelworks. Although experts estimate that this system will remain predominant during the eighties it is important to ask questions about the limiting nature of coking coal supplies.

36. It will be noted that the price of coking coal has undergone a moderate increase compared with the rise in the price of oil[25].

Table 5

	1952-1956	1971	April 1979	May 1980
Coking coal	100	200	532	540
Oil (Arabian light)	100	100	658	1,062

37. According to the listed resources, there will be no short-fall of coking coal[26] in the eighties or in subsequent decades. Steel industry operations broadly based on the recovery of scrap would possibly permit a reduction in the consumption of coking coal.

38. On the other hand, there is a problem regarding coking plants: the United States and Europe are slow in replacing their old coking plants, even more so in manufacturing new plants.

39. However, reserves of coking coal are very unevenly distributed. The industrialized countries control substantially all the production, whilst the majority of the developing countries (with the exception of China, Colombia and India[27] have almost none. Thus, regardless of the abundant

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(25) Index 1980. Institute of Economic Research, Hamburg, in Voest Alpine, op. cit., page 74.

(26) See "Stahl und Eisen" 28 July, 1977 - "The Economist", 17 May 1980 - in Voest Alpine, op. cit. pages 61 and 65.

(27) In Africa there is no coking coal except in South Africa. In any case the operation of new plants installed in developing countries to 1990 will not require more than 25-30 million tonnes of coke, i.e. much less than the requirements of Japan alone. For its part India has to import high-quality coking coal: more than 1 million tonnes were imported in 1979-80 from Australia and Canada.

world-wide availability of coking coal, numerous developing countries are primarily interested in ensuring greater autonomy by the possibility of using other sources of energy, such as charcoal, hydrocarbons (natural gas) or non-coking coal (low-grade coal).

Charcoal

40. Charcoal was used for iron and steel making up to the end of the XVIIIth century (beginning of the XIXth century), but was then replaced by coke in the blast furnaces. However it is still used in some countries, mainly Brazil, and also on occasions in Argentina and Malaysia.

During the last few years charcoal, which produces high quality cast iron, has had a new lease of life. Projects have been investigated in the Camerouns and Philippines and, in particular, in Brazil where several blast furnaces operating on charcoal are under construction (Belgo-Mineira, Acesita) and where the Brazilian Iron and Steel Production Institute estimates that the production of charcoal-based cast iron should increase from a little over 4.0 million tonnes in 1980 to approximately 10 million tonnes in 1990[28], assuming rational industrial exploitation of the forests.

There is always the question of damage done to forests, either as a result of savage felling[29] and their long-term disappearance, or because of the sterilizing effect of intensive forest exploitation on the soil, leading finally to the same result.

41. Whatever the circumstances, it is probable that the use of charcoal as a reducing agent will open up a channel for certain countries in Africa (Camerouns project), America (Honduras and Paraguay projects) or Asia (Malaysia and Philippines) located in the tropical zone, by permitting them to start up small-scale production plants in the proximity of national iron deposits based on their domestic requirements, for example in the Congo, Gabon, etc.

(28) See IBS Congress, Rio de Janeiro, April, 1980

(29) Which allows an acceptable price to be obtained for charcoal.

Hydrocarbons: natural gas

42. Examination of the 1990 projects has shown that numerous direct reduction projects were currently under way or starting in hydrocarbon-producing developing countries, 95% using natural gas. We also know that several direct reduction projects using natural gas were abandoned or frozen in the United States, Great Britain, Spain, etc., following the increase in the price of gas which is catching up on the price of oil[30]. In fact whenever natural gas is substituted for oil it cannot be considered economic as a reducing agent. On the other hand whenever available gas is likely to be wasted, either because it is toxic, because it is difficult to find an interesting local use, or because it would be too costly to liquefy it for export, it becomes a potential reducing agent of considerable interest.

This interest arises when reduction processes which are more economic in energy requirements are gradually being introduced (HYL III and MIDREX processes), and when there is no other national reducing agent. We know this to be the case with numerous Latin American, African and Asiatic hydrocarbon-producing countries.

43. Several investigations have emphasized the extent of the potential that toxic natural gas alone represents for oil countries. If it were used as a reducing agent it is estimated that the gas wasted by OPEC in 1977 would have made it possible to produce 345 million tonnes of sponge iron, 250 million tonnes of this being from Algeria, Iran, Nigeria and Saudi Arabia[31].

Toxic gas continues to be wasted because it is too costly, at the present time, to envisage its liquefaction or direct export. Venezuela has in particular shown the way by constructing its iron and steel industry on the simultaneous utilization and valorization of this gas.

(30) Orders of magnitude of corresponding prices (per 10^6BTU):

Oil	>US$ 6.0
Gas	>US$ 4.0
Coal	>US$ 2.0

(31) Cf. Stahl und Eisen, 25 August 1980. "Entwicklung der Eisenschwammerzeugung in der Welt".

Non-coking coals (low-grade coals)

44. Numerous direct reduction processes based on the use of non-coking coal are available; however at the present time these processes have only achieved a limited use in industry (about 5% of all the direct reduction projects). Many countries which do not have coking coal do, however, have non-coking coal (including low-grade coals). It must not be forgotten that non-coking coals are increasingly likely to be sought as substitutes for oil and petroleum products for the production of thermal energy: the result of this will be that the price of coals which can be converted into coke will tend to follow the price of oil more closely than the price of coking coal, so that direct reduction using coal will be affected by the increasing price of energy(32).

45. It nevertheless remains a fact that the use of non-coking coal as a reducing agent constitutes, and will constitute, an interesting possibility for those developing countries which do not have any other resources. It will be necessary for direct reduction processes based on coal to be the subject of sufficient attention on the part of those who are developing the techniques, so that they can be used under conditions of the highest efficiency and economic performance. This is a question which seems to have been solved in certain cases (New Zealand)(33).

46. In conclusion, therefore, energy represents a constraint for the iron and steel industry. Coking coal exists, but its increasing price, less rapid than that of oil, leads one to assume that the relative contribution of the cost of energy in the cost of steel production (more than 20% of the cost of the steel at the present time) will tend to increase.

47. Possibilities exist for countries which do not have coking coal to overcome the resultant constraint:

(32) Cf. Voest-Alpine report - doc. cit.

(33) New advances seem to be taking place in this field, cf. the new Korf, DRC, etc. processes, and not overlooking the Swedish Plasmared process.

- by using charcoal: this use is limited by ecological considerations and the social cost,
- by the use of natural gas, provided that the price of the gas used is totally dissociated from the price of oil, so that it can be maintained at around US$ 0.3 to $0.6/10^6$ BTU (or the equivalent of US$ 1.7 to 3.4/barrel of oil),[34]
- by the use of low-grade coal, provided that its price can be dissociated from the price of steam coal, and that reliable processes are developed,
- and on the assumption that other reducing agents (plasma, arc, nuclear energy) cannot become effective before the next decade[35].

Water

48. Water is an essential raw material in iron and steel production. From 80 to 200 m^3 of water are required in the production of one tonne of crude steel[36]. To the extent that only 3 m^3 of this quantity is actually evaporated it is possible to reduce the quantity of water used considerably (below 20 m^3/tonne of steel) by means of recycling operations, the cost of which is obviously more than progressive. Assuming a consumption of 20 m^3 of water per tonne 40 million m^3 per year are needed for the operation of an integrated complex producing 2 million tonnes of steel. This quantity corresponds to the consumption of a town of 800,000 inhabitants, at a rate of 150 litres per person per day, or the irrigation of 4,000 to 5,000 hectares which would be capable of producing either the annual cereal requirements for 125,000 inhabitants (200 kg per person per year) or the annual requirements of vegetables for 2,000,000 persons (75 kg per person per year)[37]. It is therefore a limiting factor, in particular in the desert countries of the Saharan or even Mediterranean regions.

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(34) Cf. J. Astier in SEAISI Quarterly - October 1980, p. 24

(35) Irrespective of the interest of the new Swedish process based on the use of plasma.

(36) See "Environmental control in the iron and steel industry" - IISI, Brussels, 1978 and "Environmental pollution control in the iron and steel industry" - Jack B. Carmichael - 1978 - UNIDO internal note.

(37) Estimating the yields per hectare as 5 tonnes of cereals and 30 tonnes of vegetables.

49. The constraint can be lifted in these regions by sea-water desalination, provided that energy is available at low price, for example by using toxic natural gas or gas which it is difficult to export. The desalination cost must in any case be compared with the cost of more intense water recycling, taking into account costs arising from the effluent disposal and the gains obtained by the recovery of waste products.

Pollution problems

50. The reduction of pollution corresponds to the demand for a "better quality of life" which is becoming more and more pressing, in particular in the more industrialized countries. In the case of the iron and steel industry this imperative applies externally, for the protection of the environment and of the urban or rural populations involved, but also internally, for the protection of thousands and sometimes tens of thousands of workers engaged in the operation of the iron and steel unit.

51. It has often been assumed, explicitly or implicitly, that developing countries were prepared to accept the effects of pollution as an inevitable counterpart of a rapid industrialization process.

In fact it is clear that, during the eighties, and from the many statements made by the Group of 77 on this subject, the reduction of pollution from the iron and steel industry will become a major objective, even in the developing countries, so as to reduce urban pollution which has already reached disturbing levels and so as to make the working conditions of iron and steel employees acceptable, whilst at the same time encouraging their productivity[38].

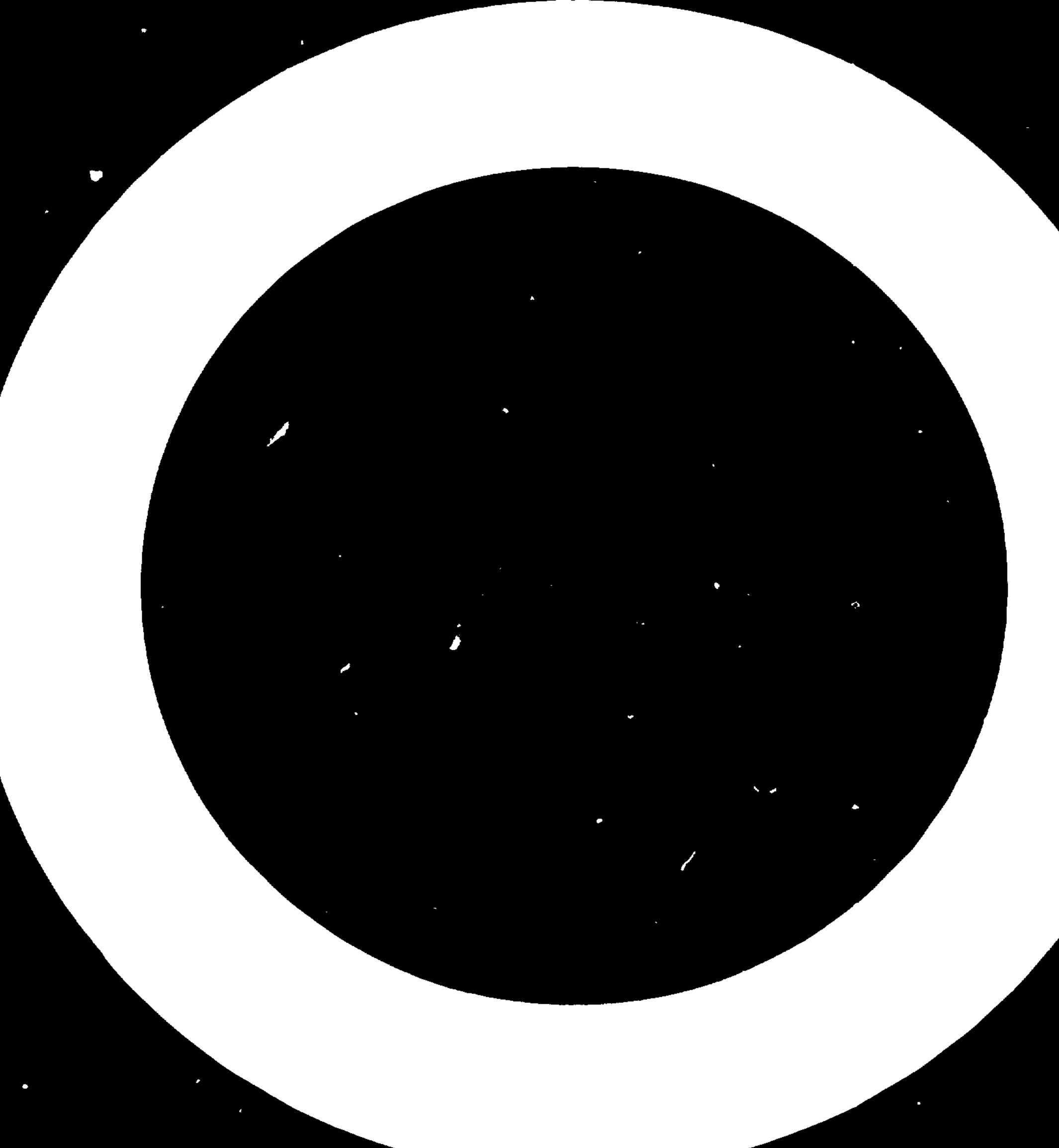
52. The reduction in pollution represents an additional cost for the developing countries, since it is estimated that the cost of anti-pollution installations represent about 12 to 20% of total investments in the advanced countries. This cost increases the difficulties of financing iron and steel installations; by contrast it makes it possible to obtain additional gains as a result of the reduction in the consumption of water, and the recovery of

(38) The reader who is interested in these specific problems may refer to the documents prepared for the UNEP/UNIDO meeting of experts on the "Environmental and resource aspects of the direct reduction route to steel making" - Puerto Ordaz, Venezuela, 26-30 April 1982.

materials: by-products such as coke, dusts, metals, etc.[39], and the creation of an environment which is less unfavourable for workers.

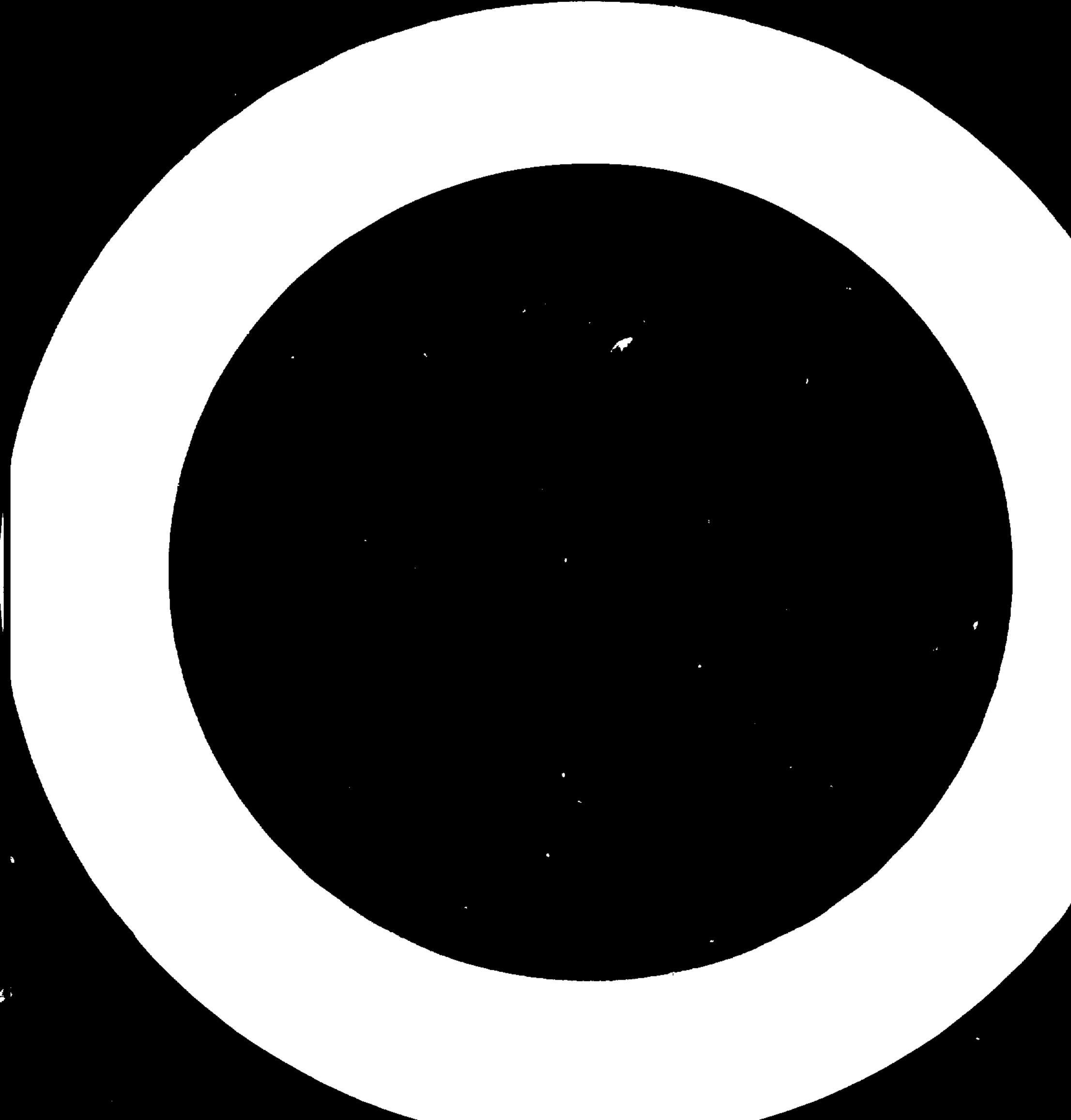
It will also be noted that the reduction of pollution is, in the final analysis, one more aspect of the technical and economic mastery of the iron and steel system.

(39) It is estimated, for example, that the French iron and steel industry could recover about 35,000 tonnes of lead and zinc.



DOSSIER III

MARKETS, PRODUCT RANGES AND SCALE ECONOMIES



I. EXTERNAL MARKETS: THE TREND IN INTERNATIONAL TRADING IN STEEL PRODUCTS

1. Exports of iron and steel products have undergone a rapid increase since 1950.

	in 10^6 tonnes(1)
1950	20.5
1955	34.0
1960	52.7
1965	78.5
1970	117.5
1975	148.2
1979	181.7

2. Their rate of increase has exceeded the rate of increase in iron and steel production. This was equal to the average rate of increase of international trading in 1967 and 1974, but slightly less during the following period 1974 to 1977.

(2)

Average annual rate of increase in world trade		
	Iron and steel products	All products
1967-1974	9.3	9.3
1974-1977	5.7	7.4

3. This slowing-down is explained by a pronounced decline in internal trading between market economy countries (60% of total trade in 1972 to 49% in 1977, partially offset by an acceleration in trade towards developing countries and countries with centrally planned economies)(3)

(1) IISI statistics - Crude steel equivalent

(2) UNIDO documents on the general development of industry - ICIS - Global and Conceptual Studies Branch

(3) Trends in the market for finished and semi-finished products of iron and steel, 1972-1977.

In any case, the proportion of exports in world steel production has steadily increased:

	as %
1950	10.7
1955	12.6
1960	15.9
1965	17.2
1970	19.7
1975	22.9
1979	24.9

4. Between 1970 and 1979 flat products continued to represent approximately 45% of the trade, but their relative share, and the share of ingots and semi-finished products, declined, whilst the share of long products increased slightly and the share of pipes and tubes rose from 12.5% in 1970 to 16.4% in 1979. (Tables 1 and 1a)[(4)].

	Ingots, semi-products and rails	Long products	Flat products	Pipes and tubes	Total
1970	11.5	29.4	46.6	12.5	100
1979	6.9	31.8	44.9	16.4	100

5. During the period 1970-1979, the respective weights of the major exporters changed considerably: Europe and the United States represented 87.1% of world exports in 1950, but their share had fallen to 48.1 in 1979, the

(4) Other statistics available for 1972 and 1977 (Economic Commission for Europe) show approximately the same tendency.
The importance of long products and tubes reflects the increasing role of the developing countries, which are consumers of these products, in international trading:

	Ingots, semi-finished products	Long products	Flat products	Pipes and tubes	Total
1972	14	30	45	11	100
1977	17	33	38	12	100

balance being taken over by Japan, other European countries, the USSR and European countries with a centrally planned economy and, to a lesser extent, by the developing countries (Diagram 1).

6. During this period, the respective weights of importers also changed (see Table 2).

7. Apart from Japan the weights of the main steel producing regions increased (Diagram 2).

	1950	1979
EEC	19.2%	29.0%
United States	7.0%	11.4%
USSR and Eastern bloc countries	4.8%	13.5%

whilst the relative weights of other countries and developing regions dropped, except for Asia (see Table 2, Diagram 2).

8. Within the framework of this trend in international trade in iron and steel products it is useful to specify the part played by the developing countries. The tables in the annex summarize the main facts.

9. In the first place developing countries are steel importers. Their imports rose from 14,023,000 tonnes in 1970[5] to 33,135,000 tonnes in 1979 (see Tables 3 and 4).

These imports represented:

15.2% of the world total in 1970,
25.3% of the world total in 1975,
23.5% of the world total in 1979.

The increase was faster for long products and pipes than for semi-finished and flat products.

10. Exports from the developing countries are tending to increase, but are relatively modest:

(5) Not including Southern Europe

2.6% of world exports in 1970,
2.2% of world exports in 1975,
5.6% of world exports in 1979(6).

11. The overall steel trade balance for the developing countries showed an increasing deficit during this period:

11,582,000 tonnes in 1970,
26,401,000 tonnes in 1975,
25,392,000 tonnes in 1979.

Imports satisfy a large part of the consumer requirements in developing countries; and this part has increased steadily.

12. The propensity of the developing countries to export is also tending to increase, in particular from 8.1% in 1970 to 9.1% in 1979 in Latin America and from 13.7% in 1970 to 17.9% in 1979 in Asia. Certain developing countries are becoming net exporters, in particular:

- Brazil, now a net exporter, selling finished products (sheet and coils) to the Federal Republic of Germany, Japan, the mediterranean countries, Mexico and the United States;
- The Republic of Korea, selling heavy plate, coils and heavy girders in South-East Asia, Japan and the United States; Korean steel exports rose to US$ 2,340 million in 1981 instead of US$ 276m in 1975(7);
- Venezuela, whose exports increased from 71,983 tonnes in 1979 to 231,935 tonnes in 1980 (including 136,000 tonnes of coils and 46,000 tonnes of machine wire).(8)

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(6) The relative share of the various product groups having evolved as follows between 1972 and 1977 (as a percentage of world exports)

	Ingots and semi-finished products	Long products	Flat products	Pipes and tubes
1972	1	2	1	2
1977	4	3	1	3

(7) Metal Bulletin, 12 February 1982

(8) Source: Venezuelan customs.

By contrast India, a net exporter in 1970 and 1975, became a net importer in 1979 with a negative balance of 1,544,000 tonnes and is likely to remain such for a long period[9], whilst Mexican imports continue to rise, from 899,000 tonnes in 1975 to 3,153,000 tonnes in 1980 (including 1,830,000 tonnes of flat products and tubes)[10].

13. Irrespective of the speed of certain evolutions it does not seem that the production of the new iron and steel industries in the developing countries are likely to "swamp" the markets of industrialized countries, a fear which has sometimes been expressed, because these new steel exporting flows are not so much the result of systematic aggressive strategies, but are caused by:

- technical constraints, when a large plant is commissioned and its production temporarily falls out of line with the rate of increase in the domestic demand;
- production quality control reasons, where the exporting of limited quantities permit the level of national production to be tested on international markets;
- currency balancing requirements, the gain in foreign currency resulting from exports of steel products tending to balance the outflow of currency necessary for imports of iron ore, coking coal and equipment;
- the signing of compensation or buy-back agreements by which imported equipment and services are paid for by selling part of the production of the new installation;[11]

together with the corresponding evolutions in the economic situation, for example:

. the entry into production in the Republic of Korea of a 5 million tonne strip mill,

. or again a fall in domestic consumption, as has been seen in Brazil since 1981, and which has to be progressively re-absorbed.

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(9) Metal Bulletin, 15 December 1981.

(10) Source: IMIS - 1982

(11) See agreements now being negotiated in India for the Vizakapatnam, Mangalore, etc. projects.

14. It will also be noted that the development of European exports of iron and steel products shows, in recent years, increasing sales in the direction of Latin-American and Asiatic countries which are in the process of developing their iron and steel industry. This is, in particular, the case with French exports:

French exports (in thousands of tonnes)

	1960 to 1966	1967 to 1973	1974 to 1980
Brazil	117	173	565
India	237	17[illegible]	382
Mexico	18	60	403
Republic of Korea	3	13	395
Venezuela	308	236	465

Source: CSSF

which are also developing to Tunisia after a slowing-down due to the entry into production of the Menzel Bourguiba steelworks in 1966:

French exports (in thousands of tonnes) to Tunisia

1960 to 1966	1967 to 1973	1974 to 1980
227	263	358

Source: CSSF

15. Finally it will be seen that the evolution of these tonnages does not take changes in values into account. Whilst Japanese exports in 1981 reached their lowest volume since 1974 their value had never been higher.

16. Nevertheless, it will be noted with interest that certain trends seem to correspond to an intensification of regional inter-relationships, i.e.:

- the appearance of new exporters on the European periphery who prefer to direct their sales towards the EEC:

Balance of external trading in iron and steel products in 10^6 tonnes (crude steel equivalent)		
	1974	1978
Finland	- 0.51	+ 1.00
Spain	- 0.5	+ 4.36

- the orientation of Brazilian steel exports, of which 88.8% went towards the American continent in 1972 (67.7% to Latin America and 21.1% to North America) but 92.8% in 1977 (38.5% to Latin America and 54.3% to North America)(13).
- or the trend in the pattern of trade in South-East and East Asia, as shown in the following tables:(14)

These trends converge: they show that Japan has lost part of its regional market to the new exporters, whilst the regional market tends to become the main outlet of these new exporters.

17. It will be recalled that the relative decline in the dominant exporters (Japan or the EEC) reflect the current change from mass exports to more qualitative exports: special steels, high tensile steels, coated sheet or products of first-stage converting, in particular welded pipes for oil and gas pipelines or weldless pipes for the oil and chemical industries, Japan being by far the leading world exporter of pipes.

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(12) Source: OECD, quoted by Voest Alpine, doc. cit. p. 48.

(13) EEC statistics - Geneva

(14) "Forecast on demand and supply of steel in eight countries" - Japan Iron and Steel Exporters' Association - August 1980.

Imports of steel products into eight Asiatic countries (ASEAN + Republic of Korea + other Asiatic countries) Growth of suppliers' shares				
	1976	1977	1978	1979 (estimate)
Japan	83	78	72	68
Other countries:	17	22	28	32
EEC	3	5	8	7
Republic of Korea	1	3	3	5
Other Asiatic countries	1	1	4	4
Other new exporters	9	10	11	13
Others	3	3	2	3
Total	100	100	100	100

Destination of iron and steel exports from the Republic of Korea						
	1974	1975	1976	1977	1978	1979 (Jan - June)
United States	63.7	39.7	38.3	51.9	56.7	33.7
Japan	4.2	2.6	3.1	3.3	9.3	15.9
7 other Asiatic countries	10.8	11.6	7.9	21.0	16.0	29.0
Others	21.3	46.1	50.7	23.8	18.5	21.3
Total	100	100	100	100	100	100

Destination of steel exports from other Asiatic countries						
	1974	1975	1976	1977	1978	1979
United States	42.1	10.6	19.2	21.8	24.0	5.2
Japan	4.2	4.9	0.2	1.9	4.4	25.4
7 other Asiatic countries	19.4	34.1	29.3	26.2	49.5	54.4
Other countries	34.3	50.4	51.3	50.1	22.1	15.0
Total	100	100	100	100	100	100

It is also explained by the advantages inherent in exporting converted steel products, machinery, equipment or turnkey industrial plants, thus permitting them to be valorized. In fact, one tonne of steel processed from US$ 50 of iron ore is worth approximately US$ 500, whilst a motor vehicle is sold at a price of approximately US$ 6000/tonne, giving the following proportions[15]:

Ore	=	1
Steel	=	10
Vehicle	=	120

18. These trends lead one to question the internationalization content of an increasing portion of iron and steel production, gradually affecting a number of developing countries. These trends seem to be less a result of the predominating initiative of large international manufacturing centres and trade (integrated iron and steel groups, Japanese shoshas) within the framework of the process described by P. Drucker as "production sharing" than of national initiatives tending to grant Brazil, the Republic of Korea, etc.[16] their own international trade and information systems. But it is probable that analysis will, once again, disclose the intervention of one or other in successive or simultaneous relationships of conflict and cooperation.

(15) For a 4 HP vehicle (Renault 4L) weighing approximately 750 kg and valued at US$ 5000 (before tax).

(16) Cf. creation of "Interbras" in Brazil (subsidiary of Petrobras and the creation of "General Trading Companies" in the Republic of Korea in the middle of the seventies.

B. IRON AND STEEL PRODUCTION AND THE DOMESTIC MARKET: DOWNSTREAM LINKS

19. As a priority, the development of the iron and steel industry in developing countries is orientated towards meeting the domestic demand. The increasing participation of a number of developing countries in the international steel product trade, although limited in absolute value, does not contradict this orientation: in the Republic of Korea, as in Brazil or in other Asiatic countries, steel production began by meeting local requirements before turning towards overseas markets.

The structure of production and the structure of the demand

20. The development of production structures tends to reflect the structure of the demand and the evolution of this structure, although imperfectly and with a lag.

The greatest needs in the least advanced countries come from the capital equipment and construction sectors which call on long products: concrete reinforcing rods, light and medium extrusions, rails and girders. The construction and agricultural sectors also call on drawn products, galvanized plate and pipes (irrigation, water supply, etc.). In oil countries with a low level of industrialization, the accent is on pipes (welded and weldless) and long products (infrastructures); the hydrocarbons and building and public works sectors are capable of absorbing more than 80% of the steel consumption (50% or more for building and public works alone).

21. As the industrial system becomes more complex, the demand for rolled products develops: medium and heavy plate for shipbuilding and the construction of medium or heavy equipment, then sheet for the production of durable consumer goods (cars, domestic electrical appliances).

This corresponds to the development of the iron and steel industry noted in the countries of South-East and East Asia:

- initially, production of simple long products for the building and public works sector, then welded pipes and drawn products, followed by thin sheet (from imported rolls) for galvanizing or tinning;
- then production of hot-rolled plate for the production of heavy and medium duty plate (Republic of Korea, other Asiatic countries);
- finally the mass production of thin sheet[17] (Brazil, Mexico, Republic of Korea, etc.).

A dynamic relationship is established between the complexity of an industrial system in an economy, the pattern of demand for steel products and, with a variable time-lag, the steel production organization.

Consumption of steel and gross fixed capital formation

22. The crisis which has affected the world iron and steel industry since 1974 has turned thoughts towards changes in the demand and towards those consumer sectors which exert a major influence on this development. The Institut International de la Sidérurgie in Brussels recently published the initial results of long-term work launched in this field[18].

This work questions the validity of the method of forecasting demand which has been based up to the present time on a "steel consumption intensity curve", linked with per capita income trends. It highlights the fact that the "relationship normally accepted between the growth of the national product and the demand for steel" is uncertain[19], whilst a closer relationship exists between steel consumption and gross fixed cap al formation, in particular between steel consumption and investments in capacity (as opposed to replacement or intensified technology investment)[20].

(17) See "Forecast on demand and supply of steel in eight countries in 1980", August 1980, Japan Iron and Steel Exporters' Association.

(18) "Causes of the mid-1970's recession in steel demand", Brussels 1980.

(19) IISI, op. cit., page 46

(20) IISI, op. cit., page 59.

23. Mexico gives a clear illustration of the correlation between the trends in steel consumption and in gross fixed capital formation[21]. This correlation is also found in many other cases, i.e. Colombia, Tunisia, etc.[22].

<u>The importance of the energy sector: new energies and the recovery of steel consumption</u> ?

24. The increase in oil prices has often been given as one of the major causes for the economic recession and, subsequently, the reduction in the demand for steel. Here we shall question the real impact of this event on recent trends in steel consumption, and conversely will attempt to ascertain the positive effects on the world steel industry that the forecast energy boost could trigger.

The IISI survey showed that the point of inflection of the demand curve preceding the appearance of the crisis itself was reached in certain zones from the end of the sixties, that is to say well before the so-called "*first oil shock*"[23].

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(21)

	Apparent trend in steel consumption	Trend of the GFCF*	(as % of the previous year's figure)
1968	7.6	9.6	
1969	5.5	7.4	
1970	9.3	8.3	
1971	-5.8	-3.7	
1972	14.5	13.4	
1973	25.1	16.0	
1974	16.0	8.7	
1975	3.9	6.9	
1976	-7.7	-5.6	
1977	17.9	-7.6	
1978	14.8	15.4	

Source: IISI, op. cit., page 116 + Gross fixed capital formation

(22) Cf. P. Judet: "La sidérurgie de Menzel Bourguiba" 230 pp. Tunis 1967.

(23) IISI, op. cit., pages 41 to 46.

25. However, whilst the IISI places the emphasis on the braking effect of the high cost of energy on the industrialization process (and on the recovery of investment)(24), other works emphasize the drive which the application of alternative energy sources is likely to give to steel investment and demand. The Voest Alpine survey uses different sources to confirm(25) "that the implementation of new technologies will result in a veritable investment boom in the construction of new energy (and transport) systems". This is also evident in various surveys published by the EEC, showing the expansion of all uses of steel linked with energy and transport since the eighties (production of tanks, oil and gas pipelines, electrical equipment and machinery(26).

26. The Voest Alpine study was supplemented by a paper on "Steel production and the sphere of influence of the energy situation" presented at the meeting on "The energy situation and the iron and steel industry"(27). This paper sets out, in effect, a first partially quantified inventory of the effects of the new energy situation on certain steel uses, including:

- new offshore drilling platforms: about 1 million tonnes of steel per year;
- new refineries (installations for the refining of heavy petroleum): about 2 million tonnes of steel per year;
- new drillings (from 52,000 in 1976 to 80,000 in 1980): about 5 million tonnes of steel per year;
- installations and vessels for coal transport (international trading in coal increasing from 200,000,000 tonnes to 600,000,000 tonnes per year): about 1 million tonnes of steel per year;

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(24) IISI, op. cit., page 142

(25) "Contribution to the world iron and steel 1990 scenarios", July 1980.

(26) "Objectifs généraux acier 1980-1985 et 1990" - EEC, Brussels, July 1978.

(27) Vienna 7 - 11 September 1981 - "Steel production and the sphere of influence of the energy situation" - W. Nieder, Voest Alpine AG.

- the development of rail transport, with rolling stock requirements increasing from 4,500,000 tonnes to 10,000,000 tonnes between now and the start of the next decade;
- new needs for steel as a result of the multiplication of collective urban heating networks, etc.

This study provides an initial inventory to be followed up, and concludes by stating:

- that the "energy crisis" will in this way make a contribution towards solving the "iron and steel crisis",
- and that, as a consequence, steel will remain the "material of the century".

27. Other institutes (and the ECSC) forecast a major increase in industrial investment between 1980 and 2000, this growth being based on the development of new energy and transport systems(28). The USSR forecasts the gradual replacement of oil by gas, and the increasing use of energy in the form of electricity, all operations being reflected in an increasing consumption of steel(29).

28. This is why, in order to highlight these questions more fully, the UNIDO Secretariat has carried out a "Study of the markets created for the iron and steel sector by the development and diversification of energy production" on the basis of the IIASA energy scenarios and models. This study, which is the subject of a special publication(30), attempts to measure, in quantitative and qualitative terms, the impact of new energies on the demand for steel by utilizing at the same time:

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(28) "Das Deutschland Modell" in "Bild der Wissenschaft", 1 February 1978, and Guido Brunnes, ECSC, in "Stahl und Eisen" - 3 December 1979.

(29) Soviet journal "Energietechnik", March 1977, in Voest Alpine, doc. cit., page 30.

(30) D. Launay - August 1981.

- the report of the IIASA Energy Group published under the title "Energy in a finite world: a global system analysis",
- and the Bechtel report entitled "Resource requirements: impacts and potential constraints associated with various energy futures" - 1978.

The study based entirely on the IIASA upper scenario shows that:

a) "the rise in the demand for ferrous metals for energy requirements will remain overall lower than the world economic growth" (p.9);

b) the impacts of new sources of energy, such as fast breeder reactors and the liquefaction of coal, will not make themselves felt before the year 2005;

c) up to the year 2000, and in particular up to 1990, the requirements for steel will come primarily from petroleum and gas and then from nuclear reactors (pressurized water) but will only change slowly, as can be seen from the following table:

Steel demands for primary energy supplies

	1980	1990
Total (1,000 t)	24,580	29,351 (+ 19.5%)
of which		
Petroleum	11,642	13,475 (+ 15.7%)
Gas	6,127	7,471 (+ 21.8%)
Coal	286	340 (+ 19.3%)
Nuclear (LWR)	4,548	5,889 (+ 29.5%)
Hydro-electric	1,976	2,174 (+ 10.0%)

d) the demand for alloy and stainless steels will increase only slightly faster than the demand for carbon steels (21% against 19%).

The conclusions drawn from the IIASA work therefore appear to be considerably less optimistic than the work cited above. These non-concordant statements call, therefore, for a more detailed examination and discussion, the more so since some recent information seems to show that the new energy situation will have a not unimportant impact on the iron and steel industry.

29. Mention has been made, for example, of the bottlenecks caused in American industry and engineering (specialized equipment relating to foundries, forging and the production of high grade steels)[31] for the start of the "Synfuel" programme.

Also well known is the shortfall which obtained for some months on the tube market (weldless tubes, large diameter tubes) and which resulted in a chain of initiative:

- in the United States, where the decision has been taken to construct new units for the production of tubes (US Steel - Armco Steel - CFI) so as to meet the forecast requirements[32]:

	1980	1984	1985	1986	1987	1988
Capacity, 10^6 t.	3,700	4,800	5,400	5,700	6,000	6,300
Forecast demand, 10^6 t. (weldless and welded tubes)	4,700	7,200	7,300	7,900	8,200	8,600

- In Japan, where the major iron and steel companies are increasing their production capacities for tubes so as to meet the general requirements for export and, in particular, the needs of the United States (long-term contracts), so as to maintain their share in the exporting of weldless tubes[33];
- in Europe, where an increase in exports of tubes of 23% has allowed Mannesmann to increase its production of crude steel by 2%.

30. Certain experts feel that this boom will be only a passing one, and that excess capacity in tube manufacture runs the risk of causing a collapse of the market. The recent downward changes in oil prices (at the start of 1982) have, in effect, been reflected in a sudden reduction of 20% in drilling activities in the United States[34] in a matter of a few weeks, and also by the appearance of over-stocking of tubes, rising to up to 15 months for standard grades.

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(31) Cf. Business Week - November 1980.

(32) National Supply Company in 'Metal Bulletin', 4 September 1981

(33) Japan Economic Journal, 6 October 1981.

(34) Cf. Financial Times, 2 April 1982.

31. Given the uncertainty affecting subsequent developments in the price of oil the question of the impact of the new energy data on iron and steel consumption, in quantitative and also in qualitative terms, still remains. It will be noted, on this point, that the evolution in the tonnage of alloy steels and stainless steels will not be sufficient to account for the qualitative evolution, since welded tubes and, even more, weldless tubes, are manufactured from high quality carbon steel, the production of which involves advanced technical mastery. Knowing that the Japanese steel industry has been able to apply an increase in the price of their weldless tubes for export from US$ 920 to US$ 1,200 per tonne over one year, and that Sumitomo has, during the last financial year, obtained 90% of its profits from the production of tubes, it may be asked whether the impact of the new energy demands on the iron and steel industry will not tend to be reflected:

a) in an accentuation of the differentiation between those steel industries capable of delivering products (tubular), in particular of high quality, to meet the new energy requirements on the one hand and those steel industries having to undertake a long apprenticeship to arrive at this point;

b) in a segmentation of iron and steel production, part of this production being able to impose prices and to develop on the basis of its own profits, another part experiencing the full force of world competition and only continuing to operate at the price of on-going external support.

Energy economies and reductions in the specific consumption of steel

32. Whilst the impact of a new energy situation on the evolution of the consumption of steel is still difficult to evaluate, it is, by contrast, obvious that the need to economise on energy (and raw materials) will be effectively reflected in an acceleration in the reduction in the specific consumption of steel, making technical coefficients which have been considered as quite recent very rapidly obsolescent.

Between 1970 and 1977 it has been found in the Federal Republic of Germany that the specific consumption had fallen as follows:

- from 412 to 370 kg of steel per 1000 kg of electrical machinery,
- from 873 to 668 kg of steel per 1000 kg of shipbuilding products,
- from 612 to 557 kg of steel per 1000 kg of rail rolling stock,
- from 883 to 783 kg of steel per 1000 kg of threaded goods, etc.[35]

In France the average reduction in the specific consumption exceeded 2% per year. This reduction is particularly noticeable in the automobile industry; it is likely to accelerate again when new models are launched in Europe with a low consumption of fuel (3 litres per 100 km or 80 mpUSg), possibly from the end of the 1980's.

This reduction in specific consumption results both from:

- replacement of steel by lighter materials (aluminium, plastic materials);
- of the qualitative slide, now taking place within iron and steel production itself, where ordinary steels are giving place, progressively, to steels of higher quality: high strength carbon steels, high alloy steels or, more frequently, low alloy steels. As compared with 1973 (index 100) the consumption of all steels in the EEC reached an index of 90 in 1978, whilst the consumption of fine and special steels reached an index of 97.3 in the same year. The trend is even more clearly marked in Japan where the consumption of fine or special steels (October/December 1973 = 100) reached an index of 122.9 at the end of 1978 instead of an index of 84.8 for ordinary steels[36]. The importance of this slide is such that it gives a plausible character to the forecast according to which the service given by one tonne of rolled steel in the year 2000 will correspond to the same service given by two tonnes of rolled steel in 1974[37].

The reduction in specific consumption also forms part of a more general movement which is drawing the whole of the iron and steel industry towards "quality".

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(35) Source: EEC

(36) Sh. Hosoki and T. Kono: "Japanese steel industry and its rate of development" - Communication to the Amsterdam Conference of the Metal Society, September 1979.

(37) Cf. "Les besoins en énergie de la sidérurgie de l'an 2000" - Annales des Mines - November 1978.

The demand for quality

33. Iron and steel production is being drawn towards increasingly higher quality:

- firstly under the effect of the increasing pressure of demands for economies in energy and raw materials. These economies in energies and raw materials arise from the combined action of improved control of production operations and the installation of new equipment. Automation, continuous shift working and tighter quality controls have, as their effect, not only to economise on energy and raw materials but also to obtain a more constant and higher quality from production. The search for energy economies results from the promotion of higher quality;
- secondly under the effect of the increasing demands from users;
- finally, under the effect of competition from other materials.

34. The requirements of the oil companies go back many years; they are reflected in stringent standards to which the producers of pipelines or tubes (quality of sheets and welding) must adhere; these requirements are reinforced still further as a function of the use of iron and steel products in the arctic regions, for offshore drilling, for the production of very large diameter tubes, etc.

To the requirements of the oil companies have been added, since the energy crisis, those of numerous other users of iron and steel products:

- car manufacturers, seeking lighter sheet with higher strength or sheet with better corrosion resistance;
- users of tins for food products, where aluminium is coming into competition with tinplate, are now interested in TFS (Tin-Free Steel), etc.

The users require, at the same time:

- products of increasingly high performance,
- products of consistent quality,
- products at competitive prices.

35. The iron and steel industry - and it is important to emphasise this - has ceased to be a sellers industry and has become an industry where the producer can only sell his production if it corresponds exactly to the needs of the users.

Care must be taken not to push this trend to the extreme, noting that not all uses of steel demand uniformly high quality products or products of absolutely consistent quality.

The systematic and unnecessary use of American or European standards could, in fact, lead to the exclusion of local iron and steel products which are regarded as being of inadequate quality, less as a function of the real needs of the user than because of the habits obtaining on the more sophisticated foreign markets.

The imperative for quality should not in any case become a 'superstition': it must however be taken into account within the framework of an increasingly close linkage between iron and steel producers and the users of their production.

36. In this context the effective linking of production with the domestic market implies, amongst other conditions:

- the establishment of a sales network for handling national products, sufficiently experienced and technically able not only to know the users (private or public) and to evaluate their quantitative and qualitative needs, but also to direct and support their choices and, progressively, to be able to specify by common agreement those improvements which are desired or desirable(38).

- the reinforcement of regional institutional groupings such as ILAFA, SEAISA and UAFA, providing them with the means to play a more active

(38) Cf. Amsterdam Conference, paper by K. Irvine: "Developing Steel for the Market" - September 1979.

role in the distribution and interpretation of information on the development of quality requirements for products and of standards, together with the promotion of research for the development of products adapted to the needs of local or regional users;

- regional coordination of national iron and steel industries so as to organize, on a broader and more rational basis, the satisfaction of diversified needs (in respect of quality) in the converting industries downstream of production.

The quality imperative and technological complexity

37. Within the framework of a study on the "technological complexity of the products of the iron and steel industry", a group of Soviet experts emphasize the fact that the problem of improving the quality of steels is of the greatest importance, even in the developing countries:

38. The problem of improving metal quality is of the highest importance for all countries, including the developing countries, since the use factor of metal products in various consumer countries varies between wide limits, being equal on average to 0.8. Of the remaining quantity of metals nearly 15% represents a guarantee for the safety factor, necessary because of the heterogeneity of steel. Taking into account a steel consumption factor for the production of rolled products only slightly more than half the total volume of steel produced is used in the form of finished products.

In order to evaluate the efficacy of measures for improving metal quality it is necessary to determine the relationship between the changes which have taken place in the performance of metal and its detailed use (for example, between the increase in the purity and uniformity of the metal and the increase in its strength and safety, between the increase in the mechanical properties of the metal, the reduction of products and the increase in their service life, between changes in the form of rolled products and the reduction in volume of converting, etc.).

At the level of their consumption characteristics metal products of improved quality are equivalent to a larger volume of products of ordinary quality. Furthermore the economic value is a function of the state of conversion or utilization at which the effect of the qualitative improvement is achieved. This is connected with the fact that the value of the work carried out per unit of metal product increases during its progress from the initial stage of production up to the final stage of consumption.

Investment economies in regard to direct labour, energy and capital are ensured in the iron and steel industry because of the relative reduction in the production of metals, in conversion and in equipment, because of the reduced volume of metal converted on the one hand and the reduced number of machines and equipment produced on the other.

The quality of the metal products is characterized by a large number of properties, and cannot be measured using a single tool. The comparative evaluation of the quality of the metal is carried out on the basis of the principal property considered as the most significant for a given use (for example: its strength), provided that all the other properties fall within the limits accepted for that use.

For steels of the ordinary grades, carbon steels and low carbon steels, as well as for building steels and alloy steels for the production of the metal products studied, the principal qualitative characteristics are the elastic limit and mechanical strength on static testing (or fatigue resistance) and ancillary ductility (elongation or resilience).

For the evaluation of the quality of ferrous metals standards are used which relate strictly to the chemical composition of the metal, its mechanical properties (elastic limit, mechanical strength, elongation or compression, sometimes resilience, bending tests, etc.); in this way it is possible to establish standards for the quality of the metal: hardness, macrostructure, heat treatment, etc. More than 100 different criteria have been determined which can be collected together in 10 groups (Table 14). All these criteria characterise the technological complexity of metal products and the products of the consumer industries, together with the iron and steel industry. They lead to an increase in the values of the complexity indices(39).

It is very important to determine the stage of production where the effect of qualitative improvement is achieved. This is linked with the fact that complex work, together with expenditure in energy and capital, increases from the initial stage of production to the final stage. Economy in expenditure for the steel production processes and rolling are reflected in reduced waste during the metallurgical process.

The utilization of metals in mechanical engineering, characterized by better strength properties and more rational ranges of rolled metal products, ensures a reduced consumption, increases the productivity of labour and in this way reduces production and construction costs.

The use of machines constructed with improved metal reduces the cost of operation and makes it possible to minimise the stock of machines, energy capacities, etc. In this way the qualitative improvement spreads downstream of the iron and steel industry and results in overall economy in expenditure on labour, energy and capital.

(39) This analysis is based on standards in force in the USSR, and the information is extracted from the study: "Technological complexity of iron and steel industry products - Contribution to the World 1990 iron and steel scenarios" - Moscow, May 1982, prepared by a group of Soviet experts: Messrs. N.I. Perlov, L.V. Kovalenko, N.F. Sklokin and V.V. Shchepansky, headed by Prof. V.A. Romenets.

C. SCALE ECONOMIES

39. "Drawback of size" is the title of an editorial in the "Metal Bulletin"[40] which once again draws attention to the vulnerability of large units as a result of their difficulty in adapting to rigid changes in the environment and in the demand[41]. Large iron and steel plants probably reached their maximum size in the mid-seventies, whilst mini-steel units, far from corresponding to a passing phase, have now been confirmed as a successful and lasting innovation, not only in Italy where the "Bresciani" have given proof of their vitality but equally on the European periphery in Spain and Greece and also in the more dynamic iron and steel industries of the developing countries, even including the United States.

At the present time there are 17 projects for mini or medium iron and steel projects under study or construction in the United States (extensions for a capacity of 9,625,000 tonnes)[42] and 10 projects under study or construction in an Asian country (approximately 750,000 to 1,000,000 tonnes of new capacity).

Furthermore those responsible for the Brazilian iron and steel industry have stated that the development of this industry will now place the emphasis on small and decentralized units[43].

40. Today experience shows that "scale economies" are an economic phenomenon which have to be evaluated in their overall content and not only in terms of costs per installed tonne which, theoretically, decrease. It is necessary to take account of the fact that:

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(40) 18 November 1980, page 19.

(41) Cf. Metal Bulletin of 9 May 1978 regarding the vulnerability of large units and the statement of Herr Speer (FRG) to the effect that "the new plants of tomorrow will not necessarily be synonymous with giant plants", or again Metal Bulletin, 10 July 1978.

(42) Information communicated by members of the Working Group on the Iron and Steel Industry at UNIDO/IS.

(43) Metal Bulletin, 20 January 1981.

- a large unit involves the risk of inflexibility and an inability to adapt rapidly to a changing environment;
- scale economies are quickly cancelled out by low market shares or by too slow an entry into full production;
- the advantage of large size varies with the level of very high transport costs, which may fully justify a small plant which could be too easily described as "uneconomic" (but in what context ?).

The more an iron and steel unit becomes not solely an articulated assembly of equipment but a company closely linked with its upstream and downstream units, the more its efficient operation will depend on mastery of the entire system. Recent Chinese experience shows the difficulties encountered at the Wuhan plant where the hot rolling mill is operating at a reduced level due to a shortage of energy in sufficient quantity, or at the giant Paoshan complex where completion has been held back as a result of cumulative problems(44). The reality of scale economies goes hand in hand with efficiency in management. This is why it is not possible to deal with scale economies without referring to size education, that is to say progress in stages towards the mastery of systems.

41. This questioning of scale economies has already opened the door, for a large number of medium and small developing countries, to the iron and steel industry, whereas this would have been regarded as totally impossible a few years ago. Referring to the list of projects in Dossier I about 30 small or very small iron and steel units are now being constructed or studied(45). This is an important advance, the more so since the mini-industry can be integrated into various routes:

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(44) Cf. Financial Times of 14 November 1980 and Metal Bulletin of 20 January 1981: the second stage of the complex has, for the present, been cancelled.

(45) Excluding those units in course of realisation in Brazil, India, Mexico, the Republic of Korea and another Asian country.

- electric furnace, supplied with scrap,
- electric furnace, supplied with pre-reduced ore, but also
- small blast furnace, using coke like El Foulaah in Tunisia (400 t/oven), or using charcoal, of the Brazilian or Malaysian type (150 t/oven), followed by an LD steelmaking unit
- open hearth furnaces, generally regarded as on the way to disappearance, but the flexibility (using scrap and cast iron) and ease of operation of which have retained the attention of Algeria which is now doubling the capacity of its Wahran unit (45,000 tonnes x 2 = 90,000 tonnes) by building a new open hearth furnace[46].

42. The promotion of mini-plants in the developing countries does, however, call for some clarification in regard to size, cost and viability.

The mini-plants in the Brescia region in Italy have an average capacity of 100,000 tonnes a year, 50,000 tonnes per year apparently representing a threshold.

The new American mini-plants have capacities of 300,000 to 500,000 tonnes per year. This is also the capacity of the mini-plants announced by the USSR. This confirms the impression that the mini-iron and steel industry, starting from production capacities of 100,000 tonnes a year or less, is now tending towards considerably higher levels.

In a large number of developing countries, on the other hand, smaller plants can be seen, with projects of capacities of 50,000 tonnes per year, falling to 20,000 and even 10,000 tonnes per year in several African countries.

It does not seem, however, that the viability conditions of these micro-plants will be entirely satisfactory: whereas the mini-iron and steel [illegible]stries established in Italy, Europe or in the United States have a cost [illegible]onne installed which is less than US$ 500 the cost of a micro-plant with

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(46) [illegible]t is true that account must be taken of the lower cost of energy in [illegible]lgeria.

a capacity of 20,000 tonnes per year can rise to more than US$ 2,000 per tonne: this is reflected in amortization and financial costs reaching US$ 300 for each tonne produced, more than the cost of a tonne of concrete reinforcing rod on the world market.

This indicates that the possibilities opened by the mini-iron and steel units should be listed with care, taking into account:

- all the possibilities offered, not only by the technique of the electric furnace supplied with scrap or pre-reduced ore, but also involving the technique of small blast furnaces using either coke or charcoal, and also employing the open hearth furnace technique;
- the conditions of economic viability, and, in particular, the minimum size below which it is inadvisable to fall. Is the "threshold" around 50,000 tonnes per year, or is it possible to reduce this even lower, and if so to what level ?

At all events it will be recalled, in this respect:

a) that the only direct reduction processes suitable for sizes of less than 100,000 t per year are:

- either direct reduction processes using coal, which are still largely at an experimental stage,
- or processes for direct reduction using natural gas of the "Kinglor-Meteor" type, the applications of which outside Italy are still limited to a single unit in Burma (20,000 t/year);

b) that the supply of scrap for an electric furnace, even of modest capacity (20,000 t/year), presents a difficult problem in a small and little-industrialized country.[47]

Identification of the viability conditions for mini and micro-plants is a necessary undertaking which needs to accompany the new impulse given to research on the miniaturization of iron and steel production.

(47) Entry into the iron and steel industry may be through the installation of a rolling mill supplied with imported billets.

For, whilst the interest of the industrialized countries is satisfied with a relative "miniaturization" of production units for concrete reinforcing rods of 100,000 to 500,000 tonnes capacity, which are well adapted to the size of regional markets, numerous developing countries need, for their much more reduced markets, new solutions which would involve, amongst other things:

- the miniaturization of entire integrated or semi-integrated production units down to 50,000 and even below 50,000 t/year;
- the development of direct reduction units matching these dimensions;
- the development of rolling mills for flat products, making it possible to utilize production capacities of less than 200,000 t/year (of the Steckel Sendzimir type).

It will also be necessary for priority orientations to be given to research, considering the preoccupations and interests of the most disadvantaged developing countries, rather than those preoccupations and orientations which have normally been dominant in the most advanced countries.

STATISTICAL ANNEX

Table 1

World-wide exports of steel by products

(1000 tonnes)

	1970	1972	1974	1976	1978	1979
Ingots and semi-products	6,651	4,696	6,297	6,795	5,333	5,604
Track (rail) equipment	668	663	995	1,188	951	1,038
Extrusions	6,592	7,877	10,984	10,052	10,425	9,831
Square and round bars	6,636	7,071	12,180	10,785	10,504	12,502
Wire rod and wire	5,387	6,208	8,256	7,419	8,239	8,158
Long products	18,615	21,156	31,420	28,256	29,168	30,491
Plate and strip	29,599	35,432	45,202	38,843	44,030	42,938
Pipes and tubes	7,724	8,605	12,848	13,530	15,789	15,482
Total	63,257	70,552	96,762	88,612	95,271	95,553

Source: IISI, Steel Statistical Yearbook, 1980

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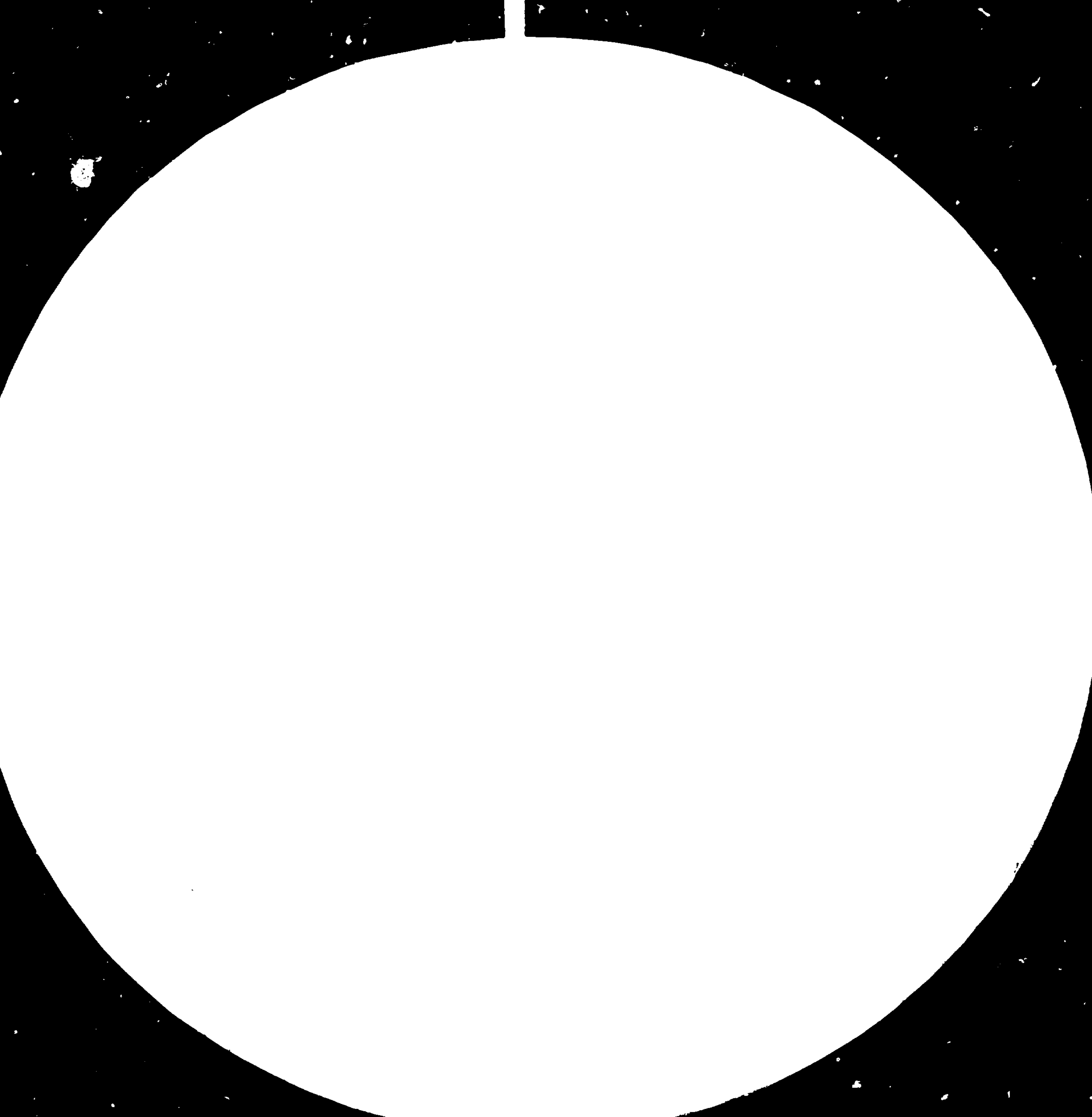

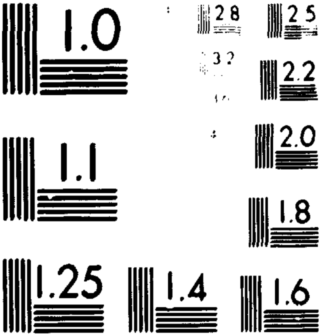

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Table 1/a

Structure of world-wide steel exports by products

(percentages)

	1970	1972	1974	1976	1978	1979
Ingots and semi-products	10.5	6.7	6.5	7.7	5.6	5.9
Track (rail) equipment	1.1	1.0	1.0	1.3	1.0	1.1
Extrusions	10.4	11.1	11.4	11.3	11.0	10.3
Square and round bars	10.5	10.0	12.6	12.2	11.0	13.1
Wire rod and wire	8.5	8.8	8.6	8.4	8.6	8.5
Long products	29.4	29.9	32.6	31.9	30.6	31.9
Plate and strip	46.8	50.2	46.6	43.8	46.2	44.9
Pipes and tubes	12.2	12.2	13.3	15.3	16.6	16.2
Total	100.0	100.0	100.0	100.0	100.0	100.0

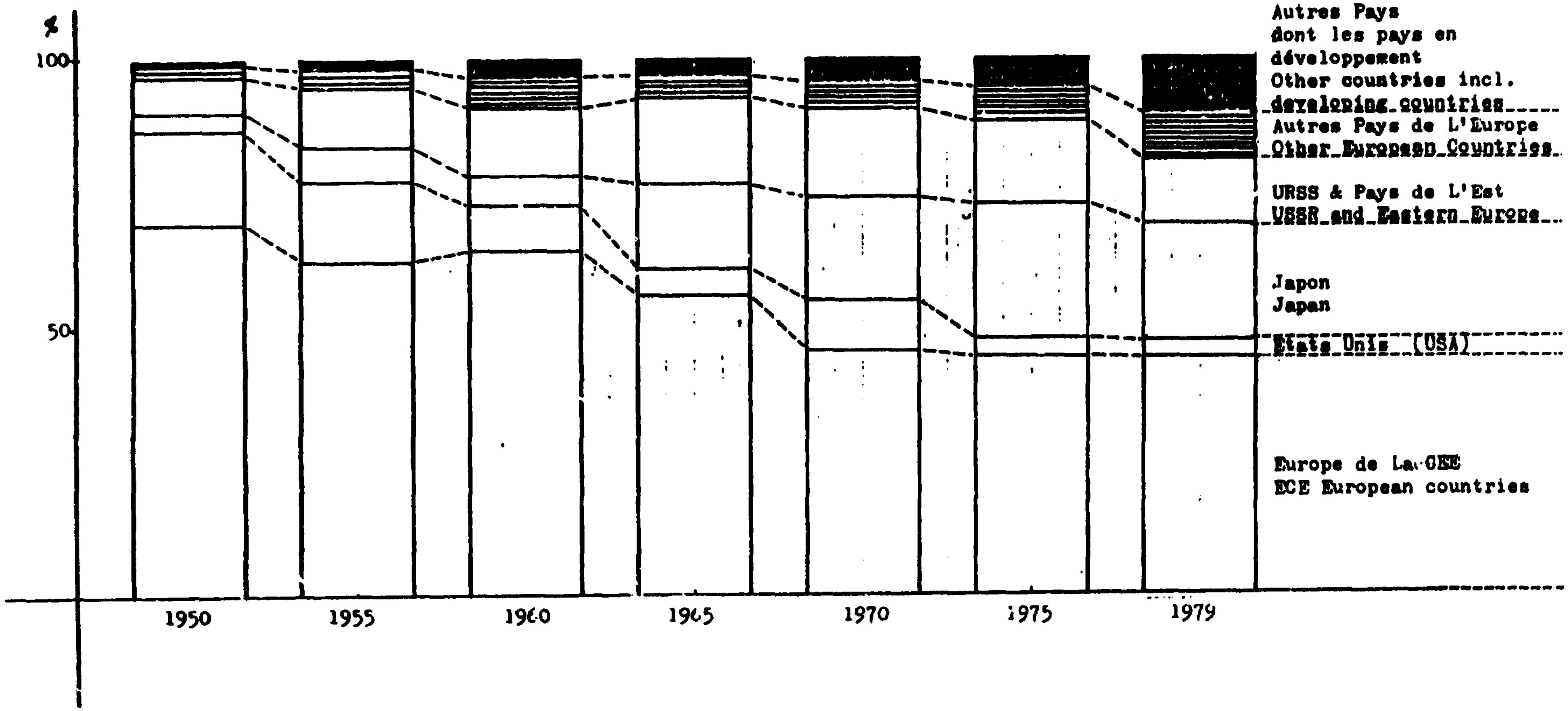
Source: IISI, Steel Statistical Yearbook, 1980

Graphique 1

Diagram 1

Structure des Exportations Mondiales de l'Acier[1]

Structure of the World-wide Exports of Steel[1]



Source: IISI, Steel Statistical Yearbook. 1980

1/ Les échanges intra-européens et intra CEAM compris.
Inter-european and inter-CMEA exchanges included.

Table 2

Structure of world-wide steel imports and exports by regions (*)

Exports

(as percentages)

	Europe (EEC)	United States and Canada	Japan	USSR and Eastern European countries	Other European countries	Other countries (a)
1950	69.6	17.5	3.4	7.1	1.9	0.5
1955	62.7	15.6	6.8	10.9	3.2	0.7
1960	64.5	8.6	5.5	13.2	6.2	2.0
1965	56.0	5.1	16.0	16.2	4.5	2.2
1970	45.8	8.9	19.4	16.6	5.1	4.2
1975	44.9	3.6	25.4	15.3	6.4	4.4
1979	44.3	3.8	22.0	12.5	8.9	8.6

Imports

	Europe (EEC)	United States and Canada	USSR and Eastern European countries	Other European countries	Latin America	Africa and the Middle East	Asia	Other countries
1950	19.2	7.0	4.8	14.4	13.4	13.8	11.7	15.6
1955	31.4	2.9	6.4	13.5	12.7	10.5	11.9	10.7
1960	33.3	6.7	15.2	12.1	7.4	8.3	10.2	6.7
1965	27.8	14.8	13.3	12.5	5.2	8.1	8.5	9.9
1970	34.7	13.1	13.1	11.9	3.7	6.9	9.5	7.0
1975	26.6	9.4	16.7	10.9	7.6	12.5	10.9	5.3
1979	29.0	11.4	13.5	8.5	4.9	9.6	16.6	6.5

Source: IISI, Statistical Yearbook, 1980

(*) Inter-European and inter-CMEA exports and imports included

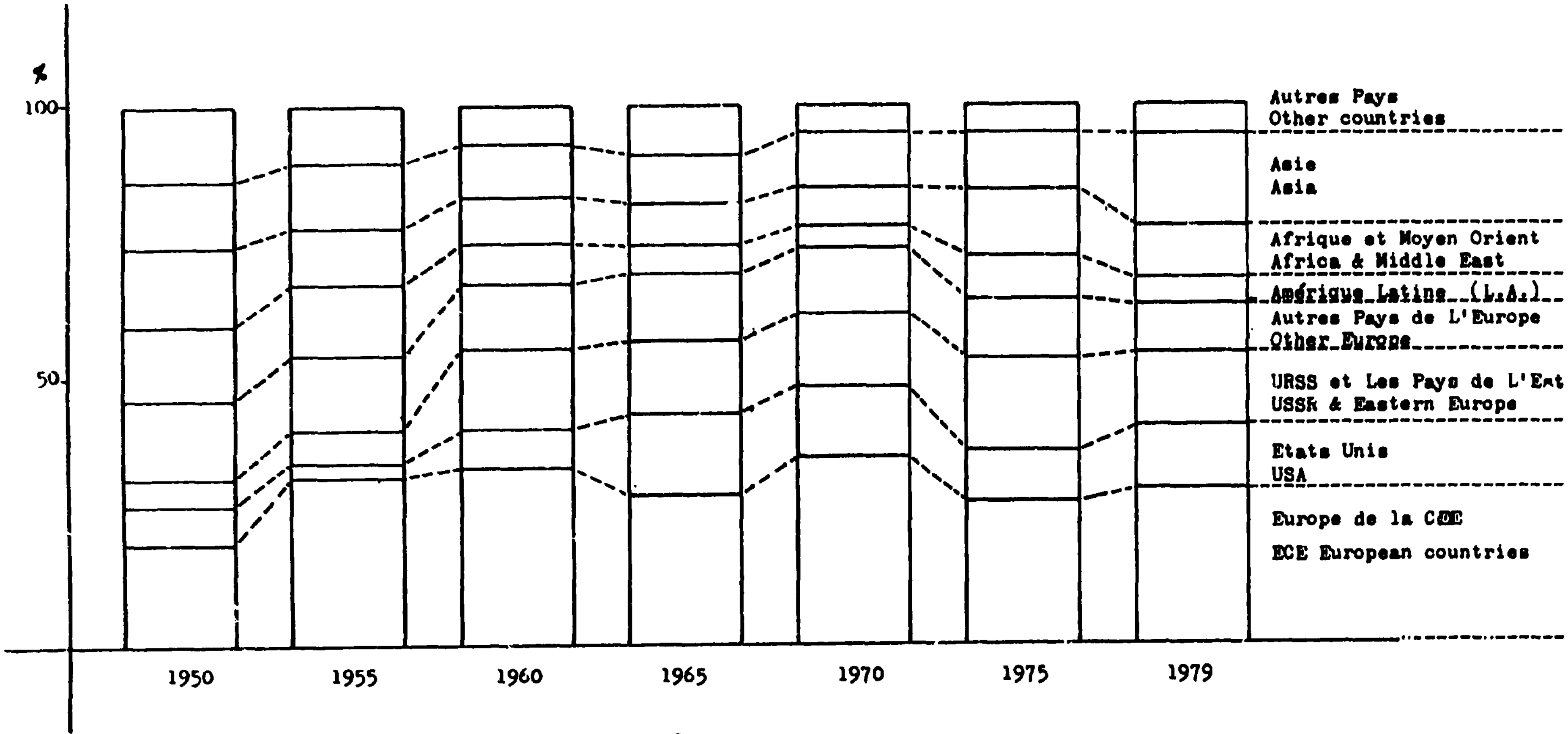
(a) Including developing countries

Graphique 2

Diagram 2

Structure des Importations Mondiales de l'Acier[1/]

Structure of the World-wide Imports of Steel[1/]



Source: IISI, Steel Statistical Yearbook, 1980

1/ Les échanges intra-européens et intra-CEAM compris.
Inter-european and inter-CMEA exchanges included.

Table 3. Imports and exports - developing countries

(1000 tonnes)

	Imports			Exports		
	1970	1975	1979	1970	1975	1979
Africa	2,592	3,286	3,456	-	-	-
Latin America	3,135	8,069	6,348	1,060	372	2,479
Asia	5,628	8,103	13,831	1,381	2,157	5,262
Southern Europe	1,222	2,824	2,545	220	375	582
Middle East	2,668	9,472	9,498	-	-	-
Total for developing countries	15,245	31,754	35,678	2,661	2,904	8,323
World total	90,396	113,987	139,764	90,396	113,987	139,764
Percentage	16.9	27.9	25.5	2.9	2.5	6.0
World total, excluding intra-regional trading	59,553	79,665	99,684	59,553	79,665	99,684
Percentage	25.5	39.8	35.8	4.5	3.6	8.3
Total for developing countries (excluding Southern Europe) - Percentage	15.2	25.3	23.5	2.6	2.2	5.6
Total for developing countries, excluding intra-regional trading - Percentage	23.5	36.3	33.2	4.1	3.2	7.8

Source: IISI, Steel Statistical Yearbook, 1980

Table 4

Imports and exports of steel: developing countries

(1000 tonnes)

Countries	Imports			Exports		
	1970	1975	1979	1970	1975	1979
Greece	536	666	945	179	334	482
Portugal	439	497	650	41	26	100
Turkey	247	1,661	950	-	15	-
Southern Europe	1,222	2,824	2,545	220	375	582
Argentina	753	1,771	585	253	41	539
Brazil	579	2,889	620	583	149	1,484
Chile	91	54	32	12	89	76
Colombia	262	233	363	-	-	-
Mexico	188	696	1,573	208	67	270
Peru	174	290	80	-	-	-
Venezuela	543	1,311	1,147	-	-	-
Other Latin American countries	545	825	1,948	4	26	110
Latin America	3,135	8,069	6,348	1,060	372	2,479
Algeria	170	903	1,042			
Kenya	124	90	202			
Morocco	246	373	289			
Nigeria	469	1,030	650			
Tanzania	61	52	43			
Tunisia	54	121	2			
Zaire	131	75	24			
Zambia	45	49	-			
Other African countries	1,292	593	1,204			
Africa	2,592	3,286	3,456			

(cont'd)

Table 4 (cont'd)

Countries	Imports			Exports		
	1970	1975	1979	1970	1975	1979
Egypt	165	842	632			
Iran	947	3,993	1,482			
Iraq	339	1,485	2,097			
Kuwait	105	252	392			
Lebanon	228	234	238			
Libya	193	593	523			
Saudi Arabia	172	1,005	2,356			
Syria	206	356	646			
Other Middle Eastern countries	313	712	1,132			
Middle East	2,668	9,472	9,498			
Hong Kong	481	491	1,375	63	27	50
India	598	723	1,604	686	739	60
Indonesia	388	963	1,302			
South Korea	600	1,677	2,678	80	931	3,188
Malaysia	366	528	800	32	14	75
Pakistan	522	405	572			
Philippines	869	596	900	99	2	20
Singapore	616	1,209	1,337	67	185	319
Other Asian countries	645	938	2,063	345	249	1,520
Thailand	543	573	1,200	9	10	30
Asia	5,628	8,103	13,831	1,381	2,157	5,262

Table 5

Steel foreign trading balance
in the developing countries
(1000 tonnes)

	1970	1975	1979
Southern Europe	- 1,002	- 2,449	- 1,963
Latin America	- 2,075	- 7,697	- 3,869
Africa	- 2,592	- 3,286	- 3,456
Middle East	- 2,668	- 9,472	- 9,498
Asia	- 4,247	- 5,946	- 8,569
Total deficit	12,584	28,850	27,355
Total deficit (excluding Southern Europe)	11,582	26,401	25,392

Source: IISI, Steel Statistical Yearbook, 1980

Table 6

Steel foreign trading balance in the developing countries
(1000 tonnes)

	1970	1975	1979
Greece	- 357	- 332	- 463
Portugal	- 398	- 471	- 550
Turkey	- 247	- 1,646	- 950
Southern Europe	- 1,002	- 2,449	- 1,963
Argentina	- 500	- 1,730	- 46
Brazil	+ 4	- 2,740	+ 864
Chile	- 79	+ 35	+ 44
Colombia	- 262	- 233	- 363
Mexico	+ 20	- 629	- 1,303
Peru	- 174	- 290	- 80
Venezuela	- 543	- 1,311	- 1,147
Other L.A. countries	- 541	- 799	- 1,838
Latin America	- 2,075	- 7,697	- 3,869
Algeria	- 170	- 903	- 1,042
Kenya	- 124	- 90	- 202
Morocco	- 246	- 373	- 289
Nigeria	- 469	- 1,030	- 650
Tanzania	- 61	- 52	- 43
Tunisia	- 54	- 121	- 2
Zaire	- 131	- 75	- 24
Zambia	- 45	- 49	- -
Other African countries	- 1,292	- 593	- 1,204
Africa	- 2,592	- 3,286	- 3,456
Egypt	- 165	- 842	- 632
Iran	- 947	- 3,993	- 1,482
Iraq	- 339	- 1,485	- 2,097
Kuweit	- 105	- 254	- 392
Lebanon	- 228	- 234	- 238
Libya	- 193	- 593	- 523
Saudi Arabia	- 172	- 1,005	- 2,356
Syria	- 206	- 356	- 646
Other M.E. countries	- 313	- 712	- 1,132
Middle East	- 2,668	- 9,472	- 9,498
Hong Kong	- 418	- 464	- 1,325
India	+ 88	+ 16	- 1,544
Indonesia	- 388	- 963	- 1,302
Rep. of Korea	- 520	- 746	+ 510
Malaysia	- 334	- 514	- 725
Pakistan	- 522	- 405	- 572
Philippines	- 770	- 594	- 880
Singapore	- 549	- 1,024	- 1,018
Other Asian countries	- 300	- 689	- 543
Thailand	- 534	- 563	- 1,170
Asia	- 4,247	- 5,946	- 8,569

Table 7

Trends of developing countries towards foreign trading

(percentages)

	Trend towards exporting(1)			Trend towards importing(2)		
	1970	1975	1979	1970	1975	1979
S. Europe	10.2	13.3	14.3	34.3	52.3	38.7
Latin America	8.1	2.0	9.1	17.6	29.2	19.5
Africa	-	-	-	66.5	52.3	44.8
Middle East	-	-	-	51.7	72.0	65.6
Asia	13.7	14.0	17.9	37.7	37.8	38.3
Total for the developing countries	11.0	8.1	13.9	33.6	42.9	36.6

Source: IISI, Statistical Yearbook, 1980

(1) TE = Exports/Production as %

(2) TI = Imports/Production as %

Table 8

	Exports production %			Imports consumption %		
	1970	1975	1979	1970	1975	1979
Greece	39.8	50.2	48.2	60.7	51.6	52.1
Portugal	10.6	5.9	14.9	49.0	48.0	50.0
Turkey	-	1.1	-	13.9	54.0	27.4
Southern Europe	10.2	13.3	14.3	34.3	52.3	38.7
Argentine	13.9	1.9	16.8	22.9	41.3	16.3
Brazil	10.8	1.8	10.7	9.5	25.7	4.9
Chile	2.0	17.5	11.8	11.4	9.6	4.5
Colombia	-	-	-	38.2	27.0	50.4
Mexico	5.4	1.3	3.9	4.5	11.2	17.8
Peru	-	-	-	37.8	29.9	14.5
Venezuela	-	-	-	33.6	55.7	40.5
Other L.A. countries	-	-	-	-		-
Latin America	8.1	2.0	9.1	17.6	29.2	19.5
Algeria	-	-	-	23.1	64.3	49.7
Kenya	-	-	-	-	-	-
Morocco	-	-	-	73.7	76.4	41.3
Nigeria	-	-	-	72.2	74.5	63.4
Tanzania	-	-	-	-	-	-
Tunisia	-	-	-	31.2	37.6	0.3
Zaire	-	-	-	-	-	-
Zambia	-	-	-	-	-	-
Other African countries	-	-	-	-	-	-
Africa	-	-	-	66.5	52.3	44.8
Egypt	-	-	-	17.9	53.2	45.1
Iran	-	-	-	54.4	74.2	48.1
Iraq	-	-	-	75.5	73.9	76.8
Kuweit	-	-	-	47.9	71.2	77.5
Lebanon	-	-	-	82.6	80.4	55.5
Libya	-	-	-	47.3	75.7	62.2
Saudi Arabia	-	-	-	40.0	71.3	63.1
Syria	-	-	-	76.3	75.9	63.4
Other M.E. countries	-	-	-	-	-	-
Middle East	-	-	-	51.7	72.0	65.6
Hong Kong	63.0	22.5	41.7	74.3	67.7	74.7
India	10.9	9.2	0.6	9.3	8.5	13.3
Indonesia	-	-	-	65.0	66.5	64.9
Rep. of Korea	16.6	46.7	41.9	46.9	53.8	38.5
Malaysia	26.2	7.6	36.2	60.4	71.0	76.2
Pakistan	-	-	-	75.0	75.4	76.3
Philippines	88.4	0.6	5.0	64.3	54.8	58.4
Singapore	58.8	98.4	(*)	77.0	(*)	(*)
Other Asian countries	98.6	24.6	35.8	ND	ND	ND
Thailand	5.9	4.0	6.8	68.5	51.7	63.2
Asia	13.7	14.0	17.9	37.7	37.8	38.3

(*) transit zone

Table 9. Imports of primary forms in 1975
(SITC 672)

Quantity in metric tonnes
(developing countries having iron and steel projects)

Ranking	Country	Quantity
1	Argentina	1,193,906.79
2	Brazil	860,963.30
3	Iran	566,593.14
4	Korea, Rep. of	564,143.99
5	Venezuela	421,423.53
6	Iraq	368,450.09
7	Philippines	286,474.12
8	Mexico	181,513.14
9	Thailand	118,390.85
10	Singapore	101,258.95
11	Indonesia	95,775.75
12	Nigeria	73,519.00
13	Egypt	60,503.04
14	Algeria	60,249.09
15	Saudi Arabia	59,546.62
16	Ecuador	43,287.07
17	Burma	29,300.76
18	India	25,250.00
19	Jordan	24,213.55
20	Syrian Arab Republic	23,776.15
21	Morocco	17,238.17
22	Colombia	15,783.10
23	Cameroon, United Rep. of	14,631.58
24	Malaysia	14,109.16
25	Tanzania, United Rep. of	11,617.00
26	Peru	9,679.23
27	Ivory Coast	8,099.47
28	Bolivia	5,830.26
29	Trinidad and Tobago	5,436.87
30	Libyan Arab Jamahiriya	4,517.07
31	Zambia	1,218.34
32	Honduras	777.32
33	Zaire	512.93
34	Chile	490.69
35	Paraguay	447.96
36	Bahrain	352.34
37	Liberia	194.75
38	Ghana	180.46
39	Togo	8.00
40	Senegal	2.18
41	Congo	0.10
	TOTAL	5,269,665.91

Table 10. Imports of long products in 1975
(SITC 673 + 676 + 677)

Quantity in metric tonnes
(developing countries having iron and steel projects)

Ranking	Country	Quantity
1	Iran	1,217,427.92
2	Iraq	738,984.47
3	Brazil	561,661.67
4	Algeria	507,304.07
5	Nigeria	457,593.00
6	Libyan Arab Jamahiriya	414,154.94
7	Indonesia	386,177.23
8	Singapore	366.468.97
9	Morocco	270,035.65
10	Korea, Rep. of	265,530.95
11	Egypt	217,113.27
12	Malaysia	211,747.05
13	Venezuela	206,510.93
14	Saudi Arabia	204,271.88
15	Mexico	192,808.82
16	Syrian Arab Republic	165,884.05
17	Thailand	139,270.43
18	Ghana	123,968.30
19	India	113,123.00
20	Philippines	87,051.67
21	Tunisia	76,634.34
22	Trinidad and Tobago	76,419.99
23	Ecuador	70,978.57
24	Zambia	67,551.25
25	Peru	60,893.10
26	Argentina	54,287.03
27	Tanzania, United Rep. of	35,278.00
28	Ivory Coast	33,507.98
29	Zaire	33,500.02
30	Jordan	31,453.54
31	Chile	29,752.74
32	Bolivia	29,317.36
33	Gabon	28,914.38
34	Colombia	25,665.92
35	Kenya	24,059.00
36	Senegal	18,652.03
37	Cameroon, United Rep. of	18,086.30
38	Honduras	15,676.10
39	Bahrain	15,160.00
40	Togo	10,733.82
41	Paraguay	10,358.28
42	Congo	8,651.34
43	Burma	7,384.59
44	Liberia	5,886.24
45	Central African Republic	825.69
	TOTAL	7,638,715.88

Table 11. Imports of flat products in 1975
(SITC 674 + 675)

Quantity in metric tonnes
(developing countries having iron and steel projects)

Ranking	Country	Quantity
1	Iran	1,718,098.26
2	Brazil	1,335,122.99
3	Argentina	511,940.95
4	India	494,866.00
5	Singapore	470,454.24
6	Indonesia	379,530.08
7	Korea, Rep. of	328,298.06
8	Nigeria	325,312.00
9	Thailand	299,248.71
10	Venezuela	281,105.28
11	Mexico	252,007.40
12	Algeria	224,178.49
13	Ghana	199,340.36
14	Philippines	186,836.25
15	Colombia	167,609.93
16	Iraq	163,720.92
17	Egypt	115,101.34
18	Peru	99,279.78
19	Morocco	88,770.55
20	Syrian Arab Republic	74,551.52
21	Libyan Arab Jamahiriya	56,668.29
22	Zambia	51,261.55
23	Kenya	51,083.00
24	Ecuador	50,308.01
25	Saudi Arabia	49,815.66
26	Tunisia	41,726.38
27	Ivory Coast	38,542.17
28	Trinidad and Tobago	32,809.19
29	Tanzania, United Rep. of	28,930.00
30	Burma	26,051.60
31	Chile	25,708.84
32	Zaire	25,364.74
33	Malaysia	17,771.03
34	Bolivia	16,405.52
35	Senegal	15,554.40
36	Jordan	14,721.75
37	Bahrain	10,414.65
38	Honduras	9,315.82
39	Cameroon, United Rep. of	7,716.26
40	Gabon	7,191.92
41	Paraguay	6,307.85
42	Liberia	4,330.80
43	Congo	3,073.73
44	Togo	3,036.37
45	Central African Republic	592.73
	TOTAL	8,310,175.37

Table 12. Imports of tubes and pipes in 1975
(SITC 678)

Quantity in metric tonnes
(developing countries having iron and steel projects)

Ranking	Country	Quantity
1	Iran	659,299.04
2	Nigeria	351,543.00
3	Indonesia	201,328.49
4	Algeria	181,364.71
5	Libyan Arab Jamahiriya	165,341.26
6	Venezuela	149,171.50
7	Trinidad and Tobago	141,979.32
8	Brasil	125,611.44
9	Egypt	105,925.04
10	Peru	104,854.53
11	Mexico	83,588.37
12	India	81,817.00
13	Syrian Arab Republic	63,650.78
14	Malaysia	54,872.51
15	Iraq	54,864.93
16	Gabon	48,004.50
17	Ecuador	46,280.95
18	Korea, Rep. of	31,628.83
19	Bolivia	29,724.92
20	Bahrain	29,552.9[illegible]
21	Philippines	28,417.04
22	Burma	28,126.15
23	Saudi Arabia	26,664.87
24	Colombia	24,324.74
25	Morocco	23,384.41
26	Jordan	19,120.16
27	Tanzania, United Rep. of	16,334.00
28	Ghana	11,925.26
29	Chile	11,819.06
30	Thailand	11,292.01
31	Tunisia	10,048.70
32	Zambia	9,811.42
33	Argentina	8,911.23
34	Ivory Coast	8,042.87
35	Cameroon, United Rep. of	8,012.11
36	Zaire	7,959.63
37	Senegal	7,355.70
38	Kenya	6,302.00
39	Togo	3,509.18
40	Honduras	3,142.43
41	Congo	1,977.15
42	Liberia	1,951.32
43	Paraguay	1,012.70
44	Central African Republic	536.42
	TOTAL	2,990,384.62

Table 13. Total imports of iron and steel products in 1975 (SITC 672 to 678)

Quantity in metric tonnes
(developing countries having iron and steel projects)

Ranking	Country	Quantity
1	Iran	4,161,41[illegible].38
2	Brasil	2,887,359.40
3	Argentina	1,769,046.01
4	Iraq	1,326,020.43
5	Nigeria	1,207,967.00
6	Korea, Rep. of	1,189,601.84
7	Indonesia	1,062,811.57
8	Venezuela	1,058,211.26
9	Algeria	971,096.37
10	Singapore	938,182.17
11	India	715,056.00
12	Mexico	709,917.74
13	Libyan Arab Jamahiriya	640,681.56
14	Philippines	588,779.09
15	Thailand	568,302.02
16	Egypt	4[illegible]8,642.70
17	Morocco	399,428.80
18	Saudi Arabia	340,299.05
19	Ghana	338,182.17
20	Syrian Arab Republic	327,862.51
21	Malaysia	298,499.76
22	Peru	274,706.66
23	Trinidad and Tobago	256,645.38
24	Colombia	233,383.70
25	Ecuador	210,854.62
26	Zambia	129,842.58
27	Tunisia	12[illegible],409.43
28	Tanzania, United Rep. of	92,159.00
29	Burma	90,863.12
30	Jordan	89,509.[illegible]
31	Ivory Coast	88,1[illegible]
32	Gabon	84[illegible]
33	Kenya	81[illegible]
34	Bolivia	81,[illegible]
35	Chile	67,771.[illegible]4
36	Zaire	67,337.[illegible]
37	Bahrain	55,479.95
38	Cameroon, United Rep. of	48,446.27
39	Senegal	41,564.33
40	Honduras	28,911.69
41	Paraguay	18,126.80
42	Togo	17,287.38
43	Congo	13,702.34
44	Liberia	12,363.12
45	Central African Republic	1,954.84
	TOTAL	24,208,942.33

Table 14. Exports of selected semi-finished and finished steel products from selected developed countries to developing countries, 1977 to 1980

Country	Year	Total Exports 1,000 T	%	Ingots and Semis 1,000 T	%	Tubes and Fittings 1,000 T	%	Long Products 1,000 T	%	Flat Products 1,000 T	%
Japan	1977	33,629.0	100	2,348.4	7.0	1,932.2	5.7	77.8	0.2	n.a.	n.a.
	1978	30,924.0	100	2,259.4	7.3	2,285.9	7.4	98.1	0.3	n.a.	n.a.
	1979	30,879.0	100	2,707.0	8.8	1,819.4	5.9	44.7	0.15	n.a.	n.a.
	1980	29,704.0	100	2,411.0	8.1	2,159.6	7.3	59.5	0.2	n.a.	n.a.
Germany, Fed.Rep.of	1977	15,440.2	100	197.8	1.3	287.2	1.86	587.8	3.8	500.7	3.2
	1978	18,517.0	100	633.7	3.4	588.0	3.18	775.8	4.2	876.6	4.7
	1979	19,286.4	100	445.8	2.3	343.1	1.77	600.0	3.1	796.2	4.1
	1980	19,044.0	100	791.1	4.2	534.7	2.8	648.3	3.4	977.9	5.1
France	1977	9,689.0	100	214.7	2.2	262.8	2.7	501.5	5.2	513.3	5.3
	1978	10,469.0	100	337.6	3.2	348.6	3.3	648.3	6.2	709.0	6.8
	1979	10,495.2	100	296.1	2.8	352.0	3.4	432.2	4.1	680.4	6.5
	1980	10,707.1	100	294.3	2.8	374.4	3.5	349.6	3.3	715.4	6.7
Italy	1977	6,717.0	100	234.7	3.5	420.4	6.3	646.9	9.6	206.2	3.1
	1978	8,240.0	100	175.4	2.1	527.3	6.4	1,072.5	13.0	261.9	3.2
	1979	6,912.0	100	125.7	1.8	336.1	4.9	1,285.7	18.6	206.3	3.0
	1980	6,763.0	100	119.0	1.8	433.1	6.4	1,181.5	17.5	201.6	3.0
United Kingdom	1977	4,402.0	100	8.9	0.2	150.3	3.4	395.5	8.9	307.8	7.0
	1978	4,376.0	100	12.0	0.27	113.8	2.6	42.4	1.0	437.7	10.0
	1979	4,527.0	100	21.5	0.47	79.3	1.75	602.4	13.3	310.5	6.9
	1980	2,780.0	100	7.0	0.3	82.5	3.0	363.4	13.1	138.2	5.0
United States	1977	1,858.0	100	169.2	9.1	211.0	11.4	258.5	13.9	291.9	15.7
	1978	2,292.0	100	85.1	3.7	323.4	14.1	287.2	12.5	391.2	17.1
	1979	2,659.0	100	144.2	5.4	356.8	13.4	283.8	10.7	401.0	15.0
	1980	3,844.0	100	542.8	14.1	320.6	8.3	614.6	16.0	780.2	20.3

Source: United Nations. Economic Commission for Europe, Annual Bulletin of Steel Statistics for Europe, 1981, and trade data supplied by the United Nations Statistical Office.

Table 15. Classification of additional technical requirements for higher quality ferrous metals and the effects shown in their use

Additional requirements (in comparison with standard requirements)	Additional expenditure in the production of a higher quality metal				Effects of metal quality improvement
	Cost increase due to metal charge	Cost increase due to production process	Technological change	Losses	
1	2	3	4	5	6
	Additional requirements for chemical composition				
Reducing the limits for sulphur and phosphorus impurities	Selection of pure metal charge (with stringent limitation of the use of pig-iron in the charge)	Increased heating time (Formation of special slag or slag removal)	Smelting in electric furnace instead of open-hearth furnace		Ensuring high reliability of products due to good metal homogeneity. Improvement of weldability and cold strength.
Reducing residual chromium, nickel, copper and other elements	Selection of metal charges containing lower amounts of these elements	-	-	-	Improving steel workability during patenting and cold stamping
Reducing or narrowing the carbon limits	-	Accurate control of the production process	Complication of the production process, more frequent sampling	Possible losses due to separation of the metal that does not meet the strict specifications	Reducing variations in mechanical properties after heat treatment

(continued)

Table 15 (contd.)

Increasing the content of alloying elements	Additional consumption of ferro-alloys and alloying elements	-	-	-	Improved strength, ductility, durability plus metal economies in use
Additional analyses of chemical composition on final rolled products	-	Direct expenditure on analyses	-	Possible losses due to separation of the metal that does not meet the strict specification	Ensuring metal of high homogeneity and reliability
		Additional requirements for mechanical properties			
Additional strength and ductility tests	-	Expenditure for preparing and testing specimens	-	-	Ensuring metal of high homogeneity and reliability
Increasing the standard of strength and ductile properties	-	Narrowing the limits for carbon and other elements	-	Possible during ordinary operations due to rejecting charges not meeting the strict standards	Improvement of the strength and ductility, metal economies in use
Increasing the volume of control work	-	Expenditure for preparing and testing additional specimens		Due to metal sorting increasing the number of tests	Ensuring highly reliable metal

(continued)

Table 15 (contd.)

Additional requirements for purity and homogeneity					
Fracture test for determining fibrous deformation of the structure	Ensures high quality raw materials	Improvement of the production process, highly skilled personnel	-	Due to selecting the metal	Ensuring high reliability by reducing brittleness
Standardization of macrostructure according to numerical reference standards	Selection of ingots of strictly defined mass and shape	Precise conditions of melting and casting (specification of temperature and speed)	-	Due to selecting the metal	Ensuring metal of high reliability
Non-metallic inclusions standardization	Ensures high quality raw materials	Right process technology, strictly defined ingot mass, obligatory observation of temperature and slag conditions	In the case of very strict requirements it is necessary to change the process technology up to the use of slag and vacuum remelting	-	Improvement of surface quality of worked parts (polishability) and reducing processing costs at the user's works
Hair-crack standardization during tests on specimens (by turning, magnetic methods or others)	-	Specimen control	-	Due to sorting metal that does not meet specified standards for specimens	Ensuring high reliability of superduty steel and improving the surface quality of worked parts (polishability)
Standardization of defects detected by the user on ready-to-use parts (hair cracks)	-	-	-	At the expense of payments for sorting out parts above agreed standards	ditto

(continued)

Table 15 (contd.)

Ultrasonic inspection	-	Inspection at the metallurgical plant and at user's works	-
Determination of the gas content	-	Expenditure for additional tests	-
Increasing the amount of macrostructure examination work	-	Expenditure larger number of specimens, preparation and testing	-
	Additional requirements for microstructure ar		
Microstructure standardization; perlitic shape	-	Technological improvement, adequate heat treatment	-
Carbide network	-	Observation of cooling-temperature schedule; more accurate finishing temperature	-
Steel grain	Deoxidation control, usually with aluminium	Precise carrying out of the production process	-

(continued)

At the expense of payments for sorting the metal at the metallurgical works	Improvement of the reliability of high duty steel before making parts from it
-	Improving the reliability of vacuum-treated steel, etc.
Probably due to macrostructure rejection	Ensuring high reliability of the steel
<u>d decarburization depth</u>	
Due to sorting metal that does not meet the strict standards	Improvement of uniformity and workability of the steel
Due to sorting metal not meeting specification (for rounder sections)	Improving steel toughness and ensuring higher reliability
Due to sorting metal not meeting strict standards	Improvement of the uniformity of the steel, reduced distortion of parts during quenching

Table 15 (contd.)

α-phase	Use of higher nickel and lower chromium content	-	-	Due to sorting metal not meeting strict standards	Increasing steel ductility in hot working and the non-magnetic properties
Raising microstructure standards	-	Technological improvement by adequate heat treatment	-	ditto	Ensuring higher reliability
Depth of decarburization layer	-	Detailed observation of the production process, additional control	Expenditure for technological process complexity in raising the requirements	Due to sorting metal not meeting strict standards	Possibility of applying cheaper treatment and reduction of waste at user's works, owing to reduced tolerances
		Additional requirements for physical properties			
Quench penetration guarantee	-	Careful development of the process, narrowing the carbon limits	-	Due to sorting metal not meeting strict standards	Increasing the durability of consumer products
Quenchability guarantee	-	Strictly defined chemical composition	-	Due to sorting metal in certain cases	Increasing the durability of consumer products
Standardization of the tendency to intercrystalline corrosion	-	-	-	Due to sorting metal	Ensuring resistance to intercrystalline corrosion
Standardization of the tendency to graphitization	Narrowing the limits of residual chromium content	Observation of soaking time during annealing by decreasing the charge	-	-	Ensuring steel of high reliability

(continued)

Table 15 (contd.)

Magnetic properties - lowering the upper limit of coercive force in low-alloy electrical steel	-	-	-	Due to metal sorting	Increasing the required electrical properties
Increasing the lower limit of coercive force and residual induction in magnet steel	-	-	-	Due to metal sorting	Increasing the required electrical properties
		Additional requirements for production methods			
Melting steel in ladles with liquid synthetic slags	-	Lowering production costs by reducing the time of electric melting	Direct expenditure for the use of synthetic slag, taking into account faster electric smelting	-	Improving metal reliability due to lower sulphur content, reduced hair cracks and non-metallic inclusions
Steel melting with subsequent remelting	-	-	Direct expenditure for electroslag remelting and additional costs for hot working the steel	Additional losses from melting losses and rejects	Increasing the reliability of superduty steel by decreasing non-metallic inclusions, improving macrostructure and improving the mechanical properties
Steel melting with subsequent remelting in vacuum arc furnaces	-	-	Direct expenditure for vacuum-arc remelting and additional costs for hot working the steel	ditto	Increasing the reliability of superduty steel by decreasing non-metallic inclusions, improving macrostructure, improving mechanical properties and reducing the gas content

(continued)

Table 15 (contd.)

Melting steel in vacuum induction furnaces	Ensuring a high quality charge	-
Steel melting with subsequent double remelting	-	-
	Additional requirements for surface	
Improvements in surface finish (grinding, polishing, etc.)	-	Direct expenditure on finishing
Roughing, planing, polishing	-	Direct expenditure on roughing or planing
Pickling	-	Direct expenditure, differentiated according to the type of rolled product and steel group

(continued)

Direct expenditure on vacuum induction remelting, and additional costs for small ingot processing	Additional losses from melting and rejects	Increasing the reliability of superduty steel by decreasing non-metallic inclusions and lowering the content of gases.
Direct expenditure on the double remelting, and additional costs for the hot working of the steel	ditto	Major improvement of the reliability of superduty steel due to reduced non-metallic inclusions, improved macro-structure and mechanical properties and lowering the content of gases

and appearance

-	-	Reduced cost of metal working at user, and improved appearance
-	Losses due to rejects during roughing or planing	Reduction of waste at user's works
-	Losses due to processing	Reduction of cost of metal treatment at user's works, and improvement of surface quality

Table 15 (contd.)

		Heat treatment			
Normalization or annealing	-	-	Direct expenditure, differentiated according to type of rolled products and treatment	Losses due to treatment	Equalization and raising of mechanical properties, improving steel treatment
Heat hardening	-	Complication of the technology because of the quenching and subsequent tempering	Direct expenditure, differentiated according to type of rolled products and treatment (with special or rolling process heating)	ditto	Improving strength properties of the steel and economy
		Additional requirements for dimensions and accuracy			
Determination of standard or multiple lengths	-	-	-	Increased waste during cutting (in addition to normal processing waste)	Reduced waste during steel processing at user's works
Improved accuracy, minimum curvature, buckles, camber	-	Increased costs due to more strict requirements for surface quality, reduction in service life of rolls	-	Sorting possible in case of strict standards	Cost reduction during metal working at user's works

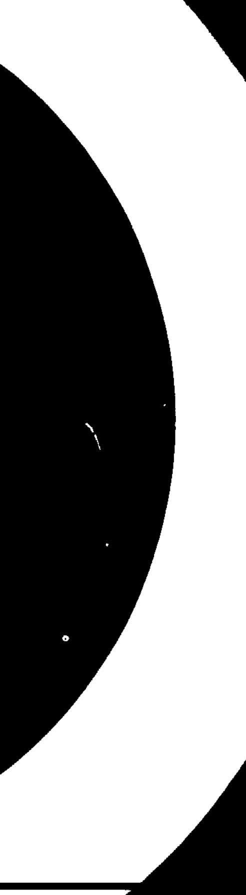
(continued)

Table 15 (contd.)

		Additional requirements for marking and packing			
Additional stamping and marking	-	Direct expenditure	-	-	Prevention of loss at user's works
Improvements in containers, packing, coating	-	Ditto	-	-	Improvements in steel preservation during handling and storage

DOSSIER IV

TECHNOLOGY AND RESEARCH



1. Certain statements on the iron and steel industry have recently suggested that it could be following the same pattern of development as the railways[1]. As a basic activity, providing industry with essential products, it is now an old industry which has matured and is now declining: more and more of a liability, less and less profitable, it is gradually being taken over by the State and will tend to become a kind of public service, offering users a standard product based on slow technical development. Today specialists from all sources are disputing this opinion, regretting "that decision-makers, and a number of theoreticians, talk as if the steel industry had reached its peak or is in decline; this has tended to give strength to protectionist policies and to compromise adjustment processes", and hoping that "those responsible would understand that steelmaking is one of the most important branches of the entire industrialized economy, and that it is destined to progress .... to the extent that its driving factors are not stifled ....".[2]

2. It seems in fact that current technical developments in the iron and steel industry do not match this image of a declining industry. Are these developments going to continue and accelerate until real technical breakthroughs are achieved ? This question is asked for the eighties.

A. NO MAJOR DECISIVE BREAKTHROUGHS DURING THE EIGHTIES

3. There is general agreement that during 80's there may not be any new technological breakthroughs of the kind of the Bessemer process, or LD oxygen steelmaking and continuous wide strip mill. This is the conclusion which emerges from discussions at the Amsterdam Conference devoted to "Changes in iron and steel technology"[3]. "It is inconceivable that a radical new process capable of replacing the standard coking plant/blast furnace/oxygen converter route could emerge within the next ten years"[4]. This opinion

(1) cf. Metal Bulletin: "Off the rails" - 15 September, 1978 (editorial)

(2) Ed. Florkosky Jr.: Communication to OECD Symposium, Paris, February 1980.

(3) Conference organised by the Meta' Society in September 1979.

(4) Paper from Messrs. Sanbongi and Komada in Amsterdam.

is repeated in the Voest Alpine contribution[5] and confirms the evaluation of the Office of Technology Assessment[6] that any radical changes may not occur until after 1990.

4. The following table summarizes some long-term technological forecasts:

Table 1

Radically new processes	Possible transition to a significant industrial stage		
	1985	1990	2000
Production of steel using plasma arc			?
Direct steelmaking		?	?
Continuous steel production[7]		?	?
Hydrometallurgical production of cast iron		?	X
Steel production using nuclear energy			?
Various systems using hydrogen		?	X
Top casting of steel		?	X
Coke substitute (formed coke)		?	X
Direct fabrication of rolled products from powder	?	X	X
Direct reduction process	X	X	X

Source: Report from Office of Technology Assessment (OTA) in Metal Bulletin Monthly, October, 1980.

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(5) Voest-Alpine "Contribution to the world iron and steel 1990 scenarios" by G. Meindl, July 1980, p. 83 - based, inter alia, on "Industrial World", July 1976.

(6) "Technology and steel competitiveness", OTA, US Congress, 1980.

(7) "Industrial World" of July 1976, cited by Voest-Alpine, estimates that this process could be economically feasible (profitability stage) in 1990, becoming a standard process in 2000.

B. **NO MAJOR BREAKTHROUGH, BUT MULTIPLE DEVELOPMENTS AND ACCELERATED IMPROVEMENTS**

5. There is general agreement that, during the eighties, the predominance of the main route, coking plant/blast furnace/oxygen converter, supplemented by the scrap/electric furnace route, will be confirmed and extended.

From the beginning of the eighties, Thomas and Bessemer converters and open hearth furnaces will tend to disappear completely: this process has almost been completed in Japan.

6. Whilst the sixties were noted for the extension of mass production capabilities, and the years 1974-1980 were a period of adjustment, the eighties should mark the entry of steelmaking into an era of "intensified technology".(8)

Within the overall stability of the main route, modernization and intensification will increase, thus improving control of operations and of conversion of the installations.

7. Modification and intensification will involve the use of dry quenching in the manufacture of coke right up to controlled temperature rolling, including more accurate control of the blast furnace (pressure, temperature, distribution of the charge and gas flow, etc.), and more efficient refining of steel, etc. These developments will allow the efficiency and profitable nature of the main process to be improved.

8. The development of continuous pouring will signify in particular that the process has become fully developed: continuous casting was applied to 0.3% of world steel production in 1960, and to approximately 20% in 1979. This development varied in accordance with the countries concerned.

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(8) Cf. Nippon Steel News, October 1979.

Technological developments in the steel industry in the nineties.

1960-1974	1974-1980	1980
Mass production techniques	Temporary adjustments/ measures (energy problems)	Advanced technologies

Table 2 (9)

Percentage of steel production using continuous casting	1972	1979
West Germany	13.9	39.3
Brazil	2.2	27.6
E.E.C.	7.2	30.4
Korea, Republic of	0	30.4
USA	5.8	16.7
Finland	73.9	88.8
Italy	12.7	46.4
Japan	17.0	52.2
Sweden	16.0	39.0
USSR	5.5	9.5
Whole world	8.1	20.7

It is anticipated that at least 80% of Japanese steel will be continuously cast in 1990, a percentage which has already been exceeded by the Nisshin Steel Company since 1980 (81%). By the same date Kawasaki Steel had achieved 70.3%, and Nippon Steel, Nippon Kokan and Sumitomo 60%[10], involving a considerable advance over their fixed objectives. The Japanese, German, Italian and Finnish iron and steel industries have led this development, leaving the majority of the steel industries in the developing countries behind.

9. During the eighties this process of intensified and improved technology will accelerate as a result of pressures from both upstream and downstream.

Economies in energy and materials are being effected upstream.

(9) EEC/Steel/25, page 93

(10) Japan Economic Journal, 23 December 1980

Steel production downstream is, and will be, increasingly drawn towards quality, in view of the persistent demand of users searching for products that would provide a reduction in weight and corrosion (cars), have the ability to withstand very low temperatures (transportation of hydrocarbons in arctic regions, or transportation of LNG), or very high pressures and temperatures (nuclear chemistry), etc. In addition, this tendency is linked with the willingness of manufacturers to provide cheaper steel products of a given quality such as stainless steels with a lower nickel content(11) which are easier to work, and sheet steel for cans without tin (tin-free steel), silicon-free sheet for electric motors, etc.(12).

10. These trends show the preoccupation of steel manufacturers and their customers, both being concerned with consistent quality, energy economy and economies in raw materials. High performance and cheaper steels are required, but with improved specifications: these two trends converge and finally merge together. In fact, they both depend on the pursuit of quality and the application of advanced technology which involves changing the priorities specified above from the investigation of new systems and processes to the perfecting of increasingly sophisticated products which meet the new requirements.

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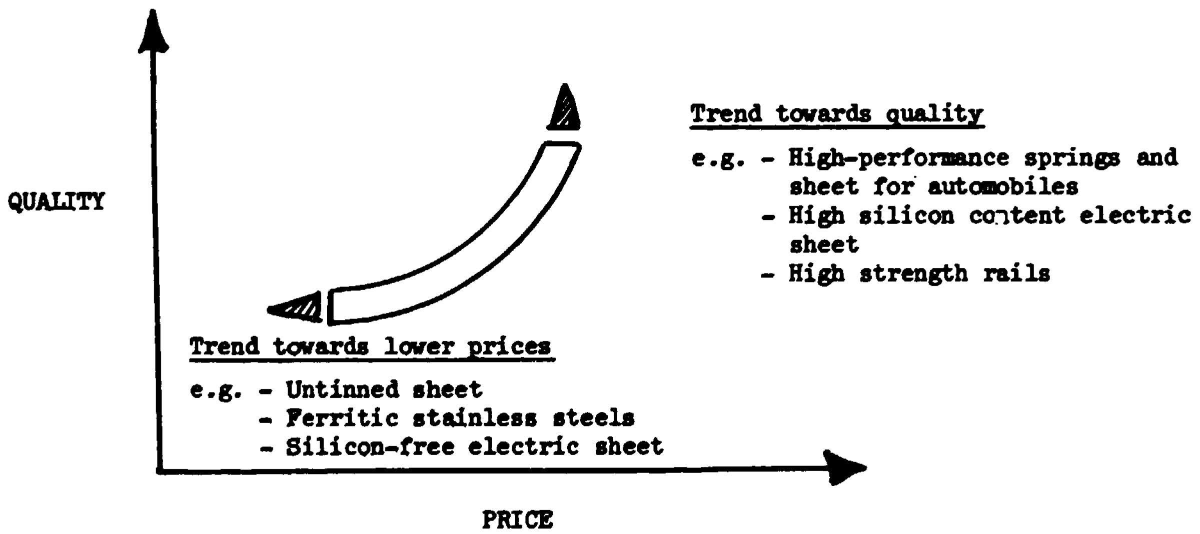
(11) By economising on metals, such as nickel, with a high energy content.

(12) Cf. Nippon Steel News, October 1979. The following diagram shows the two-dimensional effect of trends in market requirements.



11. Thus an outline is sketched of technical changes which will affect the iron and steel industry during the eighties. Strong impulses will be exerted from outside the industry, mainly connected with the question of energy:

- either directly, with a view to economising on energy and materials in the steel-making process itself,
- or indirectly through the supply of new products complying with new conditions for the application of energy.

These external impulses will result in the appearance of new products linked with a rapid improvement in processes, internal dynamism being renewed by external pressures and vice-versa.

The Direct Reduction Process

12. The Office of Technology Assessment considers that direct reduction processes constitute one of the rare and radical technical advances of the eighties. In fact it is found (see Dossier I "Projects") that iron and steel plant projects based on a direct reduction process have multiplied during the recent period. The majority of these projects are based on the use of natural gas as a reducing agent, in particular in the Midrex and Hyl processes which are currently subject to successive improvements, allowing resort to continuous production and a reduction in gas consumption.

13. It is not easy to speak of "a breakthrough" in the Northern countries, where the increase in price of natural gas, which tends to fall into line with the price of oil (cf. Dossier II "Raw materials and energy") has resulted in the closure of certain plants (Oregon Steel in the United States), the freezing of projects (the Hunterston Plant in Great Britain), and a loss of enthusiasm (Spain).

Nevertheless, one may query the effective impact (in the "North") of the following new techniques or processes during the eighties:

- the use of coke-oven gas for producing sponge iron[13]
- the advance of direct reduction processes using non-coking coal as a reducing agent[14]
- the use of very high temperature plasmas based on gas, coal or hydrocarbons[15].

It is probable that the rapid increase in price of energy, including non-coking coals, will not favour the general progress (the breakthrough) of direct reduction processes in the more industrialized countries.

14. On the other hand the impressive number of new advantages from the direct reduction process in developing countries is a sign that a breakthrough is being achieved in oil countries which have an abundant supply of natural gas. This breakthrough should become even more apparent during the decade to the extent that numerous developing countries, where prospecting has been poorly carried out until now, will become oil countries. This phenomenon is occuring in West Africa, where the former oil countries of Nigeria, Gabon and Angola have new oil neighbours including Cameroun, Congo[16], the Ivory Coast and Zaire. These countries often have deposits of high-grade iron ore, and thus become candidates for the installation of direct reduction plants.

15. Mexico has developed the first industrial process, the HYL process; nevertheless, distribution and control of the direct reduction processes is in the hands of companies from the more advanced countries[17].

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(13) See Communication from M.J. Astier, Paris, Metal Bulletin of 14 October 1980.

(14) DRC Process (Amcon - Davy MacKee), new Korf process, etc. Metal Bulletin of 21 November 1980 and 9 December 1980.

(15) Plasmared process proposed by SKF. Cf. SKF Steel International 6 - 15.6.1979

(16) Where production will jump from 2.0 to 7.0 million tonnes/year

(17) Including the HYL process, distributed jointly by the Mexican HYLSA company and by the Swindell Dresser and Kawasaki companies.

The technical breakthrough represented by direct reduction will be the more effective in those countries which do not have cheap reducing agents (natural gas), not only from the point of financing and construction of the project but also the development of the research aimed at giving these processes their overall impact.

C. TOWARDS THE MASS PRODUCTION OF HIGH-GRADE STEELS

16. Recent development in the iron and steel industry has shown, under the pressure of higher quality requirements (cf. above):

- stagnation (or decrease) in ordinary steels,
- but considerable progress in high-grade and special steels.

In Japan the respective indices for the production of these two categories of products have developed as follows*:

	1973	1979
Ordinary steels	100	84.8
High grade and special steels	100	122.9
Heavy sheet	100	56.4

More particularly the production of stainless steel has ceased to increase, despite the crisis, since 1973.**

In 1,000 tonnes	1973	1979	Index 1973 = 100
EEC	1,748	2,324	132
Spain	52	156	300
USA	1,[illegible]14	1,905	111
Japan	2,018	2,289	115

* Source: S. Hosoki and T. Kono - Amsterdam Conference 1979

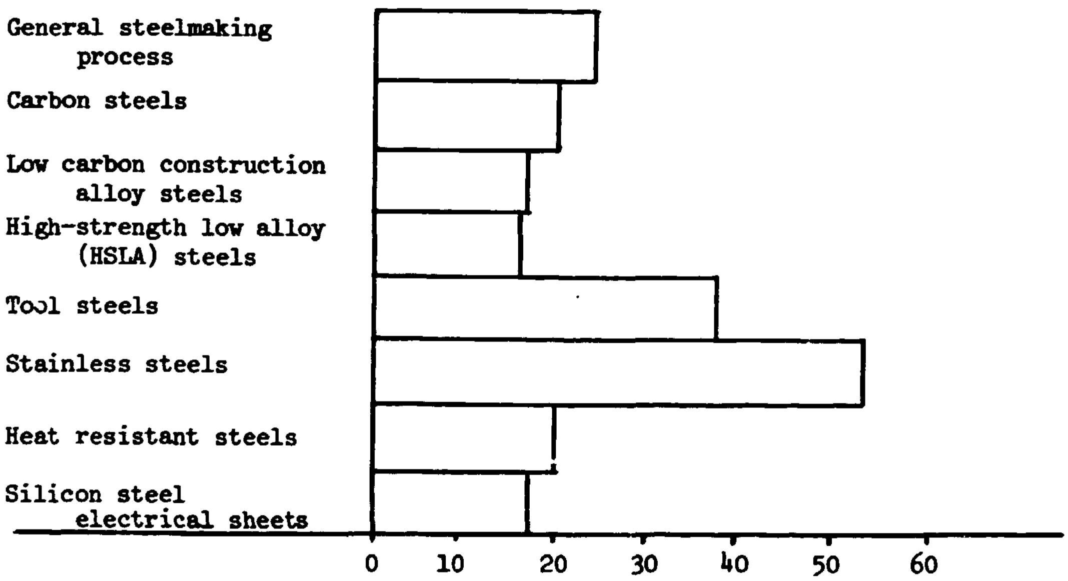
** Source: "World Stainless Steel Statistics" Inco 1979. A recent report forecast that the demand for stainless steels would increase up to 1990 at a rate of 8% per year in the developing countries.

This pressure towards higher quality has resulted in research into new steels based on:

- resistance to corrosion (offshore oil constructions),
- uses at very low temperatures (Arctic oil),
- requirements resulting from mass production of engineering products using steels with more stable properties (higher purity).

It is significant that between 1974 and 1976, in the American iron and steel industry, majority of the patents were taken out in the field of special steels or the so-called high-strength steels:

NUMBER OF U.S. PATENTS GRANTED :
July 1974 - July 1976



However these high quality steels are not absolutely equivalent to "special steels" or "fine and alloy steels". More specifically, the process of intensification which is in progress will continue further.

17. The process of intensification will be reflected in particular by a <u>new structuring of the iron and steel industry</u> where the distinction which up to now has been very clearly shown between the (mass) production of normal steels and the production (in small quantities) of high grade and special steels will tend to disappear as a result of the increasing possibilities offered by conventional routes for the production of high grade steels.

18. This new structuring will, in particular, involve:

- rolling at controlled or low temperatures or with controlled cooling, for example the Torsid process introduced by a group of French steelmakers[18] or the two-stage production of sheets;

- the secondary refining of steel and ladle metallurgy[19], supplementing the oxygen steelworks (LD or OLP) or electric furnaces making it possible to obtain, in bulk, special and high quality steels[20]. The special sheet intended for the production of gas and oil pipelines for use in the Arctic will now be produced in LD steelworks of high capacity, together with many grades of carbon or low-alloy steels.

19. This explains the accelerated alignment and merging of former producers specializing in high-grade and special steels and large steel undertakings having mass production capacities based on oxygen converters and high-output electric furnaces. It can be seen that "the reinforcement

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(18) Cf. Metal Bulletin, 22 February 1980

(19) Cf. K. Sanbongi, K. Komoda and T. Kono - op. cit.
Ladle degassing processes
ASEA, SKF and VAC processes
DH processes
RH processes
or AOD processes the practice of which is rapidly expanding.

(20) This makes it possible, by improving the quality, to reduce the duration of the operating cycle. Cf. Revue de Métallurgie - December 1980 or Metal Bulletin, 13 June and 14 November 1980.

of links between high-grade and standard steel production is natural"[21]. This movement arises from the increasing efficiency of the conventional route, culminating in the simultaneous mastery of mass and quality production to the point where it becomes infinitely more costly to manufacture numerous grades of high-grade and alloy steels in the older special steelworks than in ordinary high-performance plants[22].

D. TOWARDS NEW DIFFERENTIATIONS ?

20. This development highlights the inadequacy of any evaluation of the iron and steel industry in terms of crude steel[23], which reflects, decreasingly, the true nature of the evolution of the iron and steel industry. Evaluations in terms of crude steel, which have been useful and suitable for many years, today, tend to mask the possible rapid increases in effective capacity (evaluated in terms of weight as well as in the quality of the finished products).

There is also the risk of masking new differentiations between the iron and steel industries in the industrialized countries and the new ones in the developing countries. This question is directly related to the implementation of the Lima objectives: what advantage would it be, in effect, to produce 25% or even 30% of crude steel if this production was not directed towards the manufacture of an increasingly wide range of rolled products and high-quality steels, whilst at the same time effecting economies in energy and raw materials ? From this point of view the Lima objective needs to be qualified, from the general viewpoint of a new method of evaluating the progress of the iron and steel industry and giving preference to calculations in real terms, of final products rather than under a vague terminology of crude steel.[24]

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(21) Statement of the French Ministry for Industry in Metal Bulletin of 13 June 1980 regarding line-ups between Sacilor and Pompey, Sacilor and Ugine-Aciers and, possibly, between Usinor and Creusot-Loire. Cf. "Le Monde", 16 April 1980.

(22) Cf. on this subject many examples in France, Austria, etc.

(23) Some estimate that one tonne of steel manufactured in the year 2000 may be equivalent to two tonnes of steel in 1974. Cf. Annales des Mines - November 1978.

(24) The question of the difficulties resulting from the evaluation in terms of raw steel is put forward in EUROFER, IISI, Mr. Signora, etc.

21. This development also poses the problem of a new differentiation between:

- firstly the advanced iron and steel industries, integrated and multi-purpose, offering high quality mass production, and
- secondly the new iron and steel industries in the developing countries, overcoming with difficulty the stages between the phase of mass production to the phase of intensification.

As a bulletin of the City Bank has emphasized: "the renewal of competition on the world steel market is based precisely on the rapid development of techniques which improve system operational flexibility and reduce costs"[25]. The process of differentiation is also outlined at several levels: not only between the iron and steel industries in the older industrialized countries and the industries in the developing countries, but at the same time even within the group formed by the industrialized countries, between the main group led in particular by the integrated Japanese and German steel interests[26] and the others which follow at various distances.

22. The impact of this evolution will exert itself directly on iron and steel production and the economy of the industry, since iron and steel installations, when engaged in high-quality mass production, will only operate to specification under satisfactory conditions of cost, price and cash-flow.

The results of the Japanese groups which, despite their low market share (approximately 70%) have increased their profit during the financial year 1979-1980, fit into this perspective, while in many developing countries the iron and steel interests have to support the cumulative weight of high investment costs, low market shares and an average quality level of the product.

(25) City Bank Bulletin - June 1980, p. 14.

(26) Whence the reticence of German steel interests in regard to the quotas established by the EEC (Davignon) to the extent that they feel that they have nothing to fear from competition either with the Americans or the Japanese, or with the Third World.
Cf. "Steel quotas rattle the EEC" in Business Week, 10 November 1980.

23. This impact will also be exerted <u>indirectly</u> on the possibilities and conditions for the production of capital goods, in particular goods intended for expanding outlets of the energy systems (new oil, shale, coal, renewable energies), in transport systems, etc. The manufacture of these goods will need iron and steel products with a highly favourable quality/price ratio or quality/weight ratio, or again improved machining properties(27). Just as it is impossible to produce oil and gas pipelines if the sheet used does not meet the API standards(28), there is danger that in the future it will become difficult, in the developing countries, to progress in the production of equipment goods without resorting to import of highly sophisticated iron and steel products, use of which will then tend to become established as standard. This also shows the way in which iron and steel production is linked to conversion and manufacture of machinery and equipment. It can be understood, under these circumstances, that certain producers of high-performance steels (better machinability, for example) prefer initially not to export their new production and instead reserve them for improving the cost p ice and competitiveness of their own engineering products in external markets.

24. This leads us to emphasize the following:

- the impossibility of envisaging any development in the iron and steel industry without considering its links (both present and future) with the engineering industry and, in particular, with the capital goods industry by posing the question: "Which iron and steel industry for which engineering industry ?". In this respect a comparison needs to be made between the worldwide study on the steel industry and parallel work carried out by UNIDO on the development of the capital goods industry in the developing countries(29);

(27) Steels of the type at the present time developed by Creusot-Loire permitting machining economies (15 to 35%) and increases in cutting speeds (50% and more); a category of steel already produced and used by the Japanese.

(28) American Petroleum Institute.

(29) Cf. Documents prepared by UNIDO/IS for the Warsaw meeting of November 1980 (ID/WG.324/4) and for the Brussels consultation (September 1981).

- the need to take into account the massive preponderance of the industrialized countries in regard to the manufacture (and trading) in capital goods and, as a consequence, in regard to defining the standards which control the use and manufacture of these goods;

- the need to identify the possibilities for developing local manufacture of capital goods progressively linked with local iron and steel production. Is it possible to progress along this line? And how does one avoid limiting manufacture of products based on obsolete techniques but instead master progressively the advanced techniques ? How does one operate on the possibilities of alternatives offered by the centrally planned economy countries, etc.?

25. These questions give rise to further queries concerning the efficiency of the training programmes capable of leading to the progressive mastery of techniques and of the iron and steel industrial system. Traditionally, technical mastery in iron and steel production passes through three major stages: firstly long products, then flat products, finally high grade and special steels; firstly the production of ordinary steels in mass, then the production of high grade and special steels in small quantities. Arrival at maturity of the available routes implies already that the third stage be telescoped with the two previous stages and that there should no longer be any mass production - or at least it is risky to do so - unless this production is also of high quality[30]. How, in this case, can one shorten the process and make it possible for new iron and steel ventures to attain rapidly this level of mastery? Does this make it necessary for them to pass through the mastery of installations of small or medium size before going on to installations of large size? In any case this underlines the extreme importance of circulating information to ensure an integration of working teams, for matching iron and steel productions with the needs of its downstream users.

(30) Which introduces a new graduation into technological complexity.

26. <u>The success of new iron and steel industries</u> therefore implies:

- that they immediately aim very high: a very high technical level, as well as proven capability in systems management;

- that they immediately pay attention to adapting and appropriating techniques, that is to say research and development.

E. RESEARCH AND DEVELOPMENT: AN ESSENTIAL REQUIREMENT

27. The report of the Office of Technology Assessment(31) strongly attributed the low dynamism of the American iron and steel industry to the insufficient depth of research and development within the industry. On the other hand, it is not surprising that the Japanese iron and steel industry has overtaken most of its competitors in this field, especially since, like the German industry, it is increasing its efforts, whilst funds available for R & D remain the same as in the USA and decrease in France.

Table 3 Sums devoted to research, 1978

	Japan	USA	FRG	France
Percentage of turnover devoted to research	1.4	0.7	0.7	0.4(32)
Sums devoted to research (US$m)	450	210	90	28
Index: Japan = 100	100	46	20	6

Source: IRSID (French Iron and Steel Research Institute) documentation

(31) Op. cit.

(32) Of which 0.25% for IRSID and a little more than 0.15% for research carried out by steel companies on their own account.

28. The stake of R + D in the iron and steel industry is of importance, because it is not so much a question of devoting scarce resources, but to a systematic preparation for a radical technical breakthrough (of the LD process type) so as to reduce dependance on others, overcome delays, and contribute to the operation of the steel industry under acceptable economic conditions.

In fact, one cannot over-emphasize the relationship between research and high quality in steel production. In this movement research tends to depend firstly on quality control linked to the production of continuously improved products, and secondly on more fundamental knowledge and research relating to the chemical composition, physical structure and behaviour of steels which also govern this production. The production performance of a steel industry is, in fact, inseparable from the continuous preparation and adaptation of techniques to suit local conditions.

This orientation is even more necessary when steel production involves the use of raw materials and local energy sources which do not necessarily correspond with normal international standards. Thus, it seems wrong that R & D is often treated as a "luxury product" in the steel industry.

29. In addition one must strongly emphasize the social, or rather socio-economic, dimension of research because there is a close relationship between research for performance, production quality, and improvements in working conditions. The latter are closely linked with an improvement in a steelwork's performance, resulting in longer refractory life, a reduction in time devoted to the particularly arduous work of restoring refractory material, the satisfactory use of the continuous casting process, fewer surface faults allowing a reduction (and even deletion) of the various scarfing operations, etc.

30. Research is thus organized on the site, starting from the application of techniques and the pursuit of quality; research departments must be created, constituting an intermediate link between production (where experience is accumulated) and more fundamental research of the university type (localized or not within the University). In any case, the rapid supply and the free circulation of information are basic conditions for ensuring valid research, as well as the development of the collective application of proficiency and know-how.

The Japanese iron and steel industry offers a very good example of the close link which exists between production quality/performance, the development of work teams (Jishu Kanri) and collective know-how, the intense and free circulation of information and the importance of research and development.

31. Finally we should emphasize the necessary character of research, not only for the most advanced iron and steel industries but also for the iron and steel industries in the developing countries:

a) The development of research capabilities is a mark of the vitality and the production of every iron and steel industry which is already established. As is already well known, to produce is to assimilate, to produce is to adapt and, finally, to invent. In this sense the expenditure devoted to research forms part of the very life of industry.

b) A definite orientation of iron and steel research is, furthermore, the condition of entry into the iron and steel industry or of greater mastery of this industry by numerous developing countries, whether it involves:

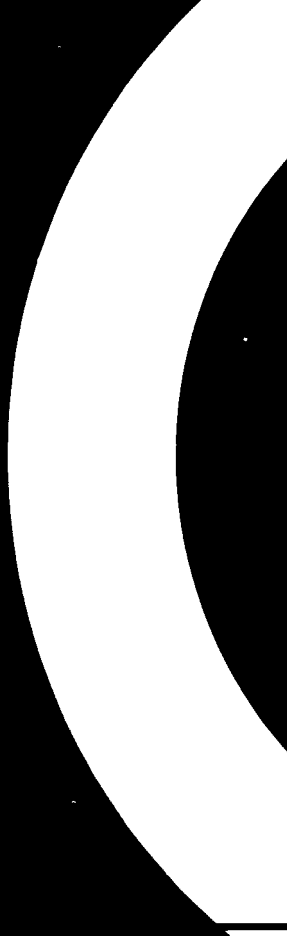
- better defining of the conditions of viability of small or very small units,
- development of direct reduction processes (or modules) adapted to the smallest sizes,
- intensification of research work on the development of solid reducing agents,

- development of rolling mills for flat products (of the Steckel-Sendzimir type) of smaller dimensions,
- development of continuous casting machines with a single line,
- development of modern equipment, designed for ease of maintenance, etc.,

and, more generally, to the adaptation of installations designed for an industrialized environment into the non-industrialized environments of the developing countries.

D O S S I E R V

DESIGN, CONSTRUCTION AND ACHIEVEMENT OF FULL PRODUCTION



1. To design, implement, produce and control the manufacturing processes and administration of an iron and steel plant are obligatory stages of any project.

All the variables covered in the various dossiers come into play throughout these stages: financing, costs, markets, prices and marketing, raw materials and energy, technology and production scales, the necessary infrastructures and human resources, etc.

2. This dossier, limited to problems which have not been analysed elsewhere or which require special explanation, mainly covers aspects of the design and implementation stage and the achievement of full production and industrial management stage.

A. PROBLEMS IN DESIGN

Aspects of design

3. In general the ability to design projects is lacking in the developing countries; it is currently the privilege of engineering companies in industrial countries. Local participation in developing countries is generally limited to the detailed engineering (according to the terminology used in Latin America). Exceptionally, some Third World engineering companies may take on a complex project from its conception to implementation and entry into full production (e.g. the Dastur Company and Mecon in India, the Bufete Company in Mexico, etc.).

The list of 1990 projects (see Dossier I, Table 12) reveals the existing imbalances and the need which the majority of developing countries have of foreign assistance.

4. The first problem arising is the danger of losing control of essential choices, this faculty being the mainstay of a policy of self-reliance[1].

(1) See UNIDO study "The Technological Self-Reliance of Developing Countries: towards Operational Strategies", UNIDO/ICIS.133, 15 November 1979.

Engineering firms are generally linked or integrated with the owners of technological processes, or are themselves the owners. Where information is incomplete, the name of the engineering firm is, ipso facto, that of the technological process, so that there is really no choice in the matter.

In order to make a real choice, it is necessary to reverse the problem: to provide at least for a preliminary evaluation of technologies, and then to select an engineering firm.

This implies: a) structured technical-economic-marketing information; b) multiple-criteria methods of evaluating technologies involved in decision-making[2], to the extent that the options are interdependent, whether they involve the choice of partners, financing, legal structures, destination of markets, and the choice of equipment suppliers and technologies. Within these interdependences, financing appears to be the strategic variable. The latitude available for decision-making by developing countries is limited in the existing economic order (see Dossier VII: Costs and Financing).

The constraint of the necessary infrastructures

5. Steel-making is a "development pole"[3] not only because of the physical and economic relationships which it involves, upstream and downstream, but also because of the infrastructure which it requires, and on which its existence and efficiency depend.

Often neglected during the design stage, infrastructural problems lead to waste of energy and financial losses later on during the operating stage.

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(2) See P.F. Gonod: "Matériaux pour de nouvelles politiques du transfert technologique" - Revue Tiers Monde No. 65 - January/March 1976, and Le Nouvel Ordre Economique et les Projets Industriels - UNIDO, ID/WG. 237/10, 16 November 1976.

(3) See F. Perroux: Note sur la notion de "Pôle de croissance" - Economie appliquée No. 8, 1953; L'effet d'entraînement: de l'analyse au repérage quantitif - Economie appliquée, 1973; and Albert O. Hirschman "The Strategy of Economic Development", Yale University Press, 1966.

6. The magnitude of the problems to be resolved is proportional to the degree of underdevelopment. The following non-exhaustive list shows the main requirements of an infrastructure: harbours, railway and road systems, supply systems, anti-pollution treatment units, the adaptation of mining supplies to the steel project requirements, a telecommunications system, the necessary materials storage facilities, spares and finished products, the installation of maintenance work-shops, and finally steel distribution centres. To these must be added the importance of human and social infrastructures (houses, schools, etc.), without which there could be no stability of personnel.

7. Transportation and the cost of transport play a decisive role in the choice of locations, to the extent that the volume of products handled by an integrated steelworks is equal to approximately four times the production volume. The cost of maritime transport has dropped in the most spectacular fashion during the last twenty years. Thus, between 1957 and 1970, the cost of delivering a tonne of iron ore to Japan dropped from US$ 20.0 to US$ 10.29, and the cost of delivering a tonne of coking coal dropped from US$ 26.23 to US$ 14.40. Thus, maritime transportation is used, and will be used, in preference to continental transportation since it is cheaper and easier to administer in many developing countries. One may question the probable trend of transport costs in the future in order to know whether it will continue to benefit coastal locations.

Whatever the trend during the decade, developing countries will find themselves confronted with the dual requirements of developing their harbour installations and their road and rail systems.

In the first place, it is necessary to provide a solution for harbour installations used for imports. Investment costs for these structures appear to be considerable(4), but the economies achieved in operating costs are also considerable.

(4) Dastur Engineering International, GmbH, study: "Report on World-wide Study on the Iron and Steel Industry - Contribution to the World Iron and Steel Scenarios up to 1990" October 1980.

The delivery of various products, packed and delivered in different ways, require appropriate installations and means of transport, but also organization to prevent hold-ups, double handling, unsuitable storage and, finally, the halting of production. Unfortunately, these problems generally remain underestimated for economy reasons or as a result of negligence. In fact, there is a considerable temptation to believe that steel industry investment may adapt itself, subject to certain work, to the existing environment, while in fact the latter must be modified accordingly.

Finally, decisions to be taken concerning inland transport must not relate to the steel industry alone. The pulling effects of the latter must combine, for example, with other objectives, for example to develop a region or to reduce inequalities in regional growth. These criteria must be taken into account from the moment a project is conceived.

8. The constitution of supply systems is another infrastructural constraint. The supply requirements (water, gas, electricity, etc.) of a steel plant are so important that they often require special investments. Problems encountered by developing countries in this field relate in the first instance to an insufficiency of available resources (in particular water), the timely installation of supply systems or production facilities, the reliability of supplies and provision of means of storage or production in case main systems fail.

When operators responsible for implementing the above conditions belong to different organizations, problems of coordination and planning between these bodies are very difficult to resolve.

Telecommunications systems

9. A steel plant requires national and international communications (authorities, supplies, customers, etc.) and communications with security and health organizations (civil protection, hospitals, etc.). This implies interconnection with the telecommunication system in different forms:

telephone, telex, mail, etc. Inadequate solutions to these problems are liable to disrupt seriously the normal activity of the plant.

Storage and maintenance installations

10. The constraints of "continuous" operation assume the construction of storage and maintenance facilities suitable for solving the most diverse supply (mining and finished products). The absence of such facilities leads to the steel industry itself finally constructing and administering these facilities. The construction of repair and maintenance workshops with a large variety of machines must be envisaged in developing countries. The price to be paid is excess installed power to guarantee the plant against production risks and to constitute a centre of assistance for other industrial operations within the national environment.

Distribution installations

11. The design of iron and steel plants in developing countries must take account of the product marketing policy. A multitude of small urgent orders implies the need for stock production in order to augment production runs. In addition, experience shows that the establishment of a product distribution system under the responsibility of the producer results in the creation and development of a solvent demand.

Social and cultural infrastructures

12. The insufficiency of the so-called social infrastructures, that is to say housing, transport, health and cultural resources, is reflected in a negative impact on the morale and productivity of workers. It turns out that these social infrastructures, by their contribution to a minimum "quality of life", have an economic impact of considerable importance, and that it is therefore rational to consider them as such from the start without waiting for their absence or inadequacy to bring in all the consequent braking and blocking effects.

13. Infrastructure constraints must therefore be taken into consideration by management, their object being not only control of a strictly demarcated industrial plant, but an industrial system with a supplementary integrating and polarizing vocation.

B. METHODS OF IMPLEMENTATION

14. Developing countries must face up to the various types of difficulties in implementing their industrial projects, for example the selection of the method of implementation, the elimination of obstacles to the participation of national operators, coordinating constraints between designers, suppliers and constructors, inspection difficulties, the coherence of planning departments in applying organizational work to the project work, local administrative delays and, finally, the influence of the method of implementation on the success of technological transfer.

In order to understand the nature of the problems encountered in developing countries it is necessary to identify the main parties involved in the implementation, and the content of their tasks.

15. The actors involved in implementation are the following: a) the designer; b) the supplier; c) the contractor; d) the holder of industrial know-how; and e) the owner.

16. The design function comprises the basic engineering, responsible for the general design, definition of process equipment, preparation of layout plans, preparation of general equipment specifications, administration of building and commissioning, supplies, inspection and testing, coordination, planning, budgeting, preparation for commissioning, and final conformity checks. Detailed engineering is responsible for working drawings, detailed drawings and installation drawings in the following general disciplines: civil engineering and earthworks, steel structures, electrical, instrumentation, pipework, vessels and boilerwork. It frequently happens that all of the above mentioned tasks are carried out within an organization which combines both functions.

17. The supplier. In fact, there are several types of suppliers corresponding to the different types of supplies: ex-catalogue, normal items, and special supplies.

Thus, the responsibility of suppliers is very different, depending on the equipment delivered. For normal items, deliveries are made from stock. For items in accordance with a standard, manufacturing times are often specified, and finally for process equipment, special manufacture is required.

Deliveries, grades, prices and after-sales service vary in accordance with the suppliers and the economic situation. Competition is generally very considerable, and financing thus forms part of commercial obligations.

18. The contractor is responsible for the construction and erection of equipment (apart from the process), and carries out work in accordance with the detailed drawings. He is responsible for costs, deliveries and quality of the work. The financial risks which he accepts, in relation to the volume, difficulty and delivery dates involved in the work entrusted to him, lead him to require technical and financial guarantees.

19. The holder of industrial know-how is rarely explicitly specified among the actors, because the designer and supplier use their ability and industrial experience to produce their own designs and carry out their own work. However, it is necessary to emphasize his importance, because in the majority of cases developing countries do not have industrial know-how and must therefore use his services. Since he has skilled labour, a thorough knowledge of the technology, production and maintenance routines, a capacity for adaptation and, finally, highly developed administrative facilities, he is able to offer considerable services to the owner acquiring the technology.

20. The final owner. Whilst control of construction is often sub-contracted, since it is closely linked in practice to the design function, the ownership function is difficult to sub-contract because it covers interests and fields which are the client's responsibility. In fact, the role of the latter is to ensure that all the partners implement his objectives. In this respect, he must continually ensure:

- compliance with quality, deliveries and costs during the design and construction stage;
- results which meet objectives in respect of technological transfer, production, maintenance, and the integration of local partners;
- that the services of local administrations and authorities are provided in good time, with the facilities required for operation of the steel manufacturing project.

The various industrial agreement formulae

21. The principal actors are associated with financiers within the framework of industrial agreements. These agreements are made in accordance with the various formulae summarized in Table 1, based on whether the functions to be fulfilled are assumed by one or more firms.

22. The industrial agreements(5)(6) reflect both the level of cooperation required by the two partners and of the force relationships between them(7).

Thus, the weaker a partner the more he will need a "packet" of goods and services to be transferred. Paradoxically, a "strong" partner may also import this "packet" without inhibition - for example in the form of "turnkey" plants - because he will have sufficient technology and administrative assimilating capability.

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(5) On the typology of industrial agreements, see S.N. Behrman: "Decision criteria for foreign investment in Latin America", Council of the Americas, 1974.

(6) For a detailed analysis of industrial agreements regarding exportation on complex industrial plants, see Euro-economics: "Export markets for major industrial complexes - Present position and future prospects" - Eurofinance - 1978.

(7) On force relationships in industrial agreements on technology, see P.F. Gonod: "Conflit-coopération dans le transfert technologique" - Mondes en Développement No. 14, 1976.

Table 1. Various types of industrial agreements (between non-affiliated undertakings)

Formula / Functions	"Break-down" formula	Design and supply formula	"Turnkey" formula	"Product in hand" formula	"Market in hand" formula
Design	X	X	X	X	X
Construction	X	X	X	X	X
Supplies	X	X	X	X	X
Transfer of production techniques				X	X
Transfer of management techniques				if required, but limited scope	if required, but limited scope
Market			compensation agreement, if required X	compensation agreement, if required X	X
Financing	X	X	supplier's credit/ purchasers' credits	supplier's credit/ purchasers' credits	supplier's credit/ purchasers' credits
Raw materials			compensation agreement, if required	compensation agreement, if required	

As other countries progress, particularly the more advanced countries of the Third World - the semi-industrialized countries - they tend to select goods and services carefully in order to limit costs by improving their quality control and their apprenticeship by increasingly incorporating capital goods, services and local engineering (for example, Brazil, India and the policy tried under the Andean Pact). In such cases, the tendency is in favour of precisely defined "break down" formulae which correspond to a shift towards more balanced situations of interdependence with the developing countries.

23. Industrial agreement formulae adjust themselves to the types of owner liable to assume risks associated with the contractual formula considered[(8)]:

Table 2

Construction formula	Typical contractor	The most frequently used formula in typical relationships:
Conventional steelmaking Breakdown formula	engineering	between industrial countries
Design and supply formula	supplier	between western and socialist economy industrial countries
Formulae (turnkey (product in hand (market in hand	assembler	between industrial and developing countries
Mini-plants	assembler	between western industrial and developing countries
Direct reduction	process owner	between western industrial and developing countries

(8) After the study by A. Benbouali: "Long-term Contractual Arrangements for the setting up of capital goods in the iron and steel industry" - UNIDO ID/WG. 324/6. - September 1980

24. The various functions considered in the agreements have different impacts and financial "weights". For example, for an investment on a virgin site, using the conventional route, their distribution is as follows:

Table 3

Functions	% of investment cost
Design and coordination function	10
Industrial know-how function	5
Suppliers function, of which - processes and standard components 40% - common components 5%	45
Transport and contracting function	30
Taxes	10

Each of these functions shoulders financial risks which vary according to the projects, the greatest risks being linked, in all cases, with the "contractor" function.

25. The various functions linked with construction are therefore largely controlled (apart from some exceptions) by the industrialized countries, whether they involve:

- design,
- industrial know-how (with the exception of the HYL direct reduction route and the "charcoal" route),
- the essential parts of the equipment supplies.

For this reason the industrialized countries largely control the costs and also, finally (with a few notable exceptions), the exporting capabilities.

From the viewpoint of implementing a new international economic order the objective of international negotiations is to reduce or overcome the constraints which arise from such a control, the effect of these being to hold back or to block the desired developments.

These negotiations will therefore be the more effective when they take into account the actors and the interests which unite them, together with the contradictions which are liable to oppose and weaken them.

26. Faced with the industrialization needs and the weakness of the design capabilities in the developing countries assemblers, as a result of their financial power, can meet the request for complete plants ready to operate. They offer their services in all the branches of heavy industry.

27. The suppliers of process equipment, consultant engineers and general companies which have financial resources, are converted, in many countries, into assemblers. A number of these however have not followed this trend for various reasons. Either they have a de facto monopoly (licences, processes, etc.) or a market directed towards the industrialized countries. Or it may be because they prefer to offer their services to an assembler as sub-contractors. Or again it may be because their sector of activity is located sufficiently downstream in the iron and steel production process. Again it may be because they do not have the necessary financial resources, and this would have led to their losing their autonomy to the benefit of banks or other companies.

28. The developing countries therefore find themselves, when importing complex integrated plants, dealing with assemblers and, for the construction of special workshops, with engineering companies and equipment suppliers. This diversifies the possibilities of competition or agreement.

29. In general the absence of iron and steel industries in the developing countries will be seen in the list of partners. This is due to the fact that engineering companies and manufacturers of equipment benefit directly from this support, or because the assembler, through his industrial group, may have recourse to the services of an integrated producer. In fact the experience of the producer is transferred through the engineering company

or the equipment supplier, but it is rare for it to be directly transferred to the partners in the developing countries through existing forms of industrial arrangements. In actual fact the developing countries can easily find suppliers of plants and equipment, but few iron and steel companies ready to assist them in their iron and steel production development. This situation is at the root of the difficulties when plants are commissioned and go into full production.

30. This linking of controls has other effects. Assemblers depend on the financial and economic power of the industrial groups. Their links with political quarters and financial environments make it possible for them to obtain financing for their clients. However, as a counterpart, and in the case of agreements concluded with the oil countries, they have the implicit or explicit function of participating in balancing the oil bill by exporting integrated equipment goods.(9) Assemblers, less numerous in heavy industry, are therefore able to establish relationships between themselves in order to control the trends on the international market. Undoubtedly this does not exclude competition, but it may contribute towards limiting it in an irregular manner. In fact investment costs have increased by more than the rate of inflation (see Dossier VII: Costs and financing), and this leaves no doubt as to the desire to achieve a compensatory transfer in respect of the oil transfer.

Rising investment costs, the difficulties of financing and the problems posed by the fusion and efficacy of technological transfer, cause serious disquiet in the developing countries concerning the oligopolic constraints imposed on them by the industrialized countries.

Difficulties in managing construction

31. Certain developing countries are tempted to choose the most general contractual formulae in order to transfer the maximum responsibility for design and construction to their partners in the industrialized countries.

(9) This phenomenon is found in industrial countries which play an important role in the capital goods market. Thus it has been calculated that between 1973 and 1977 Germany paid more than half its oil bill by profits on trading in manufactured goods. Michel Fouquin: "L'adaptation aux conditions nouvelles de la croissance" - in 'Spécialisation et adaptation face à la crise Etats-Unis, Japon, Allemagne, France, Royaume-Uni' - Economie prospective internationale - January 1980.

Sometimes they have no other choice. But in any case the investor cannot escape the inalienable responsibilities of the final owner.

He must in all cases face up to the difficulties inherent in exercising his responsibility in regard to the problems of constructing the project, as linked to the selected constructional formula.

32. This is why, in the construction phase, the final owner is confronted by the following typical problems:

- the nature and quality of relationships between the partners, (effect of the technology on the new environment),
- the promotion of local manufacture, works and services: influence on costs, deliveries, quality and financing,
- adaptation of the technological choices to local conditions: defining the possibilities of utilizing local materials, the packaging of imported material, the realization of technological transfers, the organization of sub-contracting, etc.,
- control of the state of advancement of planning of the technical project and coherence with the programming of infrastructure works: inspection, follow-up, qualitative and quantitative control, problems posed by the speed of decision-making, etc.,
- control of the budget: scheduling of expenditure, cash flow requirements, transfer of currency, management of credits, calls for funds, etc.,
- implementation of the human and management structures, control of the personnel function: policies for recruitment and training, etc.,
- assistance of the foreign partners in their administrative and technical operations with the local authorities: taxation, customs clearance, work permits, building permits, problems of water and other supplies, etc.,
- choice of partners to achieve a genuine technological transfer,

- control of the final execution of the project and the ability to manage disputes: performance tests, project balance sheets, etc. (negotiation, arbitration, etc.).

These are the difficulties posed by construction management in the developing countries. The conditions which are necessary for success in this phase and for facing up to the subsequent stages presuppose:

- an environment which is receptive to the introduction of technology,
- good human and professional relationships between the local authorities, the project management team, the personnel of the project and the various partners,
- a minimum of competence and technical and human qualities in the project management team,
- adaptation of the personnel and of the team leader to the possibilities and difficulties in the mode of realization which has been selected, so as to exercise their responsibilities effectively,
- a widely distributed competence between the partners so as to ensure the best execution of the construction of the project and of the technological transfer.

33. Without developing a specific analysis of the problems and difficulties encountered by the developing countries in regard to the various forms of realization the following should be pointed out:

- in the case of turnkey formulae: the quality and degree of detail of the preliminary studies and their influence on the level of commercial tenders, the difficulty of prior defining of the lists of spares, the problems posed by the contractual formalization of performance tests, etc.
- in the case of break-down formulae: the problems posed by distributing competences and choices between the designer and the client, the problems posed by budget revisions, etc.

C. INDUSTRIAL KNOW-HOW AND ACHIEVING FULL PRODUCTION: SOME PROBLEMS

34. The phase of achieving full production is the most difficult since it involves a progressive transfer of technical and management responsibilities to the personnel of the final owner. Its success assumes, simultaneously, the efficient transmission of know-how and a high capacity for assimilation at the various categories of the local personnel.

Many obstacles and hold-ups are encountered during this phase.

35. They arise initially from problems of recruitment and training. To difficulties of a social, cultural and vocational type are added the problems of collective apprenticeship which are poorly resolved in the training structures traditionally formed to train individuals as a function of job profiles (see Dossier VI: Labour and the development of human resources).

36. They then arise from problems of technical assistance at the time the skilled personnel sent by the engineering companies and the equipment suppliers are transferred, by the foreign partners, to other industrial operations. In general other foreigners arrive during the commissioning period; freshly expatriated, they have to discover new installations together with personnel still under training. Such a discontinuity is generally reflected by major difficulties in solving the problems which arise at a phase of non-stabilized production and, for the local personnel, by the lack of satisfaction in living through a period offering valuable teaching opportunities but without having the means to profit fully from these.

37. The problems of achieving full production are, furthermore, aggravated:

- firstly by marketing problems.

  High prices, mediocre quality and poor delivery dates result in a critical attitude on the part of consumers where local products are concerned. Extended delivery delays are particularly difficult to accept, inasfar as the forecasts and plans of users, forced to buy locally, are constantly being upset.

From the producers side the programming of production is disrupted by the multiplicity and the urgency of orders in quantities which are too small, the more so since they are required by the authorities to give priority to certain deliveries to public or private clients;

- secondly by financing problems, arising from slowness in achieving full production.

This is, in effect, the period when - paradoxically, the authorities, feeling that they have already made very considerable sacrifices to establish the new project, become disturbed in the face of the poor production results, at the approach of reimbursements of foreign loans, and they find it difficult to make a balanced analysis of the situation. Furthermore the reference to the importing price of equipment and know-how go back several years, allowing financial administrations and consumers to make unflattering comparisons.

Difficulties in cash flow and the price of the products become daily problems for the executives.

38. The achievement of full production has a direct influence on financing requirements during the period because of its impact:

- on the capacity to reimburse loans,
- on the appearance of supplementary financing needs as a function of modifications to be made to the project, and also the discharging of any losses.

These new financing needs are, generally, met by institutions (banks), different from those which have participated in the financial arrangements for the investment. Furthermore whilst the initial financing of the project was easily understoo' by the bankers the needs which appear during this transitory phase are less easily understood and hence poorly resolved. Banking organizations refuse, in general, to carry out any new analysis until production is stabilized. However the needs remain; they become increasingly large until they sometimes reach a volume similar to the total amount of the investment. Urgent solutions are then conjured up: subsidies, price increases, takeover of infrastructure investments, reduction of taxes on purchases, etc. These measures, taken under the pressure of events, rarely make it possible to solve the problem correctly.

The political authorities then become anxious, take over the files themselves and try to find a solution. This scenario is largely common both to industrialized countries and also to developing countries. In the developing countries, however, the novelty of this type of iron and steel investment induces the authorities to show greater prudence in regard to any future investment in the iron and steel sector.

D. INDUSTRIAL KNOW-HOW AND ACHIEVEMENT OF FULL PRODUCTION: ANALYSIS OF SOME EXAMPLES(10)

39. Analysis of the operation of ten iron and steel plants over a period of 6 to 15 years makes it possible to demonstrate more concretely a number of evaluation criteria.

These are the following plants:

SOLLAC	in France
SICARTSA	in Mexico
EL HADJAR	in Algeria
BHILAI MUSCO DURGAPUR ROURKELA	in India
QASCO	in Qatar
USIMINAS COSIPA	in Brazil

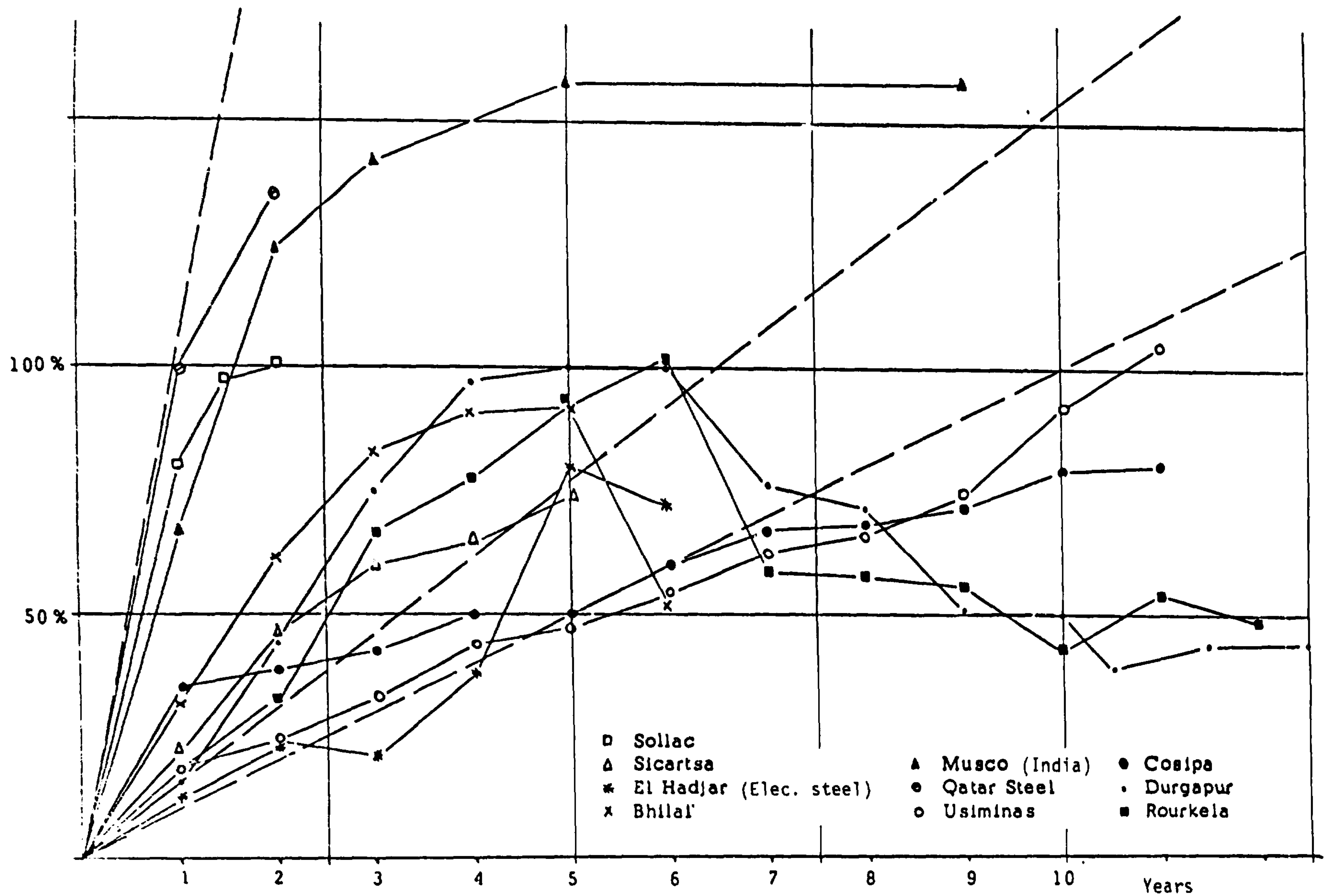
40. The respective rates of achieving full production of these various plants are shown in the following diagram.

41. Initially ignoring the technical characteristics it may be said that, in practice, all cases of reasonably envisageable operation are included. It is true that, in certain countries, there are plants which have never produced any steel: this is a limiting case, but one which is nevertheless possible.

On the diagram can be seen three principal families of curves:

a) Those which correspond to a rapid start-up: only 1 to 2 years are needed to achieve 100% production, and even in some cases to exceed the forecast capacity. It will be seen that, generally, plants which start up in this way not only achieve or exceed their nominal production capacity but maintain this, and this can be seen clearly in the case of the Musco plant;

(10) This section has been produced on the basis of a study by Messrs. J. Astier and J. Migeon: "La formation de la main-d'oeuvre dans la sidérurgie" - UNIDO - January 1982.


100%
50%
1
2
3
4
5
6
7
8
9
10
Years
Sollac
Sicartsa
El Hadjar (Elec. steel)
Bhilai
Musco (India)
Qatar Steel
Usiminas
Cosipa
Durgapur
Rourkela

b) Those which correspond to a steady but slow start-up: 10 to 11 years are needed to achieve 100% of the forecast capacity;

c) An intermediate family, reflecting steady achievement of full production at a rate which is more or less satisfactory. Within this family we can identify those plants which, after having reached a very satisfactory level of operation, then slow down their rate until an actual collapse can be seen.

The first evaluation criterion which can be extracted from an examination of the situations shown on the diagram is that, in these countries, there are plants which have start-ups and productivities as satisfactory as the best plants in the industrialized countries and that, at the other end, there are cases which would be regarded as economically unacceptable in the industrialized countries. If we look at these extremes in a little more detail other findings arise from a second analysis:

42. Case A. This consists of three examples:

- a European reference case,
- the Qatar Steel plant,
- the Musco plant.

It is necessary to analyse the case of Qatar Steel from two viewpoints: technical and human. Technically this is a unit of medium size directed towards a highly specific production: round rods of 10 - 32 mm, leading as a consequence to a simple plant and to a small staff of only 1,000 employees (the nature of the route has a considerable influence on the total manpower). This is therefore the most favourable case: direct reduction, electric steelmaking, continuous casting.

At a human level this plant, the management of which is entrusted to the Japanese, is also a special case since the personnel consists almost entirely of foreigners: Japanese engineers, Indian, Egyptian, Pakistani and Bengali foremen and workmen.

Furthermore strict selection was carried out before employing staff (at least five years practical work), and this was followed by serious training of the personnel.

This is therefore a plant situated in Qatar and belonging to the Government of this country (70% of the capital), but operated by foreign capital with the stated object of profitability.

A priori this case would seem to have little interest, since it may be felt that it does not in any way enrich the human potential of the country and that it is practically a "foreign factory".

In fact if one reasons in the long term it is reasonable to ask if this strategy is not better than it may seem initially.

Qatar is a small country (100,000 inhabitants) which would have had serious quantitative and qualitative problems in providing skilled personnel for a plant which would, without any doubt, have encountered serious start-up problems. However the country now possesses a satisfactory plant which produces products necessary for the region under good economic conditions. Well operated, this plant will encourage satisfactory attitudes towards management of production, etc. which will be consolidated in years to come.

Qatar has all the time necessary to train managers and technicians which it can then inject, if it so desires, in a progressive manner without disrupting the operation of the plant. At least this is a hypothesis which corresponds to a possible situation, even if it is not envisaged at the present time by the Qatari executives.

43. Musco (India) is also a special case, where its specific nature is linked to the type of production.

This is a plant producing special steels, that is to say a small tonnage but high quality production. Because of this quality, and hence technique, is more important than quantity. This is therefore a unit with small capacity equipment and, since the plant converts scrap iron loaded into an electric furnace, the production chain begins at the stock of scrap iron without any need to be concerned with continuity between the production of steel and the upstream production of cast iron.

Furthermore the steelworks does not have any continuous casting, but casts ingots which are then processed in a blooming mill and a rolling mill, so avoiding a second difficult interface between steel production and continuous casting.

The company responsible for the engineering and construction (PUK) encouraged the client to build a plant totally identical with its French model, and this facilitated the achievement of full production inasfar as the teaching personnel, carefully selected, were trained in France in the model plant. The Indians, on their return, found themselves within a known framework with known equipment and organization.

It is also interesting to know that the plans for extensions have been carried out by the Indians in collaboration with a French team. If we refer to the operating results this construction is obviously a great success, as reflected by a constantly rising profit situation ever since it was created.

It seems therefore that this is a satisfactory methodology for constructing a steelworks which "operates" under very good conditions.

44. In fact it is necessary to weight these "steps to be followed" by the following findings relating to:

a) the size of the plant: this is a small unit employing a limited number (1,600) of employees;

b) the structure of the plant: this is technically simple, since there is no production of the primary metal. The route is, furthermore, discontinuous; that is to say each unit is independent of the other. The electric furnace produces its steel and casts it into ingots; the blooming mill takes these ingots to produce billets, which are then sent to the rolling mill. The production process is therefore composed of independent sequences with possibilities of storage, and hence buffer stocks, of the solid products, scrap iron, ingots and billets;

c) the production, which involves high value added products, are produced using a specific technology requiring the highest quality control.

The characteristics of these cases are therefore: simplicity of the plant, high technicity, limited but highly skilled personnel, but also the existence of a plant faithfully reproducing a model already in operation.

45. Case B. In this category are plants corresponding to curve B which show a slow rise to full production (10-11 years to reach 100% of the stated capacity).

The two cases illustrating this trend are those of the first Brazilian units for flat products (the oldest, CSN, has not been taken into consideration).

These are plants with an initial capacity of 1 million tonnes, the subject of successive extensions. They are integrated plants, based on the classical route comprising coking ovens, units for preparation of the charges, blast furnaces, converters and rolling mills. It will be noted that in the first phase these plants did not have any continuous casting.

It is possible to see a regular but very slow growth of production during the first phase with, obviously, a considerable loss of production over a long period.

It is difficult to draw more lessons from these cases; however it is necessary to draw attention to the fact that these are complete, and hence complex, units with all the requirements of synchronization of the production of various parts. The management factor in large complexes of this type begins to assume increasing importance, together with the mass production factor.

Examining what takes place during extensions a very interesting phenomenon can be seen, particularly clear in the case of Usiminas, which has undergone several increases in capacity. After a laborious start-up it is found, in effect, that the increases in capacity, far from disrupting the plant, are very rapidly operated up to their maximum capacity, and even beyond this in the case of Cosipa. The structure of the plants not having been simplified by these developments one must attribute these results to the human factor without, however, being able to go into further detail (Table 4).

Table 4 U S I M I N A S

(mt = millions tonnes)

Nominal cast iron production capacity	Period of operation	Theoretical production	Actual production	Operating level	Losses
1.160 mt	10 years	11.6 mt	6 mt	51.7%	5.6 mt
1.4 mt	2 years	2.8 mt	2.55 mt	91 %	0.26 mt
2.4 mt	4 years	9.6 mt	8.72 mt	91 %	0.88 mt
3.5 mt	2 years	7 mt	6.4 mt	91.5%	0.6 mt
Total	18 years	31 mt	23.67 mt	76.3% (mean operating level)	7.34 mt

The manpower of these plants, about 13,000 employees, should be compared with that of the Musco and Qatar Steel plants.

46. Case C. This is a category which we are grouping together for simplification. In fact apart from the El Hadjar electric steelworks, treated separately. it comprises integrated plants of similar capacities for long products.

First finding: from an examination of the curves the two Indian plants show a rise in production which, if not very rapid, is at least continuous and which allows them to achieve production levels of 90% to 95% after four years, which is not at all bad, the Mexican Sicartsa plant reaching only 65% in the same period.

After having reached this level of operation, and maintaining it, the Bhilai and Durgapur plants were the subject of extensions bringing their capacities up to 2.5 mt and 1.6 mt; then a phenomenon appears, entirely unlike that found in the case of Usiminas and Cosipa: the productivity falls suddenly, as if the entire plant was disrupted if not disorganized (Tables 5 and 6).

47. It is difficult, in the absence of more detailed information, to explain this phenomenon, but some hypotheses may be advanced:

- The first is that personnel, trained to use well-known equipment did not have the necessary training to transfer their knowledge to a new context;
- The second concerns the size of the labour force in the Indian plants, which without any doubt presents extremely difficult personnel management problems;
- The third hypothesis depends upon the arrival of a large contingent of persons without plant tradition, disrupting a managerial system which was not prepared to take them in hand.

One must however attribute this fall in production, or at least the greater part of it, to human factors.

It will be recalled that the estimated manpower of these plants was 35,000 to 50,000 employees in 1976.

Table 5 BHILAI

Nominal production capacity of ingots	Operating period	Theoretical production	Actual production	Operating levels	Losses
1 mt	5 years	5 mt	4.35 mt	87%	0.65 mt
2.8 mt	15 years	37.50 mt	29.38 mt	78%	8.12 mt
Total	20 years	42.50 mt	34.73 mt	81.7% (mean operating level)	8.82 mt

Table 6 DURGAPUR

Nominal production capacity of ingots	Operating period	Theoretical production	Actual production	Operating levels	Losses
1 mt	8 years	8 mt	5.7 mt	71%	2.3 mt
1.6 mt	13 years	20.8 mt	11 mt	53%	9.8 mt
Total	21 years	28.8 mt	16.7 mt	58% (mean operating level)	12.1 mt

The Mexican Sicartsa plant has only been in existence for five years, but it is progressing very slowly and it is not likely to reach its nominal production capacity until the end of seven years. There is clearly much slower progress here than in the Indian plants during their first phase.

To what factor is this slowness to be attributed ? Not to the manpower, which is not excessive, being of the order of 7,000 employees, but perhaps to the quality of its training and perhaps also to the continuous casting of all the production, which does not exist in the Indian plants which were considered.

The example of the El Hadjar electric steelworks is mentioned to show that even a production tool taken in isolation may have problems in achieving full production, particularly when it involves a new production route in the plant.

48. After having carried out this classification to compare these different cases, is it possible to draw any conclusions ? This is a difficult exercise, and it is necessary to be very careful in the framework of an approach as limited as this to the problem.

The cases analysed show clearly that many factors are not comparable from one plant to another, and that identical effects may arise from different causes (size of the plant, production, country, techniques, etc.).

One may, however, attempt to highlight some of the parameters which are liable to influence the operation of an iron and steel plant, knowing that there is no success or failure which does not have a human cause situated either at operator, designer, or technical or political decision-maker level, and that, secondly, one of the first parameters to be taken into consideration is the size of the plant.

49. However it is also necessary to recall, on this subject, that for the same production capacity the size of the workforce may vary over a wide range. To confirm this it is only necessary to compare the manpower in plants of equivalent capacity in India and in Japan.

In fact several factors intervene which operate in opposite directions. For example, technicity or, if it is preferred, the sophistication of the plant (automation, data processing, etc.), tends to reduce the number of employees but on the other hand requires more varied and detailed knowledge and greater technicity; mechanization operates also in the same direction.

50. By contrast in some countries the quality of the surrounding industrial fabric is an important factor which must be taken into consideration. In the highly industrialized countries a considerable volume of the work is sub-contracted to smaller companies. A very considerable amount of work is in this way withdrawn from the plant itself, with all the advantages which this brings. The actual manpower of the plant is reduced in this way and various aspects of management are considerably lightened (financial, maintenance, personnel, etc.).

By contrast in those countries which do not have such an environment the plant must undertake all these activities, representing excess manning which loads and complicates management.

It is better therefore not to speak of the size of the plant but rather of the manpower necessary to carry out all the functions necessary for its operation. Sometimes an exaggerated increase in employees arises from a political desire to absorb unemployment (Table 7).

51. Finally another parameter is likely to have a considerable influence on the operation of the plant: this is the choice of the steel production route.

In this field it appears that the actual degree of complexity only intervenes by its incidence on the number and skill of the workers required. Although the iron and steel industry remains labour intensive certain techniques allow interesting comparisons, for example between the routes leading to the primary metal but following the following schemes:

iron ore - blast furnace = cast iron
iron ore - direct reduction = sponge iron

Table 7

Plant	Nominal capacity	Personnel (1976 estimate)	Manpower per tonne
BHILAI	2.5 mt	54,000	0.0216
DURGAPUR	1.6 mt	36,000	0.023
ROURKELA	1.8 mt	41,400	0.023
IISCO	1.8 mt	22,400	0.0125
MUSCO	36,000 t (special steels)	1,600	0.041
QATAR	400,000 t	1,000	0.0025
PAZ DEL RIO	0.3 mt	6,900	0.023
SICARTSA	1.25 mt	7,200	0.006
USIMINAS	2.4 mt	13,000	0.0054
COSIPA	2.1 mt	13,000	0.0062
CNS	2.5 mt	20,878	0.0083
SOLLAC	2.5 mt	16,000	0.006
SOLMER	3.5 mt	6,715	0.0019
USINOR (total)	12 mt	40,000	0.0033

It is clear that each of these two routes requires staff with very different training, but particularly in very unequal numbers, the second route being more like a petrochemicals process. Whilst there is a transfer of metal in the liquid state (1200 - 1300°C) with the blast furnace, with all the psychological and technical constraints that this involves, the product obtained by the second route (iron sponge) remains solid after the direct reduction process.

By its very nature the route plays a role in operation, but the impact of the choice of one or other route operates mainly through the types of personnel required for its utilization.

There is another factor which conditions the efficient operation of a unit and which more rarely receives attention; this is the aptitude of the overall management of the plant, and in particular the possibility of solving problems related to the interfaces which exist between various workshops, that is to say different specialities. For example a long products plant may consist of a blast furnace and an oxygen steelworks followed, in one case, by casting ingots and a blooming mill, in the other case by continuous casting.

It is necessary to appreciate that the refining operation in the converter is relatively short (40-45 minutes) and that, once completed, it is not possible to hold the liquid steel in the unit since it must be fairly rapidly transferred into a ladle; it cannot be retained in this for very long because of the cooling of the metal.

In the case of casting into ingots it is only necessary to prepare in advance the number of ingot moulds which are needed to receive the steel. If for any reason a larger margin of safety is required it is sufficient to increase the number of ingot moulds. By contrast the continuous casting unit has its own flowrate which, as its name indicates, must be continuously supplied; this requires very precise synchronization of the steelworks so that the casting equipment does not lack steel and also that the liquid metal is not kept waiting too long in the ladle.

It can clearly be seen therefore that in this case there is a need for close synchronization at the interface between the two workshops; this is not always easy to effect, even in the industrialized countries.

In fact the training requirements linked with the techniques of each workshop have superimposed on them the need to understand, at least partly, those of the other. It is therefore possible to imagine two workshops having the personnel needed to operate efficiently and independently but incapable of ensuring joint production as a result of lack of coordination.

Symbiosis of the two workshops requires an additional level of training so as to be able to face up to the "timing" imperative.

52. Considering the previous example again, but replacing converters by open hearth furnaces, the problem becomes less acute when supplying the continuous casting unit since errors have fewer consequences. In fact the operation of the open hearth furnace is a long process (several hours), and this is a heated unit which makes it possible to hold the metal simply at the cost of an additional consumption of energy. The factor of urgency linked with the converter has disappeared, and it is possible to operate more calmly.

If more independence in the sequences is sought one arrives at a plant supplied with scrap iron or pre-reduced products (whether it produces these itself or not), forming a series of workshops which may be considered as independent from the point of view of the succession of sequences.

It is important in such a process that the difficult handling of the liquid metal should be reduced to the minimum and that it should involve only one workshop, the steelworks (the electric steelworks not being the only option). Upstream of the electric furnace everything is solid, whether scrap iron or pre-reduced products. No overriding linkage problem therefore exists, except as a result of a stock breakdown against which it is possible to take precautions by providing large operating reserves.

At furnace and ingot casting level there is no urgency or interface; it is even possible, with an open-hearth furnace, to hold the liquid metal at the right temperature in the furnace. The steel is converted into ingots which are stored and then sent, as required, to the blooming mill. Here again it is sufficient to provide appropriate buffer stocks.

At blooming mill and rolling mill level there are no interface problems, since when the existing technique is used the solid metal is reheated before treatment.

Since there is no continuous linkage between the workshops any variation in production is only reflected in changes in the buffer stocks.

In the limit the operators of one workshop can ignore the problems and techniques of the other workshops.

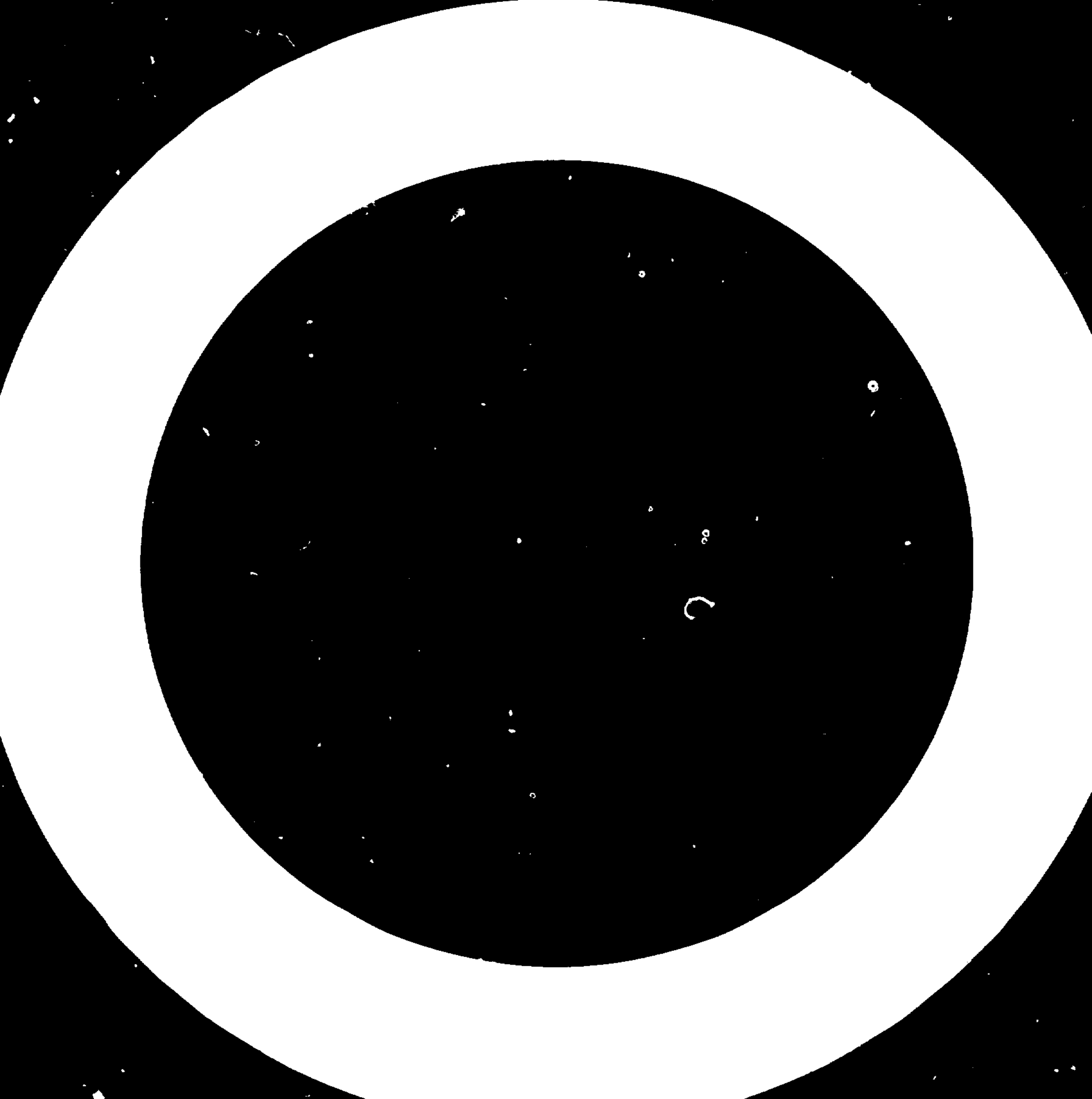
It is, in fact, these problems of highly programmed linkages located at the workshop interfaces which are the cause of a great part of the problems of modern plants.

53. On the subject of manpower the local conditions specific to each country must obviously be mentioned. Without delaying too much on these, since they are well known, it is necessary to recall the requirements of continuous operation industries which require operation throughout the 24 hours, using the three 8-hour shift system. This method of working requires considerable physical effort and, in certain countries, this leads to increasing the number of workers per shift in order to achieve the same result. This most important parameter must be taken into account, since there is no possibility of action on the climate, way of life or feeding habits and, as a consequence, on the strength of men. It is not all that unusual to see the manpower vary, for a similar plant, from 1 to 3 and even from 1 to 4.

As can be seen from this rapid survey certain factors tend to reduce manpower, others to increase it. It is necessary to be conscious of these, and in particular to know what price has to be paid in each case: higher technicity, reduction of production, security of production, etc., whilst at the same time knowing that any increase in manpower complicates the problems of training and introduces enormous management problems, both of the personnel and of the plant (see the case of plants with tens of thousands of employees).

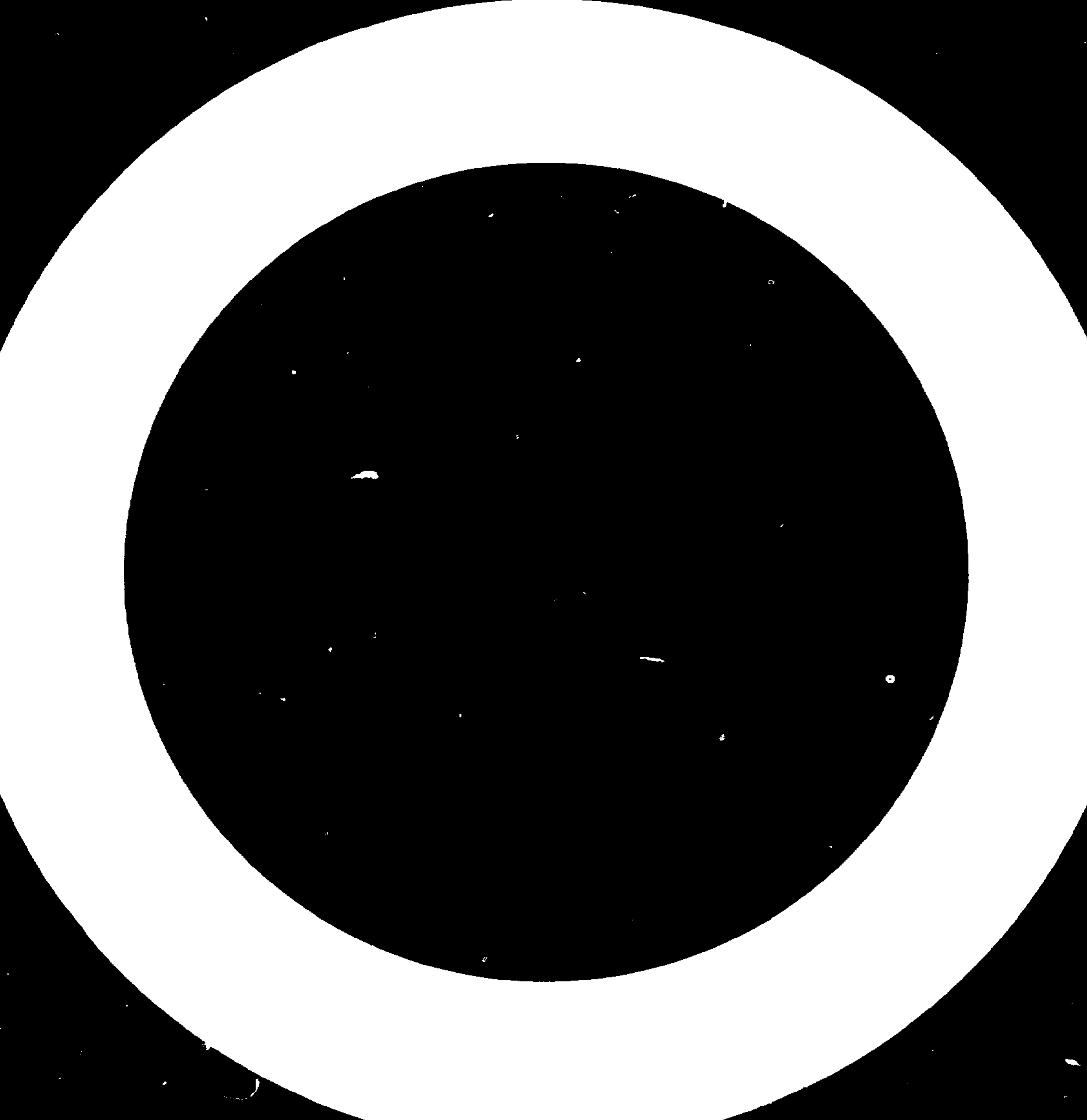
54. Finally it can be seen that the impact of the level of training on the operation of the complex is of primary importance.

Older plants are very well operated by excellent personnel, whereas in no plant can incompetent personnel achieve good results, even with modern installations; this leads to the need to give considerable attention to training problems.



DOSSIER VI

THE TRAINING OF HUMAN RESOURCES FOR THE IRON AND STEEL INDUSTRY



A. THE ESTIMATION OF MANPOWER REQUIREMENTS

1. Under the low growth scenario the production capacity of the iron and steel industries in the developing countries (excluding China) would be approximately doubled: under the normative scenario it would be multiplied by 2.5. Consequently it will, broadly speaking, be necessary to construct an iron and steel industry at least equal in capacity to that which already exists, and of higher performance. It follows that it will also be necessary to train the corresponding human resources, that it to say to at least double the existing manpower. It is possibly this, rather than the financial constraint, that will prove to be the principal challenge for the future of the iron and steel industries in the developing countries.

In addition to this general comment it is necessary to specify the needs of the developing countries in terms of human resources.

2. The estimate of the needs for a given capacity will vary as a function of the policies governing employment, production and the proposed productivity.

The objectives of the companies (and of the governments) may differ.

. It is possible to envisage the rapid supply to the country of one or all categories of steel in order to achieve strategic independence and economies in foreign currency. In such a case the human resources policy may largely consist of calling on foreign labour (e.g. Qatar) or of engaging in a systematic programme for the training of local labour (e.g. Algeria) or again a combination of these two solutions.

. It is possible to envisage creating jobs by recruiting many workers, in excess of the number of actual work stations. It is felt that such an excess may make it possible to offset the absenteeism which is often high with workers of rural origin. It is assumed that the apprenticeship of a large body of workers will be effected in the long-term.

. It is possible to envisage the mastering of a special technology or to raise the level of training of a population, the plant playing the rôle of an applications school.

It is necessary to distinguish between the transfer of intensive knowledge and extensive knowledge. In the former case it involves the transfer of a considerable body of knowledge to a small number of persons: in the latter case it involves transferring simple information to a large number of workers. When it involves transferring the technology of a sector it is necessary to transfer much knowledge to a large number of men: this is the most costly case of technological transfer. It is possible to classify technological transfer in a branch, the transfer of the technologies specific to a company and process transfer in that order of decreasing cost.[(1)]

The transfer needs will therefore vary according to the chosen objectives and with the initial level of training of the local human resources.

. These objectives may conflict with each other. For example a policy directed towards a reduction of unemplcyment may lead to low productivity, and this is not a good environment for training workers. The continuing low productivity perpetuates low wages and, even despite these, there is no guarantee that a financial profit will be achieved.

A policy directed towards the rapid achievement of full production, using the services of foreign management and imported personnel, may make it possible to achieve high levels of productivity and to obtain profits, despite salaries which are relatively high for the country. Access of local personnel to posts of responsibility, or even of production, may on the other hand take a very long time, but it is at least effected in the environment of a company which is performing satisfactorily.

It follows from this that it is valuable, from the time of proposing a plant, to define clearly a priority objective and supplementary objectives and, as a consequence, to define the level of personnel needed to realise them.

3. Estimating the personnel requirements to realise the low growth and normative scenarios obviously cannot take into account, in the absence of sufficient information, these priority objectives selected by the developing countries. A two-stage approach has therefore been adopted: firstly the extreme values, maxima and minima, for the labour requirements of the two scenarios have been calculated on the basis of observations made in companies and relating to apparent labour productivities (see Dossier V); secondly these results have

(1) G.R. Haul and R.E. Johnson: "The Rand Corporation - Transfers of United States Aerospace Technology to Japan" in "The technology factor in international trade'. R. Vernon - NBER - 1970

been interpreted within the constituent logic of the scenarios.[2]

4. The manpower requirements, based on the observed productivity ratios, may fall between the extreme figures given in Tables 1 and 2.[3]

It may be seen that the personnel needed shows considerable divergencies in the two scenarios and according to the hypotheses of high or low productivity. These requirements vary from 165,000 to 1,100,000 persons (figures rounded off) in the low growth scenario and from 530,000 to 2,015,000 in the normative scenario.

5. These results have to be interpreted within the logic of the two scenarios.

It will immediately be seen that the low productivity of labour, as observed in certain companies in the developing countries, does not necessarily result from the deliberate choice of maximising employment. This may be due to an inability to arrive at the correct rate of achieving full production, the excess of iron and steel manpower not being the result of an employment policy but rather of management difficulties - or a combination of both these reasons.

. In the low growth scenario two opposed forces may operate: on the one side the constraints of profitability which exclude financial laxity (the rationalization of crises is one of the manifestations of this tendency) and on the other the constraint of the pressure of unemployment accentuated by the poor rate of economic growth and, in certain developing countries, population pressure which leads to taking on new personnel in the iron and steel industry. It is difficult to conjecture which tendency will prevail over the other, the more so since the situation will vary from country to country.

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(2) The reader interested in the forecasting methods should refer to the ILO (International Labour Office) brochure: "The forecasting of manpower requirements in the iron and steel industry and its significance for the recruitment and vocational training of the industry's labour force" - Iron and Steel Committee - Ninth Session - Geneva 1975.

(3) The ratios have been observed in a sample of countries in the developing countries (see Dossier V).

Table 1. Estimate of the personnel needed for projects built within the framework of the low growth scenario

Number of projects	Definition	Basis of calculation for determining personnel	Capacities mt/year	Estimated personnel needed	
				H_1 lower	H_2 upper
8	Micro-plants, less than 100,000 t/year	slightly above 300 persons per plant	0.540	2,400	2,400
30	Mini-plants, 100,000 to 500,000 t/year	H_1 1,500 persons per plant (0.0050 man/t) H_2 1,000 persons per plant (corresponding to 0.0033 man/t)	8,120	26,800	40,600
12	Medium plants, 0.5 to 1.0 mt/year	mean estimates of H_1 0.0200 man/t H_2 0.0025 man/t	9,565	23,912	191,300
25	Plants larger than 1.0 mt/year	mean estimates of H_1 0.0200 man/t H_2 0.0050 man/t	45,255	226,275	905,100
Total; 75		Totals:	63,480	273,390	1,139,400

Table 2. Estimate of personnel needed for projects built within the framework of the normative scenario

of projects	Definition	Basis of calculation for determining personnel	Capacities mt/year	Estimated personnel needed	
				H_1 lower	H_2 upper
29	Micro-plants, assumed non-integrated less than 100,000 t/year	Slightly above 300 persons per plant	1.5	8,700	8,700
51	Mini-plants, 100,000 to 500,000 t/year	H_1 1,500 persons per plant (0.0050 man/t) H_2 1,000 persons per plant (corresponding to 0.0033 man/t)	18.5	66,700	101,500
17	Medium plants, 0.5 to 1.0 mt/year	mean estimates of H_1 0.0200 man/t H_2 0.0025 man/t	15.0	43,100	261,300
41	Plants larger than 1.0 mt/year	mean estimates of H_1 0.0200 man/t H_2 0.0050 man/t	82.0	410.425	1,641,700
Total: 138	Totals:	Corresponding, on average, to H_1 nearly 0.0200 man/t H_2 0.0045 man/t	117.0	528,925	2,013,200

It would not seem, however, that the characteristics of the projects and the weight of the major projects of more than 1 million tonnes, where management is more complex, would make it possible to reach the highest productivity ratios, taken overall. Furthermore stricter management, even in countries affected by under-employment, would seem to exclude any policy of over-employment in the iron and steel industry.

The estimates of the manpower needs in the low growth scenario have therefore been limited as follows :

Table 3

Number of projects	Definition	Calculation basis for defining personnel	Estimated personnel needed
8	Micro-plants, less than 100,000 t/year	Slightly above 300 persons per plant	2,400
30	Mini-plants, 100,000 to 500,000 t/year	Hypothesis : 0.0045 man/tonne	36,540
12	Medium plants, 0.5 to 1 million t/year	Hypothesis : 0.0075 man/tonne	71,740
25	Plants of more than 1 million t/year	Hypothesis : 0.01 man/tonne	452,550
		TOTAL	563,230 (560,000)

. Within the framework of the normative scenario two conjugated forces may operate: on the one side the desired objective of achieving profits in the iron and steel companies, leading to the search for high profitability and productivity by limiting any increase in employment and raising the required levels of vocational skills, and on the other the growth of the economy - of which the growth of the iron and steel industry will be one manifestation - will create opportunities for employment in other sectors. As a consequence this makes it possible to approximate the needs somewhat nearer to the upper productivity hypothesis :

Table 4

Number of projects	Definition	Calculation basis for defining personnel	Estimated personnel needed
29	Micro-plants, assumed to be non-integrated, < 100,000 t/year	Slightly above 300 persons per plant	8,700
51	Mini-plants, 100,000 to 500,000 t/year	Hypothesis : 0.004 man/tonne	74,000
17	Medium plants, 0.5 to 1 million t/year	Hypothesis : 0.005 man/tonne	75,000
41	Plants of more than 1 million t/year	Hypothesis : 0.0075 man/tonne	615,000
		TOTAL	772,700 (775,000)

These two hypotheses limit the estimates to an overall range of 560,000 to 775,000 persons - which must be added, between now and 1990, to the existing manpower of the iron and steel industries in the developing countries.(4)

These two estimates are relatively low and imply, in both cases - although to differing degrees - a policy of productivity rather than a policy of priority to employment, although the positive incidence of the two scenarios on this would not be negligible. They both imply a formidable effort devoted to training the human resources.

In effect it would be necessary to train a body of workers, divided up approximately as follows :

(4) A parallel calculation based on indicators of direct manpower according to the technological routes involved, and used by Prof. V.A. Romanets and his colleagues in the study "Technological complexity of iron and steel industry products - Contribution to the world 1990 iron and steel scenarios - UNIDO - Moscow, 1981" would lead to results very similar to these estimates.

Table 5.

	Low growth scenario	Normative scenario
Engineers, executives	17,000	23,000
Foremen, technicians and staff	95,000	132,000
Skilled workers	380,000	527,000
Unskilled workers	68,000	93,000
TOTAL	560,000	775,000

These estimates have been based on the employment structure of iron and steel industries of average performance in the developed countries (engineers and executives 3%, technicians, foremen and staff 17%, skilled workers 68%, unskilled workers 12%). This breakdown does not appear to vary significantly with the technological route used. The structure of highly-developed iron and steel industries, where automated or semi-automated processes are highly developed, differs from this (engineers and executives 3%, technicians, foremen and staff 67% and skilled workers 30%, the unskilled worker having practically disappeared).

These orders of magnitude raise a number of questions. The first relates to the capacity of the educational systems in the developing countries to train the necessary workers in both quantitative and qualitative terms.

The second relates to the magnitude of the necessary transfers of human resources from the developed countries so as to allow the commissioning of the projects, and under what conditions this transfer could be facilitated.

The third relates to the cost of local training and of that which is specific to the framework of industrial arrangements, and the teaching techniques involved.

B. THE COSTS AND QUALITY OF TRAINING

6. There is a necessary correspondence between the level of the technologies applied to the iron and steel industry and the level of the vocational skills required for efficient operation.

These qualifications may be expressed in years of primary, secondary and university education, according to the vocational categories, in the duration of technical training and in the quality of the teaching received. However the quality of the teaching can only be measured by its results. By contrast the duration of the training may be expressed in terms of costs, on the basis of unit teaching costs. In this way it is possible to calculate the value of the educational stock in various iron and steel industries - or the "human capital".[5]

In 1970 the average durations of training per worker appeared to be the following, expressed in years :

Developed countries		Developing countries	
Great Britain	11.1	Argentina	6.4
Canada	10.7	Mexico	5.1
Japan	10.6	Brazil	4.7
United States	10.4	India	3.2
Federal Republic of Germany	10.3		
Holland	9.4		
Belgium	8.4		
France	7.5		
Italy	6.4		

It is probable that the periods of training in 1980 were longer, in particular in Japan, Brazil and India.

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(5) Prof. Dr J.G. Maton, H. Debbaut and J. van de Vijvere: "Productivity, Human Capital and Physical Investments in Iron and Steel - Analysis of an International Cross-section" - Seminarie voor toegepaste economie - University of Ghent, 1972

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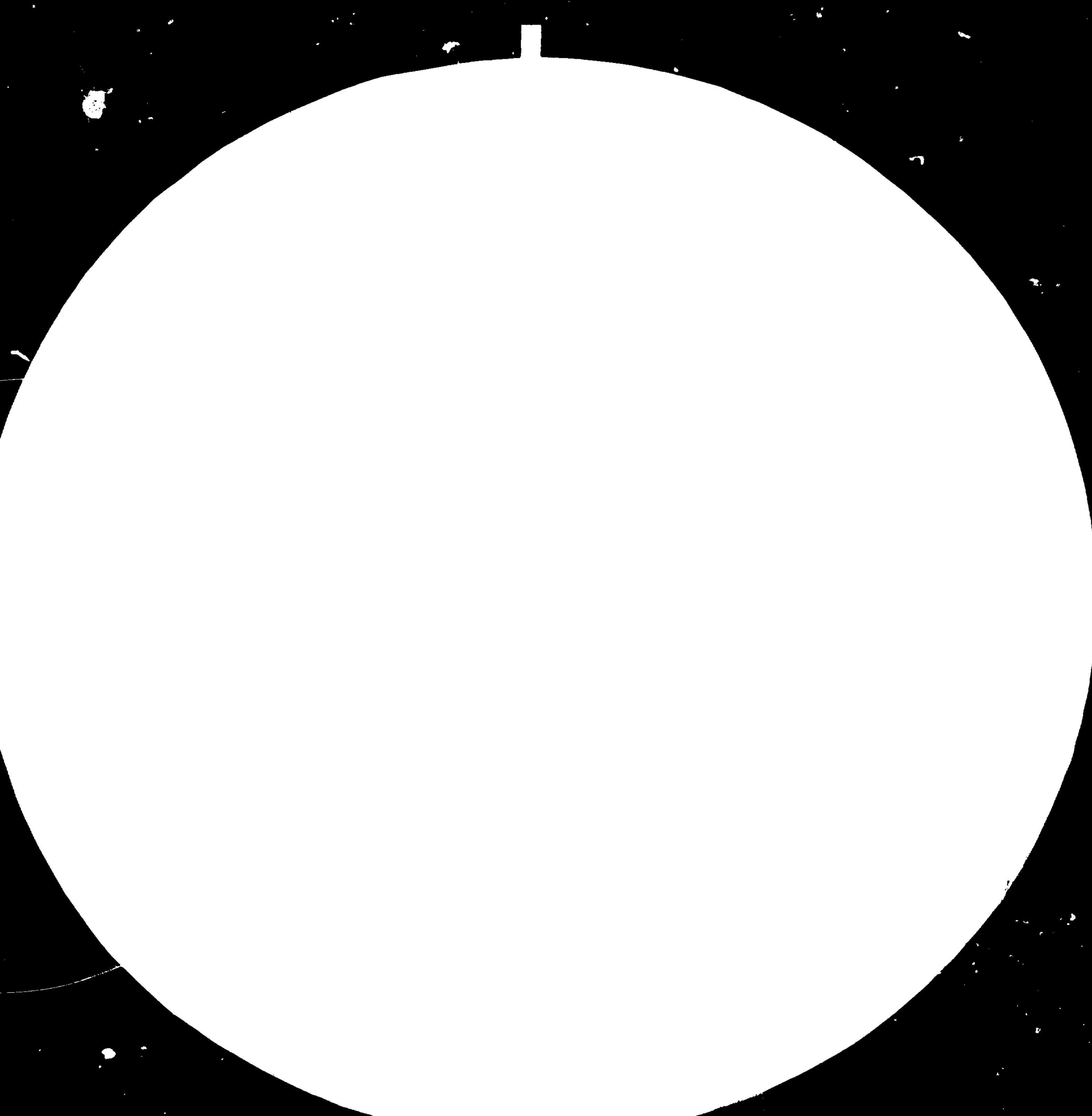

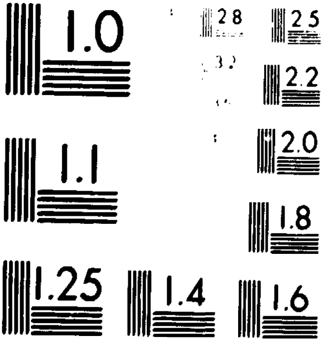

MICROCOPY RESOLUTION TEST CHART

Multiplying the duration of the training by the unit cost of the latter makes it possible to calculate the training costs per worker.[6] Wage costs, particularly those of the training staff, therefore have an effect on the results, and in 1970 they were as follows, expressed in US Dollars :[7]

Developed countries		Developing countries	
United States	18,580	Argentina	5,270
Canada	15,718	Mexico	3,047
Japan	12,995	Brazil	2,034
Great Britain	12,995	India	802
Federal Republic of Germany	9,514		
Holland	8,761		
Belgium	7,059		
France	7,059		
Italy	4,980		

The relationship, expressed as physical capital divided by human capital[8], per worker, was as follows about ten years ago :

(6) In Belgium in 1970 the ratio of the costs per pupil per year varied as follows according to the level and type of education : secondary education = 1, primary education = 0.35, technical secondary education = 1.2, higher technical education = 1.55, university = 4.12. Source : see note (5).

(7) The 1970 costs have been converted into 1980 prices by the index of deflation of the GNP (gross national product) for the United States. A more precise calculation would have replaced this deflation index by the wage cost indices for the various countries; this would, in general, have increased the figures.

(8) The 'physical capital' corresponds to the 1955-1968 investments per worker.

B. THE COSTS AND QUALITY OF TRAINING

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Developed countries		Developing countries	
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Canada	10.7	Mexico	5.1
Japan	10.6	[illegible]razil	4.7
United States	10.4	[illegible]ia	3.2
Federal Republic of Germany	[illegible]		
Holland	[illegible].4		
Belgium	8.4		
France	7.5		
Italy	6.4		

It is [illegible]able that the periods of training in 1980 we[illegible]onger, in particular in [illegible]an, Brazil and India.

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(5) [illegible]. Dr J.G. Maton, H. Debbaut and J. van de Vijvere: "Productivity, [illegible]man Capital and Physical Investments in Iron and Steel - Analysis of [illegible] International Cross-section" - Seminarie voor toegepaste economie - University of Ghent, 1972

Developed countries		Developing countries	
Great Britain	2.25	Brazil	8.0
Japan	2.64	Mexico	14.14
Canada	3.38	India	19.34
United States	3.94	Argentina	20.64
Federal Republic of Germany	3.85		
France	6.13		
Belgium	6.88		
Holland	7.70		
Italy	12.65		

These figures show the considerable differences between countries and also, from the above examples, the structural weakness of the educational stock in the iron and steel industries in the developing countries. Although there is no rigid link between the level of productivity and the educational stock it is nevertheless certain that the realization of the two scenarios will depend on the ability of the national educational systems to prepare the necessary body of personnel.

7. The national training of directors, executives, technicians, foremen and workers is not generally adequate. It is necessary to add to it a specific sectorial training which is most often carried out within the framework of industrial arrangements.

The cost of this training will be principally influenced by two factors, the type of technology being transferred and the existing level of assimilation in the receiver country.

As has been pointed out the most costly training is that which concerns the transfer of the general technology of the sector, then that of the transfer of specific technologies which are, most frequently, protected innovations, and finally the transfer of processes, often unsophisticated as they involve proven techniques.

It follows from this that the lower the educational level of a country then the longer will be the time needed for the transfer of knowledge with training being, at the limit, assimilable to an extension of schooling.

Conversely as the educational stock increases and as the acquired experience becomes greater, so the quantity and the cost of the transfer become smaller.

The cost of specific sectorial training can be higher than that of the initial educational stock. For example in the case of an iron and steel plant with 5000 workers which is created in a developing country the average cost price per worker amounts to US$ 17,000 (1980 Dollars), so that the total cost of training, US$ 85 million, represents 5% of the total investment cost. In this example the existing educational stock was not negligible: 50% of the managers and engineers, 40% of the technicians and 30% of the workers had had some prior training.

The costs can be much higher, particularly when the training is carried out abroad, and can reach levels of more than US$ 40,000 (1980 Dollars) per worker.(9)

8. This analysis should be compared with that of the excess expenditure which can be attributed to the slow achievement of full production (see Dossier V). Although the costs of specific sectorial training may be very considerable they are very small when compared with the failure to make profits which result. Of all investments that devoted to training is the most profitable. In actual fact the most important problem is undoubtedly the limited attention devoted by the developing countries in their negotiations on industrial arrangements, when the training needs are under-estimated.

To devote 8% or even 10% of the total cost of a project to training might not be excessive.

9. The acceptance, on the one hand, by the developing countries of the need to give priority importance to personnel training and not to pare down the budgets needed for this purpose, and on the other hand by the developed countries of the essential character of the human investment which must not be treated like the physical investments in the other means of production, implies a necessary counterpart.

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(9) Symposium on the training of human resources in the iron and steel industry of the Arab countries - Algiers, 16-18 May 1982.

This counterpart is the assurance that the training given will be effective.

This does not appear to have been the subject of systematic evaluations. Within companies, as within countries, there seems to have been no record made of the experiences and the results obtained. From an international standpoint there is no comparison of methods and results so that no clear indication emerges on preferable teaching techniques and a normative methodology.

Yet the iron and steel industry, like industry generally, is a hierarchic unit. The technological routes are of diverse complexity, requiring different degrees of assimilation if they are to be mastered.(10) According to the route involved the holder of the know-how may be the engineer, the foreman or the skilled worker.

Critical points appear in the processes, and the close linkage at the interface of the workshops is not always easy to master, even in the industrialized countries (see Dossier V). The linkage of these workshops requires a degree of supplementary training, not only at the level of the individual worker but also at shift level. It would appear that difficulties often appear at this level.(11)

The importance of the working group or shift has been emphasized in the case of operating blast furnaces, converters or rolling mills, where the shift has a considerable degree of autonomy when carrying out the production operations. Training of new arrivals is carried out by the working team itself.(12) It is therefore easy to understand the difficulties which are encountered at shift level in the young iron and steel industries of the developing countries.

It is also necessary to consider the changes brought about by technological modifications. With these the production workers feel the need to acquire a scientific understanding of the production processes. These were formerly under the exclusive control of the workers' experience, acquired as a result of informal and non-systematic training. Over a period of twenty years training

(10) See the study by Prof. V.A. Romanets and his colleagues: note (4).

(11) Paper by Mr Liassine, then Chairman and Managing Director of the Algerian National Iron and Steel Industry, to the Dijon Symposium on the transfer of technologies - September/October 1976.

(12) I.L.O.study - see note (2).

has moved towards formalization and systematization, and the time would seem to be past when a manager could say "what we want are men with big muscles and small heads".(13) At the same time it must be acknowledged that the balance sheet for this formalization still has to be drawn up.

Where the maintenance staff are concerned it is similarly necessary to evaluate the results of the training techniques used in two opposed directions: more specialized or more multi-purpose where preventive or remedial maintenance are involved. Similarly it will be necessary, as a result of the shift in the iron and steel industry towards quality and the modification of equipment (see Dossier IV) to evaluate the relationships between basic training and the content of the additional training which is necessary.

Despite their importance these problems have scarcely been explored. Out of a list of 46 studies of major importance(14) concerning training problems in the iron and steel industry 33 were carried out between 1964 and 1970 and only 13 during the seventies; 22 of them came from the United Kingdom and only 5, all carried out before 1970, concerned the developing countries.

10. The training of iron and steel personnel, in both bulk and quality, which is needed by the developing countries, should therefore be the subject of an in-depth examination so that the programmes can be extended and improved. At the same time care must be taken not to neglect the "upstream" aspect of the training, that is to say the design of the projects themselves. To face the training activities with an impossible task is the inevitable result of trying to transmit the knowledge needed to operate hyper-complex plants to a receiving environment where the assimilatory power of the educational stock is inadequate for this purpose.

This poses the question of the redesigning of iron and steel units, not just up to 1990 but even up to the year 2000. The real question which is posed is simply "have the personnel been fully prepared to use this production apparatus?".

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(13) See the introduction to the I.L.O. study - note (2).

(14) Bibliography supplied by the International Labour Organization, to which UNIDO expresses its gratitude.

It would perhaps be better to turn the question round and ask "is this production apparatus fully suited to the personnel?". The question goes deeper than ergonomic requirements, well-based as these may be. It would seem that certain technological options are available which allow some adaptation of the apparatus to the personnel and their capabilities for gradual apprenticeship.(15) It would appear to be technically possible today to build simpler plants which have nevertheless been designed to incorporate subsequent technological developments as and when the need to do so is felt and as soon as the advance of training allows such developments to be assimilated. This may be costly in terms of design work, but will be less costly than the losses of the present time, without counting also the negative effects of personnel turnover and absenteeism which are sometimes very high in companies in the developing countries. The constraints of a continuously operating industry, which makes it necessary to operate on a three 8-hour shift system, the physical effort required in hot climates, the inadequate nutrition of the workers and the trauma experienced by rural workers forced to change their living patterns, all result in an accelerated turnover of staff and excessive absenteeism: the latter is particularly high in the case of shift working.(16) As a consequence it is always necessary to train an excessive number of workers.

Such problems do not relate solely to workers in the developing countries. Redesigning plants to re-balance technological schemes, the production apparatus and them men involved may seem to be utopian: but today's utopia may be tomorrow's reality.

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(15) See Dossier V : "The design and implementation of projects and the commissioning of new plants"

(16) Paper given by the Algerian delegation to the Symposium on the training of human resources for the iron and steel industries of the Arab countries - Algiers, 16-18 May 1982.

C. FROM NATIONAL SOLIDARITY TO INTERNATIONAL SOLIDARITY

11. The Third Consultation on the Iron and Steel Industry will take place in a situation differing from that of the first, and even of the second. The shadow of excess production capacities may tend to obscure the real terms of international cooperation involved in the iron and steel projects of the Third World.(17) This cooperation is not simply an exchange in monetary terms but is also an exchange in labour values.

The balance sheet for the manpower employed in the developed and developing countries

12. Considering the legitimate fears of workers in the iron and steel industries of certain developed countries that they might lose their jobs as a result of possible competition from new iron and steel production in the developing countries an attempt has been made to draw up a balance sheet of the exchanges of labour contained in the capital equipment needed to establish iron and steel projects and in those iron and steel products which may be exported by the developing countries. These calculations are based in principle on tables of inter-industrial trading in terms of working hours.(18) The methodology and the bases for the calculations are set out in the annex to this dossier.

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(17) See the analysis of "surplus capacity" in the scenarios for the iron and steel industry, 1990 - Chapter II "A basis for reflection on the 1990 scenarios"

(18) According to the work of Prof. A. Tiano - University of Montpellier : "Impact du développement de l'industrie sidérurgique dans les pays en voie de développement sur les économies des pays développés" - UNIDO, February 1982. The reader interested in the theoretical aspects of the calculations may refer to the following publications :
Viestnik Eidelman: "A first intersectorial balance sheet for labour costs in the national economy of the USSR" - Statistiki 1962 - No.10 - comments on Russian work in the 'Annual Economic Indicators from the USSR, materials prepared for the Joint Economic Committee' - Washington D.C., February 1964
Denis Cépède and Pierre Gonod - "Concept et mesures de la productivité" - 'Chroniques d'actualité No.923' - SEDEIS, 20 June 1965
Nicole Dubrulle and Patrick Ranchon - "Demande finale et emploi - Approche par la méthode de l'équivalent-travail d'une production" - Cahiers du Centre d'Etudes de l'Emploi - PUF - 1977.

In this way the quantity of work contained in the capital equipment goods needed to build the production capacities of 63 million and 117 million tonnes, as envisaged in the two scenarios, has been calculated. It has been assumed that certain developing countries could produce a part of their equipment or could obtain them from other developing countries: Brazil, India and the Republic of Korea up to a level of 70%, Mexico up to 40%, Argentina, Chile and Venezuela up to 30% and the other Latin-American and Asiatic countries up to 20%. Such an assumption is rather optimistic.

Under these conditions the work equivalent of iron and steel orders from the developing countries to the capital equipment goods industries in the developing countries would be 650,000 work-years for the low growth scenario and 1,210,000 work-years for the normative scenario. Since these industries employ highly skilled labour this quantity of work can be weighted by the skills of the work, leading to an increase in the above estimates.

Next a calculation has been made of the quantity of iron and steel goods of which the value would be equal to that of the deliveries of equipment goods supplied by the developing countries.

On this basis deliveries of 10 million or 19 million tonnes of iron and steel products would, over a period of 10 years, balance the cost of the purchases of equipment goods under each of the two scenarios. Finally the corresponding quantities of iron and steel work have been calculated. These amount to 320,000 and 600,000 work-years.

Under the highly theoretical hypothesis of 100% financing by the purchasing of iron and steel products the net employment gain for the developed countries would be 650,000 - 320,000 = 330,000 work-years with the low growth scenario and 1,210,000 - 600,000 = 610,000 work-years with the normative scenario, or a ratio of 2 to 1. The hypothesis of 100% financing is, clearly, very unlikely for a variety of reasons: the oil-exporting countries would certainly not have recourse to this method of financing whilst the existence of massive deficits in the developing countries would lead to the simultaneous flow of exports and higher imports.

It is therefore more reasonable to retain a hypothesis of 50% financing, a figure which is still a high one. The reduction in the gain of iron and steel employment in the developed countries would in this case be reduced to 160,000 and 300,000 work-years under the two scenarios. The actual gain in employment in the developed countries would thus be 650,000 - 160,000 = 490,000 and 1,200,000 - 300,000 = 900,000 work-years respectively, with the ratio between gains and losses now being 4 to 1.

13. The results call for the following observations :

. Firstly they confirm the overall employment-creating role of the industrialization of the developing countries where the developed countries, affected by the economic recession, are concerned;

. Secondly it should be observed that, in the case of the sale of products intended to finance the purchase of capital goods, there will be a time lapse between the creation of jobs in the capital goods sector in the industrialized countries and the assumed losses of jobs from the failure to profit from the export of iron and steel products. The creation of jobs in the developed countries would be during the decade, and more particularly during the next five years, whereas the exports of iron and steel products from the developing countries would take place principally after 1990;

. Thirdly the exchange of work forces would be felt unequally by workers in the developed countries and between the exporting iron and steel companies and metallurgical powers. The gains would involve the employment of workers in the capital goods industries and, to various degrees, the exporting developed countries whose capacities for meeting market orders are unequal. Conversely a reduction in the exporting of simple products, manufactured and in part exported by the developing countries, would affect the developed exporting countries unequally.(19)

These are the inescapable consequences of the industrial game. However in this game there is no nil balance but a positive balance for the interested parties.

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(19) To judge the repercussions on the export trading of the developed countries refer to Dossier III and the tables of exports by groups of iron and steel products.

A N N E X

BASIS FOR CALCULATING INTERNATIONAL TRADING IN LABOUR INVOLVED IN THE REALIZATION OF THE IRON AND STEEL PROJECTS IN THE DEVELOPING COUNTRIES *

* This note has been produced on the basis of a study by Prof. A. Tiano : Impact du développement de l'industrie sidérurgique dans les pays en développement sur les économies des pays développés. University of Montpellier I/UNIDO - May 1982

The methodology depends on the use of the table of industrial trading in work-equivalents for the year 1973 as produced by the Centre d'Etudes de l'Emploi in France. The pioneer work in this field was carried out in the USSR.[20]

The French table gives, for each branch, the working time required to increase production in another branch by one million Francs. The coherence of the model implies that, when a table of industrial trading is used, the values of the equipment and of the products should be those of the same reference year.

This calculation has therefore been dependent on the accessibility of the available information. It is therefore a function of the selection of the country and of the base year. If such data had, for example, been available for the Federal Republic of Germany and for the year 1982, which seemed to show a higher labour productivity in the capital goods industry which was higher than that of France in 1973, the labour equivalent of the supplies of capital goods from the industrialized countries for constructing iron and steel industries in the developing countries would have been lower than the following estimates. In the same way if the work-equivalent of possible exports of iron and steel products from the developing countries to the developed countries had been calculated on the basis of the productivities of Japanese companies in 1982 the results would again have been lower. These comments do not, however, affect the validy of the method. In fact the choice of an industrial trading table for one country and one given year has the same significance as the utilization of standard prices in analytical accounting.

The calculation has therefore been carried out firstly of the direct labour contained in one million Francs' worth of iron and steel products and, secondly, the indirect labour needed to produce the goods and services which correspond to the equipment needed by the iron and steel industry.

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(20) Viestnik Eidelman: "A first intersectorial balance sheet for labour costs in the national economy of the USSR" - Statistiki 1962

Calculation of the direct labour in iron and steel activities has been carried out using data from specialized companies. The components in these calculations are the price structures of steelworks by types of steelworks and rolling mills (see Tables A and B).

Calculation of the indirect labour in the other branches which can be allocated to the iron and steel projects has been carried out using the French table of inter-industrial trading. The components in these calculations are the labour content of the branches (Table C)[21], price changes in equipment and iron and steel products (Table D) and the jobs created by the establishment of various types of plants for one million Francs worth of products - electric furnaces, direct reduction and furnaces, blast furnace and oxygen process, billet mills, hot wide strip mills, wire mills, heavy plate mills and cold rolling mills (Tables E to L). The results of these calculations are given in weighted and unweighted quantities of work. The weightings express the differences in skills which are approximately reflected in the differences between the average wages of the vocational categories shown in Table C. The weighting factors applied to the unweighted employment figures are 1.5 for skilled workers, 2.5 for technicians and foremen and 5.0 for engineers and executives. Since this weighting may vary considerably according to the wages structure in various countries the subsequent reasoning has been based on the unweighted results.

These results are summarized below.

1. Employment induced at national level by the creation of new iron and steel units in the developing countries

Dossier I describes several types of iron and steel projects, in particular :

(21) In the case of engineering activities two estimates are given, one based on the statistics of the Ministry of Industry, the other based on a direct evaluation carried out in a representative company supplying capital equipment goods.

- electric steelworks, for which a mean capacity of 220,000 tonnes/year has been retained (see Table E);
- the electric steelworks may be preceded by a direct reduction unit: in this case a mean capacity of 400,000 t/year has been retained (Table F);
- the blast furnace - oxygen steelmaking route, for which a mean size of 1 million t/year has been retained (Table G).

Table 6 shows that there is little difference between the effects on employment of the sale of one million Francs worth of equipment according to whether one technique or another is used: less than 4% between techniques using direct reduction or not, the former resulting in slightly fewer jobs (16.25 as compared with 16.85 in the case of weighted employment).

The impact of a billet mill of 2 million t/year is measured in Table H. A hot wide strip mill results in less jobs per million Francs (Table I), but is similar to that for a wire mill (Table J). The heavy plate workshop (Table K) is similar to the billet mill. The installation of a cold rolling workshop (Table L) involves less work, but is necessarily combined with a hot wide strip mill.

Table 6. Jobs gained through the sale of 1 million Francs worth of iron and steel units.

	Electric furnaces	D.R. and furnaces	Blast furnace and LD	Billets	Hot wide strip mill	Wire	Heavy plate	Cold rolling mill
Unweighted jobs*	8.79	8.15	9.16	8.3	6.75	7.06	8.17	5.98
Weighted jobs*	16.85	16.25	16.85	15.91	13.31	14.32	15.65	12.03

* Means of hypotheses A and B in Tables E to L

Table 6 does, however, show that it is valuable to distinguish, in the sales of rolling mills, between those producing cold rolled flat products and other types. There are also small differences between billets and heavy plate on the one hand and wire rod (-8%) or sections (-14.5%) on the other.

These standards were then applied to the data and the hypotheses covering the installation of new iron and steel capacities in the 1990 low growth and normative scenarios.

2. Employment induced in the developed countries by the growth of the iron and steel industries in the developing countries in 1990

In the two scenarios it has been assumed that the civil engineering and the actual installation will be entrusted to companies located in the developing countries, whether these are countries buying iron and steel units or other more advanced developing countries. Account has been taken of this hypothesis in Tables E to L, and these items have therefore been excluded.

Account has also been taken of the production capacities for capital goods and engineering services in certain developing countries. It has been estimated that Brazil, the Republic of Korea, India and another Asian country will contribute to the supply of 70% of their iron and steel capital goods. Mexico will manufacture or obtain from Brazil 40% of its needs; Argentina, Chile and Venezuela will obtain 30%, whilst the other Latin-American and Asian countries will obtain 20% of their needs in this way.

The total new capacities to be constructed with equipment from the developed countries thus become 40.7 mt and 74.1 mt respectively in the two scenarios. It is necessary to correlate this evaluation with the breakdown of the new capacities according to the nature of the expected products. The inadequacy of information leads to formulating a supplementary hypothesis. In Dossier I the various countries are classified into four categories of mastery of iron and steel technology. It has been assumed that the projects are divided up differently according to the categories of countries. For example category 3A will construct more cold rolling mills, category 3 even more.

Category 2 countries will only install hot wide strip mills for sections and wire rod mills, whilst those in category 1 will only install hot rolling mills for sections (Table M). The classification of the orders according to the processes of the steelworks is set out in Table N.

Summarizing therefore the orders for production capacities from the developed countries and for the developing countries will be divided up as follows :

Table 7. Orders from the developed countries for iron and steel production capacities

(thousands of tonnes/year)*

Installations for	Low growth scenario	Normative scenario
Cold rolled products	3,945	7,230
Heavy plate	1,935	4,080
Other finished products	34,760	64,585
of which wire rod	5,860	11,010

* Excluding China, Popular Democratic Republic of Korea and Viet Nam. Their inclusion would add 2 million tonnes of cold rolled products, 750,000 tonnes of heavy plate and 4 million tonnes of other products, including 1.5 million tonnes of wire rod.

It is necessar[illegible] to evaluate the value of these order[illegible] The following prices, corresponding to the costs per tonne installed in 1[illegible] the various technological routes, have been taken from Table D :

Table 8. Costs per tonne installed, mid-1973 in FF.

Steel mills	Electric furnaces	Elec. furnaces + DR	Blast furnace and oxygen steelworks
Cold rolled products (4,540 FF t/year)	5,095	5,360	5,580
Heavy plate (1,520 FF t/year)	1,975	2,340	2,560
Other products (850 FF t/year)	1,305	1,670	1,890

Multiplication of the production capacity quantities (Table 7) by the corresponding prices (Table 8) gives an estimate of the following values for orders for capital goods and services to be given by the developing countries to the developed countries :

Table 9. Value of orders for capital goods and services given to the developed countries between now and 1990 for the iron and steel projects in the developing countries

(in millions 1973 French Francs)

	Low growth scenario	Normative scenario
Cold rolled products, with electric furnaces and direct reduction	8,431	12,569
Cold rolled products with oxygen steelworks and blast furnace	13,626	29,541
Heavy plate, with electric furnaces and direct reduction	1,860	6,897
Heavy plate, with oxygen steelworks and blast furnace	2,995	6,057
Other finished hot rolled products from electric furnaces without direct reduction	4,111	15,828
Ditto, but with direct reduction	35,791	49,639
Other hot rolled products from steel supplied by an oxygen steelworks and a blast furnace	19,010	40,062
TOTAL	85,825	160,593

In order to evaluate the consequences of these orders on employment in the developed countries it is now necessary to multiply these values by the work equivalent which is set out in Table 6.

The final results of these calculations are given in Table O and in Tables P to V for the repercussions on the various branches linked to the iron and steel industry through the input-output relationships. The table below summarizes the overall results.(22)

Table 10. Overall gross gains in employment resulting from the development of the iron and steel industries in the developed countries (as thousands of work/years)

	Low growth scenario	Normative scenario
Unweighted jobs	646.44	1,212.04
Jobs weighted by skills	1,286.05	2,408.32

It is not, however, possible to consider these gains as net gains.

3. Evaluation of the net impact on overall employment in the developed countries of the sale of iron and steel units with purchase of the products

The financing of the iron and steel projects is a major barrier (see Dossier VII). It is therefore possible to envisage part of this being covered by a counterpart consisting of the delivery of iron and steel products.

(22) It will be noted that this estimate is low since it excludes orders from China, the Popular Democratic Republic of Korea and Viet Nam (a third of the envisaged capacities, which should correspond to an additional 300,000 work/years). It is also low because it probably underestimates the training and technical assistance services, which could possibly represent another 150,000 work/years. Account should also be taken of the infrastructure works needed by the installation of new iron and steel units: one million tonnes of steel implies the transport of 3 million tonnes, hence ports, railways and dams since 1 million tonnes of steel needs 20 million cubic metres of water. Finally, and in certain developing countries, the growth of iron and steel production would involve opening iron ore mines and, sometimes, coal mines. Taken overall, therefore, the new jobs actually resulting should be greater than these estimates.

A calculation was then made on the quantities of iron and steel work (according to the French standard in 1973) corresponding to the hypothesis of integral purchase in ten years in the form of the delivery of products to the value of the orders given for capital goods and services by the developing countries to the developed countries. Clearly this is a purely theoretical hypothesis, since it is unlikely in practice that all the financing will be covered in this way.

If questions are asked as to the nature of the imports it is not possible to be guided by the nature of the equipment sold. On the basis of the retained hypotheses 8.7% of the units will produce cold rolled products, 4.3% heavy plate and 87% other products. The same items of equipment will often contribute towards the production of different products, and it would not be impossible to pay with just one of the products manufactured. A structure of purchases identical to that of the sales would not have any sense. It is however probable that it would be easier to operate a transfer on hot rolled products or on semi-products. Since the operative prices for the former are better known the calculation has been based on these, wire rods being regarded as representative of all. In 1973 the average price for 5 to 12 mm wire rod was 864 FF/tonne ex works. The sale of one million Francs worth of equipment would therefore imply the importing of 1,157 tonnes of wire rod. In terms of direct labour this quantity would represent 2.55 work/years; the structure of this by skills is given in Table C, whilst the results incorporating the indirect labour are given in the following table :

Table 11. Loss of employment resulting from the purchase of the wire rod necessary to finance the sale of 1 million Francs worth of iron and steel equipment (in work/years)

Unweighted labour			Weighted labour		
Direct	Indirect	Total	Direct	Indirect	Total
2.55	1.19	3.74	4.31	1.97	6.28

By multiplying these figures by the values of the iron and steel orders (Table 9) it is possible to calculate the loss of employment in the developed countries resulting from the purchase of iron and steel products so as to finance projects in the developing countries.

The following table summarizes the results :

Table 12. Gross losses of jobs in the developed countries resulting from the purchase of iron and steel products from the developing countries and intended to finance sales of iron and steel equipment and services (in thousands of work/years)

	Low growth scenario	Normative scenario
Unweighted jobs	320.99	600.62
Weighted jobs	538.98	1,008.52

4. The balance sheet of gains and losses

In terms of total jobs the net balance of sales of iron and steel equipment to the Third World countries would therefore be a gain of 325,000 work/years in the low growth scenario and 611,000 in the normative scenario. The gains would therefore be twice as large as the losses. But it is necessary to take into account the heterogeneity of the jobs in the various branches. The operation appears more profitable from this viewpoint since the gains represent 2.4 times the losses. In terms of absolute value the net gains are 747,000 in the low growth scenario and 1,400,000 in the normative scenario.

It will be recalled that this balance sheet rests on the theoretical hypothesis that all the financing will be covered by the purchase of iron and steel products. It therefore follows that, if hypotheses are introduced according to which these purchases would cover 50%, 25% or 10% of the value of the financing, the iron and steel job losses in the developed countries would be reduced in proportion, and the net balance sheet for employment in these countries would turn out to be more positive. It should be added that, to be entirely strict, account should also be taken of the indirect employment resulting from the iron and steel production.

There is no doubt that these calculations could be improved in the future. For the present their aim is solely to illustrate a new route for the analysis of the international division of labour in terms of work equivalents, and to encourage consideration by the international community regarding the introduction of this approach as a factor in international negotiations.

Table A. Price structures for steelworks (as percentages)

	Electric furnace (200,000 t/year)	Electric furnace + direct reduction (400,000 t/year)	Blast furnace and LD process (1 million t/year)
Structural metalwork	5	5	4
Boilerwork and pipework	12	12	13
Furnaces	17.5	17.5	4
Specialized steelmaking equipment	11	11	30
Electrical equipment	11	10	9
Engineering, training, commissioning and technical assistance	24	24	20
Maritime transport	4	4	5
Erection and civil engineering	15.5	16.5	15

Table B. Price structure of rolling mills (as %)

	Hot wide strip mill (750,000 t/year)	Wire mill (220,000 t/year)	Cold rolling mill (200,000 t/year)	Heavy plate mill (1.5 mt/year)	Billets (2 mt/year)
Structural metalwork	4	4	7	7	10
Furnaces	1.8	2.5	1.8	1.8	4.2
Specialized steelmaking equpt & overhead cranes	24	26	19	32	32
Boilerwork and pipework	3	2	2	4	1.5
Electrical equipment	11.2	12.5	7.2	11.2	11.6
Maritime transport	4	2	4	6	3
Engineering, training, commissioning and technical assistance	16	18	20	11.5	10.2
Erection and civil engineering	39	32.5	39	26.5	27.5

Table C. Labour content of branches

	Direct labour (for 1 million FF, 1973)	Indirect labour	Engineers & executives (%)	Technicians (%)	Skilled personnel (%)	Unskilled personnel (%)
Structural metalwork	8.6 [1]	4.69 [4]	5.44	18.22	57.07	19.23
Furnaces	6.08 [1]	4.69 [4]	15.09	25.31	45.92	13.63
Specialized steelmaking equipment and overhead cranes	6.98 [1]	4.69 [4]	9.56	23.09	53.96	13.63
Boilerwork and pipework	10.7 [1]	4.69 [4]	5.99	16.81	60.68	16.48
Electrical equipment	11.99 [1]	3.40 [5]	14.4	11.76	45.84	28
Maritime transport	5.96 [2]	1.43 [6]	13.5	8.9	43.9	33.7
Engineering A B	2.51 [3] 5.90 [1]	0.47 [7]	37.7	3.4	25.6	2.7
Cold rolled products	2.77 [9] [10]	3.74	3.4	10.2	48	38.4
Steel wire	2.55 [9]	1.19	5.8	14.3	48.2	31.7
Heavy plate	0.43 [8]	1.19	4.9	18.6	29.4	47.1

(1) Ministry for Industry for 1973
(2) Check on balance sheets for 1973
(3) Direct evaluation from statistics and budgetary checks on a large "general enterprise"
(4) Indirect labour equivalent 1973, "large equipment" sector
(5) Ditto "electrical equipment" sector
(6) Ditto "transport and ancillary services" sector
(7) Ditto "services rendered principally to enterprises" sector
(8) Ditto "iron and steel products" sector
(9) Direct evaluation from existing iron and steel units in France
(10) Direct work in the cold rolling shop

Table D. Changes in prices of equipment and iron and steel products (approximate cost per tonne installed or tonne of product)

Electric furnaces = Base evaluation, end 1977: 950 FF - Mid-1973: 455 FF
(220,000 t/year)

Electric furnaces + Direct reduction = Base evaluation, end 1981: 3,080 FF - End 1977: 1,600 - mid-1973: 820
(400,000 t/year)

Blast furnace + Oxygen steelworks = Base evaluation, end 1981: 3,920 FF - End 1977: 2,050 - mid-1973: 1,040
(1 million t/year)

Rolling mill for billets = Base evaluation, April 1981: 950 FF - mid-1977: 500 - Mid-1973: 270
(2 million t/year)

Hot wide strip mill = Base evaluation, November 1981: 3,200 FF - November 1977: 1,670 - mid-1973: 850
(750,000 t/year)

Wire mill = Base evaluation, end 1977: 1,760 FF - mid-1973: 840

Heavy plate mill = Base evaluation, October 1981: 5,700 FF - October 1977: 2,975 - mid-1973: 1,520

Cold rolling mill = Base evaluation, November 1978: 8,500 FF - November 1977: 7,225 - Mid-1973: 3,690

Billets for rolling: Thionville parity price June 1973: 642 FF - 1977: 1,087

Merchant bars A33:	mean Thionville parity price, 1.1.73 to 1.1.74: 821 FF	- mean 1.1.77 to 1.1.78: 1,363
	mean annual prices effective 1973: 956 FF	- mean 1977: 1,410
Wire:	mean prices 1973: 864 FF	- mean 1977: 1,386
Heavy sheet:	Thionville parity price, mid-1973: 980 FF	- mean May 1977: 1,290
Thin cold-rolled sheet:	mean Thionville parity price, 1.1.73 and 1.1.74: 1,035 FF	- mean 1.1.77 to 1.1.78: 1,713
	mean annual price effective 1973: 1,055 FF	- mean 1977: 1,555

Key to tables E to L

(1) Large equipment, 4.69 jobs per million

(2) 3.4 jobs per million

(3) 1.43 jobs per million

(4) 0.47 jobs per million

(5) In order to calculate the technical structure of the indirect labour it has been considered that the technical structure of the overall population is as follows: engineers and executives 6%, technicians 11.2%, skilled personnel 49.7%, unskilled personnel 33.1%.

(6) Weighting by average salaries: skilled (1.5), technicians (2.5), engineers and executives (5).

Table E. Employment created by the installation of one million Francs of electric furnaces (220,000 t/year)

		Direct employment	Engineers and executives	Technicians	Skilled personnel	Unskilled personnel	Indirect employment	Engineers and executives (5)	Technicians (5)	Skilled (5)	Unskilled (5)
Structural metalwork		0.43	0.023	0.078	0.245	0.083	0.234 (1)	0.014	0.026	0.116	0.077
Boilerwork and pipework		1.28	0.077	0.215	0.777	0.211	0.563 (1)	0.034	0.063	0.28	0.186
Furnaces		1.06	0.16	0.268	0.487	0.144	0.821 (1)	0.049	0.092	0.408	0.272
Specialized steelmaking equipment		0.768	0.053	0.061	0.409	0.246	0.516 (1)	0.031	0.058	0.256	0.171
Electrical equipment		1.32	0.19	0.155	0.605	0.37	0.374 (2)	0.022	0.042	0.186	0.124
Maritime transport		0.238	0.032	0.021	0.104	0.08	0.057 (3)	0.003	0.006	0.028	0.019
Engineering and training	A B	0.602 1.416	0.227 0.534	0.205 0.481	0.154 0.362	0.016 0.038	0.113 (4)	0.007	0.013	0.056	0.037
Total direct employment	A B	5.70 6.51	0.769 1.069	1 1.28	2.781 2.99	1.15 0.172					
Total indirect employment		2.678	0.160	0.300	1.33	0.886					

Total employment		Not weighted	Engineers & executives	Technicians	Skilled	Unskilled	Weighted (6)
	A	8.38	0.92	1.30	4.11	2.04	16.05
	B	9.19	1.23	1.58	4.32	1.06	17.64
	$\frac{A+B}{2}$	8.79					16.85

Table F. Employment created by the installation of one million Francs of direct reduction and furnaces (400,000 t/year)

		Direct employment	Engineers and executives	Technicians	Skilled personnel	Unskilled personnel	Indirect employment	Engineers and executives (5)	Technicians (5)	Skilled (5)	Unskilled (5)
Structural metalwork		0.43	0.023	0.078	0.245	0.083	0.234 (1)	0.014	0.026	0.116	0.077
Boilerwork and pipework		1.28	0.077	0.215	0.777	0.211	0.563 (1)	0.034	0.063	0.28	0.186
Furnaces		1.06	0.16	0.268	0.487	0.144	0.821 (1)	0.049	0.092	0.408	0.272
Specialized steelmaking equipment		0.768	0.053	0.061	0.409	0.246	0.516 (1)	0.031	0.058	0.256	0.171
Electrical equipment		1.20	0.173	0.141	0.55	0.336	0.34 (2)	0.02	0.038	0.169	0.113
Maritime transport		0.238	0.032	0.021	0.104	0.08	0.057 (3)	0.003	0.006	0.028	0.019
Engineering and training	A	0.602	0.227	0.205	0.154	0.016	0.113 (4)	0.007	0.013	0.056	0.037
	B	1.416	0.534	0.481	0.362	0.038					
Total direct employment	A	4.81	0.745	0.989	2.726	1.116					
	B	5.62	1.052	1.265	2.934	1.134					
Total indirect employment		2.678	0.139	0.242	1.074	0.715					

Total employment	Not weighted	Engineers & executives	Technicians	Skilled	Unskilled	Weighted (6)
A	7.74	0.87	1.23	3.80	1.83	14.95
B	8.55	1.18	1.51	4.01	1.85	17.54
(A+B)/2	8.15					16.25

Table G. Employment created by the installation of one million Francs of blast furnace and oxygen process (1 million t/year)

		Direct employment	Engineers and executives	Technicians	Skilled personnel	Unskilled personnel	Indirect employment	Engineers & executives[5]	Technicians[5]	Skilled[5]	Unskilled[5]
Structural metalwork		0.34	0.023	0.027	0.181	0.109	0.188[1]	0.011	0.021	0.093	0.062
Boilerwork and pipework		1.40	0.096	0.111	0.745	0.448	0.610[1]	0.037	0.068	0.303	0.202
Furnaces		0.243	0.017	0.019	0.129	0.078	0.188[1]	0.011	0.021	0.093	0.062
Specialized steelmaking equipment		2.09	0.143	0.166	1.112	0.669	1.407[1]	0.084	0.158	0.699	0.466
Electrical equipment		1.08	0.156	0.127	0.495	0.302	0.306[2]	0.018	0.034	0.152	0.101
Maritime transport		0.298	0.04	0.027	0.131	0.1	0.072[3]	0.004	0.008	0.036	0.024
Engineering and training	A	0.502	0.189	0.171	0.129	0.014	0.094[4]	0.006	0.011	0.047	0.031
	B	1.18	0.445	0.401	0.302	0.032					
Total direct employment	A	5.953	0.664	0.648	2.922	1.72					
	B	6.631	0.92	0.878	3.095	1.738					
Total indirect employment		2.865	0.171	0.321	1.423	0.948					

Total employment		Not weighted	Engineers & executives	Technicians	Skilled	Unskilled	Weighted[6]
	A	8.82	0.835	0.969	4.345	2.668	15.78
	B	9.50	1.091	1.199	4.518	2.686	17.92
	$\frac{A+B}{2}$	9.16					16.85

Table H. Employment created by the installation of one million Francs of rolling mill for billets (2 million t/year)

		Direct employment	Engineers and executives	Technicians	Skilled personnel	Unskilled personnel	Indirect employment	Engineers & executives[5]	Technicians[5]	Skilled[5]	Unskilled[5]
Structural metalwork		0.86	0.047	0.157	0.491	0.165	0.469[1]	0.028	0.053	0.233	0.155
Boilerwork and pipework		0.160	0.01	0.027	0.097	0.026	0.07 [1]	0.004	0.008	0.035	0.023
Furnaces		0.255	0.038	0.065	0.117	0.035	0.197[1]	0.012	0.022	0.098	0.065
Specialized steelmaking equipment		2.23	0.213	0.515	1.203	0.304	1.5 [1]	0.09	0.168	0.746	0.497
Electrical equipment		1.39	0.2	0.163	0.64	0.389	0.394[2]	0.024	0.044	0.196	0.131
Maritime transport		0.179	0.024	0.016	0.079	0.060	0.043[3]	0.003	0.005	0.021	0.014
Engineering and training	A	0.256	0.097	0.087	0 066	0.007	0.113[4]	0.007	0.013	0.056	0.037
	B	0.602	0.227	0.205	0.154	0.016					
Total direct employment	A	5.33	0.629	1.03	2.693	0.986					
	B	5.68	0.759	1.148	2.781	0.995					
Total indirect employment		2.79	0.168	0.313	1.385	0.922					

Total employment		Not weighted	Engineers & executives	Technicians	Skilled	Unskilled	Weighted[6]
	A	8.12	0.797	1.343	4.078	1.908	15.37
	B	8.47	0.927	1.461	4.166	1.917	16.45
	$\frac{A+B}{2}$	8.3					15.91

Table I. Employment created by the installation of one million Francs of hot wide strip mill (750,000 t/year)

		Direct employment	Engineers & executives	Technicians	Skilled personnel	Unskilled personnel	Indirect employment	Engineers & executives[5]	Technicians[5]	Skilled[5]	Unskilled[5]
Structural metalwork		3.44	0.023	0.027	0.181	0.109	0.188[1]	0.011	0.021	0.093	0.062
Boilerwork and pipework		0.32	0.019	0.054	0.194	0.053	0.141[1]	0.008	0.016	0.07	0.047
Furnaces		0.11	0.008	0.009	0.059	0.035	0.084[1]	0.005	0.009	0.042	0.028
Specialized steelmaking equipment		1.68	0.161	0.388	0.907	0.229	1.126[1]	0.068	0.126	0.56	0.373
Electrical equipment		1.34	0.193	0.158	0.614	0.375	0.381[2]	0.023	0.043	0.189	0.126
Maritime transport		0.238	0.032	0.021	0.104	0.08	0.057[3]	0.003	0.006	0.028	0.019
Engineering and training	A	0.402	0.152	0.137	0.103	0.011	0.075[4]	0.005	0.008	0.037	0.025
	B	0.944	0.356	0.321	0.242	0.025					
Total direct employment	A	4.43	0.588	0.794	2.162	0.892					
	B	4.97	0.792	0.978	2.301	0.906					
Total indirect employment		2.052	0.123	0.229	1.019	0.68					

Total employment		Not weighted	Engineers & executives	Technicians	Skilled	Unskilled	Weighted[6]
	A	6.48	0.711	1.023	3.181	1.572	12.46
	B	7.02	0.915	1.207	3.32	1.586	14.16
	$\frac{A+B}{2}$	6.75					13.31

Table J. Employment created by the installation of one million Francs of wire mill (220,000 t/year)

		Direct employment	Engineers and executives	Technicians	Skilled personnel	Unskilled personnel	Indirect employment	Engineers and executives (5)	Technicians (5)	Skilled (5)	Unskilled (5)
Structural metalwork		0.344	0.023	0.027	0.181	0.109	0.188 (1)	0.011	0.021	0.093	0.062
Boilerwork and pipework		0.214	0.013	0.036	0.13	0.035	0.094 (1)	0.006	0.011	0.047	0.031
Furnaces		0.152	0.023	0.038	0.069	0.021	0.117 (1)	0.007	0.013	0.058	0.039
Specialized steelmaking equipment		1.81	0.173	0.418	0.977	0.247	1.219 (1)	0.073	0.137	0.606	0.404
Electrical equipment		1.5	0.216	0.176	0.688	0.42	0.425 (2)	0.026	0.048	0.211	0.141
Maritime transport		0.119	0.016	0.01	0.052	0.04	0.028 (3)	0.002	0.003	0.014	0.010
Engineering and training	A	0.452	0.17	0.154	0.116	0.012	0.085 (4)	0.005	0.009	0.042	0.028
	B	1.062	0.4	0.361	0.272	0.029					
Total direct employment	A	4.59	0.634	0.859	2.213	1.145					
	B	5.2	0.864	1.066	2.369	1.162					
Total indirect employment		2.16	0.13	0.242	1.071	0.715					

Total employment		Not weighted	Engineers & executives	Technicians	Skilled	Unskilled	Weighted (6)
	A	6.75	0.764	1.101	3.284	1.86	13.36
	B	7.36	0.994	1.308	3.44	1.887	15.28
	$\frac{A+B}{2}$	7.06					14.32

Table K. Employment created by the installation of one million Francs of heavy plate mill (1.5 million t/year)

		Direct employment	Engineers and executives	Technicians	Skilled personnel	Unskilled personnel	Indirect employment	Engineers & executives[5]	Technicians[5]	Skilled[5]	Unskilled[5]
Structural metalwork		0.6	0.033	0.109	0.342	0.115	0.328[1]	0.02	0.037	0.163	0.109
Boilerwork and pipework		0.428	0.026	0.072	0.26	0.07	0.188[1]	0.012	0.022	0.094	0.062
Furnaces		0.109	0.016	0.028	0.05	0.015	0.084[1]	0.005	0.009	0.042	0.028
Specialized steelmaking equipment		2.23	0.213	0.515	1.203	0.304	1.5 [1]	0.09	0.168	0.746	0.497
Electrical equipment		1.34	0.193	0.158	0.614	0.375	0.381[2]	0.023	0.043	0.189	0.126
Maritime transport		0.358	0.018	0.054	0.138	0.148	0.086[3]	0.005	0.010	0.043	0.028
Engineering and training	A	0.289	0.109	0.098	0.074	0.008	0.054[4]	0.003	0.006	0.027	0.018
	B	0.678	0.256	0.231	0.174	0.018					
Total direct employment	A	5.35	0.608	1.034	2.681	1.035					
	B	5.74	0.755	1.167	2.781	1.045					
Total indirect employment		2.62	0.158	0.295	1.304	0.868					

Total employment		Not weighted	Engineers & executives	Technicians	Skilled	Unskilled	Weighted[6]
	A	7.97	0.766	1.329	3.985	1.903	15.03
	B	8.36	0.913	1.462	4.085	1.913	16.26
	(A+B)/2	8.17					15.65

Table L. Employment created by the installation of one million Francs of cold-rolling mill (200,000 t/year)

		Direct employment	Engineers & executives	Technicians	Skilled personnel	Unskilled personnel	Indirect employment	Engineers & executives[5]	Technicians[5]	Skilled[5]	Unskilled[5]
Structural metalwork		0.6	0.033	0.109	0.342	0.115	0.328[1]	0.02	0.037	0.163	0.109
Boilerwork and pipework		0.214	0.013	0.036	0.13	0.035	0.094[1]	0.006	0.011	0.047	0.031
Furnaces		0.11	0.008	0.009	0.059	0.035	0.084[1]	0.005	0.009	0.042	0.028
Specialized steelmaking equipment		1.33	0.127	0.307	0.718	0.181	0.891[1]	0.052	0.096	0.428	0.285
Electrical equipment		0.86	0.124	0.101	0.394	0.241	0.245[2]	0.015	0.027	0.122	0.081
Maritime transport		0.238	0.032	0.021	0.104	0.080	0.057[3]	0.003	0.006	0.028	0.019
Engineering and training	A	0.502	0.189	0.171	0.129	0.014	0.094[4]	0.006	0.011	0.047	0.031
	B	1.18	0.445	0.401	0.302	0.032					
Total direct employment	A	3.85	0.526	0.754	1.876	0.701					
	B	4.53	0.782	0.984	2.049	0.719					
Total indirect employment		1.79	0.107	0.197	0.877	0.584					

Total employment		Not weighted	Engineers & executives	Technicians	Skilled	Unskilled	Weighted[6]
	A	5.64	0.633	0.951	2.753	1.285	10.96
	B	6.32	0.889	1.181	2.926	1.303	13.09
	$\frac{A+B}{2}$	5.98					12.03

Table M. Types of projects, according to the categories of countries, classified on the basis of their technological level (hypothesis)

Types of projects	Technological level			
	3A	3	2	1
	Brazil, China, PDR of Korea, India	Argentina, Rep. of Korea, Philippines, Other Asian countries, Egypt, Mexico	Colombia, Iran, Malaysia, Tunisia, Venezuela, Chile, Cuba, Nigeria, Singapore, Thailand, Algeria, Indonesia, Peru, Zimbabwe	Others
Cold rolled products	30%	20%	-	-
Heavy plate	10%	10%(1)	15%(1)	-
Other products, of which wire	60% (20)	70% (20)	85% (15)(1)	100% (0)

(1) If the approximately profitable threshold of production can be achieved, taking into account the total forecast capacity.

Table N. Classification of orders according to steelworks' processes (in thousands of tonnes/year)

	Total	Electric furnaces	Electric furnaces, direct reduction	Blast furnace and oxygen steelworks
Hypothesis: Low growth scenario				
Cold rolled products	3,945	-	1,300	2,645
Heavy plate	1,935	-	815	1,120
Other products	34,760	2,770	20,925	11,065
TOTAL	40,640	2,770	23,040	14,830
Hypothesis: Normative scenario				
Cold rolled products	7,230	-	1,985	5,245
Heavy plate	4,080	-	2,245	1,835
Other products	64,585	11,840	31,230	21,515
TOTAL	75,895	11,840	35,460	28,595

Table O. Labour equivalent of iron and steel orders from the developing countries to the developed countries between now and 1990 (as thousands work-years)

	Low growth scenario		Normative scenario	
	not weighted	weighted	not weighted	weighted
Cold rolled products, with electric furnaces and direct reduction	54.93	110.71	81.89	165.04
Cold rolled products, with blast furnace and oxygen steelworks	91.22	182.645	197.75	395.95
Heavy plate, with electric furnaces and direct reduction	15.51	30.34	57.52	112.49
Heavy plate, with blast furnace and oxygen steelworks	25.69	49.83	51.95	100.78
Other hot rolled products, with electric furnaces, without direct reduction	30.69	61.19	118.17	235.6
Ditto, with direct reduction	174.89	549.15	381.25	761.62
Other hot rolled products, with blast furnace and oxygen steelworks	153.51	302.19	323.52	636.85
TOTAL	646,44	1,286.05	1,212.04	2,408.32

Table P. Direct employment induced in the structural metalwork branch for one million Francs of orders (in works-years)

	Work content in			Work content in	
	steelworks	hot rolling	cold rolling	the complete unit	the total transfer (2)
Cold rolling mill, with electric furnaces and direct reduction	0.43 (3)	0.344 (3)	0.6 (5)	0.533	0.034
Cold-rolling mill, with oxygen steelworks	0.34 (6)	0.344 (4)	0.6 (5)	0.512	0.087
Heavy plate mill, with oxygen steelworks	0.34 (6)	0.6 (7)	-	0.494	0.009
Heavy plate mill, with furnaces and direct reduction	0.43 (3)	0.6 (7)	-	0.54	0.019
Hot rolled products, with electric furnace, without direct reduction	0.43 (8)	0.344 (9)	-	0.374	0.028
Hot rolled products, with electric furnace, with direct reduction	0.43 (3)	0.344 (9)	-	0.387	0.150
Hot rolled products, with electric furnace, with oxygen steelworks	0.34 (6)	0.344	-	0.343	0.086
Average order	0.413 (10)				

(1) Previous figures weighted by the respective cost of the component installations (cf. table D)
(2) Figure in the previous column weighted by the proportion of the type of installation in the total orders (cf. table E)
(3) Table F
(4) Table I
(5) Table L
(6) Table G
(7) Table K
(8) Table E
(9) Table J
(10) Total of quantities of work, as entered in the last column

Table Q. Direct employment induced in the furnaces branch for one million Francs of orders (in work-years)

	Work content in			Work content in	
	steelworks	hot rolling	cold rolling	the complete unit	the total transfer (2)
Cold rolling mill, with electric furnaces and direct reduction	1.06 (3)	0.11 (3)	0.11 (5)	0.255	0.016
Cold-rolling mill, with oxygen steelworks	0.243 (6)	0.11 (4)	0.11 (5)	0.135	0.023
Heavy plate mill, with oxygen steelworks	0.243 (6)	0.109 (7)	-	0.163	0.003
Heavy plate mill, with furnaces and direct reduction	1.06 (3)	0.109 (7)	-	0.442	0.016
Hot rolled products, with electric furnace, without direct reduction	1.06 (8)	0.109 (9)	-	0.442	0.033
Hot rolled products, with electric furnace, with direct reduction	1.06 (3)	0.109 (9)	-	0.442	0.171
Hot rolled products, with electric furnace, with oxygen steelworks	0.243 (6)	0.109	-	0.176	0.044
Average order	0.306 (10)				

(1) Previous figures weighted by the respective cost of the component installations (cf. table D)
(2) Figure in the previous column weighted by the proportion of the type of installation in the total orders (cf. table E)
(3) Table F
(4) Table I
(5) Table L
(6) Table G
(7) Table K
(8) Table E
(9) Table J
(10) Total of quantities of work, as entered in the last column

Table R. Direct employment induced in the boilerwork and pipework branch for one million Francs of orders (in work-years)

	Work content in			Work content in	
	steelworks	hot rolling	cold rolling	the complete unit	the total transfer(2)
Cold rolling mill, with electric furnaces and direct reduction	1.28 (3)	0.32 (3)	0.214(5)	0.394	0.025
Cold-rolling mill, with oxygen steelworks	1.40 (6)	0.32 (4)	0.214(5)	0.453	0.077
Heavy plate mill, with oxygen steelworks	1.40 (6)	0.428(7)	-	0.823	0.015
Heavy plate mill, with furnaces and direct reduction	1.28 (3)	0.428(7)	-	0.726	0.026
Hot rolled products, with electric furnace, without direct reduction	1.28 (8)	0.214(9)	-	0.587	0.043
Hot rolled products, with electric furnace, with direct reduction	1.28 (3)	0.214(9)	-	0.587	0.228
Hot rolled products, with electric furnace, with oxygen steelworks	1.40 (6)	0.214	-	0.866	0.216
Average order	0.63(10)				

(1) Previous figures weighted by the respective cost of the component installations (cf. table D)
(2) Figure in the previous column weighted by the proportion of the type of installation in the total orders (cf. table E)
(3) Table F
(4) Table I
(5) Table L
(6) Table G
(7) Table K
(8) Table D
(9) Table J
(10) Total of quantities of work, as entered in the last column

Table S. Direct employment induced in the specialized steelmaking equipment branch for one million Francs of orders (in work-years)

	Work content in			Work content in	
	steelworks	hot rolling	cold rolling	the complete unit	the total transfer[2]
Cold rolling mill, with electric furnaces and direct reduction	0.768[3]	1.68[3]	1.33[5]	1.3	0.083
Cold-rolling mill, with oxygen steelworks	2.09 [6]	1.68[4]	1.33[5]	1.525	0.259
Heavy plate mill, with oxygen steelworks	2.09 [6]	2.23[7]	-	2.173	0.039
Heavy plate mill, with furnaces and direct reduction	0.768[3]	2.23[7]	-	1.718	0.062
Hot rolled products, with electric furnace, without direct reduction	0.768[8]	1.81[9]	-	1.445	0.107
Hot rolled products, with electric furnace, with direct reduction	0.768[3]	1.81[9]	-	1.289	0.5
Hot rolled products, with electric furnace, with oxygen steelworks	2.09 [6]	1.81	-	1.964	0.491
Average order	1.541[10]				

(1) Previous figures weighted by the respective cost of the component installations (cf. table D)
(2) Figure in the previous column weighted by the proportion of the type of installation in the total orders (cf. table E)
(3) Table F
(4) Table I
(5) Table L
(6) Table G
(7) Table K
(8) Table E
(9) Table J
(10) Total of quantities of work, as entered in the last column

Table T. Direct employment induced in the electrical equipment branch for one million Francs of orders (in work-years)

	Work content in			Work content in	
	steelworks	hot rolling	cold rolling	the complete unit	the total transfer (2)
Cold rolling mill, with electric furnaces and direct reduction	1.20 (3)	1.34 (3)	0.86 (5)	0.988	0.063
Cold rolling mill, with oxygen steelworks	1.08 (6)	1.34 (4)	0.86 (5)	0.974	0.166
Heavy plate mill, with oxygen steelworks	1.08 (6)	1.34 (7)	-	1.234	0.022
Heavy plate mill, with furnaces and direct reduction	1.20 (3)	1.34 (7)	-	1.231	0.044
Hot rolled products, with electric furnace, without direct reduction	1.32 (8)	1.50 (9)	-	1.437	0.106
Hot rolled products, with electric furnace, with direct reduction	1.20 (3)	1.50 (9)	-	1.35	0.524
Hot rolled products, with electric furnace, with oxygen steelworks	1.08 (6)	1.50	-	1.269	0.317
Average order	1.242 (10)				

(1) Previous figures weighted by the respective cost of the component installations (cf. table D)
(2) Figure in the previous column weighted by the proportion of the type of installation in the total orders (cf. table E)
(3) Table F
(4) Table I
(5) Table L
(6) Table G
(7) Table K
(8) Table E
(9) Table J
(10) Total of quantities of work, as entered in the last column

Table U. Direct employment induced in the maritime transport branch for one million Francs of orders (in work-years)

	Work content in			Work content in	
	steelworks	hot rolling	cold rolling	the complete unit	the total transfer (2)
Cold rolling mill, with electric furnaces and direct reduction	0.238 (3)	0.238 (3)	0.238 (5)	0.238	0.015
Cold rolling mill, with oxygen steelworks	0.298 (6)	0.238 (4)	0.238 (5)	0.238	0.040
Heavy plate mill, with oxygen steelworks	0.298 (6)	0.358 (7)	-	0.334	0.006
Heavy plate mill, with furnaces and direct reduction	0.238 (3)	0.358 (7)	-	0.316	0.011
Hot rolled products, with electric furnace, without direct reduction	0.238 (8)	0.119 (9)	-	0.161	0.012
Hot rolled products, with electric furnace, with direct reduction	0.238 (3)	0.119 (9)	-	0.178	0.069
Hot rolled products, with electric furnace, with oxygen steelworks	0.298 (6)	0.119	-	0.218	0.055
Average order	0.208 (10)				

(1) Previous figures weighted by the respective cost of the component installations (cf. table D)
(2) Figure in the previous column weighted by the proportion of the type of installation in the total orders (cf. table E)
(3) Table F
(4) Table I
(5) Table L
(6) Table G
(7) Table K
(8) Table E
(9) Table J
(10) Total of quantities of work, as entered in the last column

Table V. Direct employment induced in the engineering branch for one million Francs of orders (in work-years)

	Work content in			Work content in	
	steelworks	hot rolling	cold rolling	the complete unit	the total transfer (2)
Cold rolling mill, with electric furnaces and direct reduction	0.602(A) 1.416(B)	0.402(A) 0.944(B)	0.502(A) 1.18 (B)	0.886(A) 1.178(B)	0.057(A) 0.075(B)
Cold rolling mill, with oxygen steelworks	0.502(A) 1.18 (B)	0.402(A) 0.944(B)	0.502(A) 1.18 (B)	0.89 (A) 1.18 (B)	0.151(A) 0.2 (B)
Heavy plate mill, with oxygen steelworks	0.502(A) 1.18 (B)	0.289(A) 0.678(B)	- -	0.376(A) 0.882(B)	0.006(A) 0.016(B)
Heavy plate mill, with furnaces and direct reduction	0.602(A) 1.416(B)	0.289(A) 0.678(B)	- -	0.398(A) 0.937(B)	0.014(A) 0.033(B)
Hot rolled products, with electric furnace, without direct reduction	0.602(A) 1.416(B)	0.452(A) 1.062(B)	- -	0.504(A) 1.186(B)	0.037(A) 0.088(B)
Hot rolled products, with electric furnace, with direct reduction	0.602(A) 1.416(B)	0.452(A) 1.062(B)	- -	0.572(A) 1.239(B)	0.222(A) 0.48 (B)
Hot rolled products, with electric furnace, with oxygen steelworks	0.502(A) 1.18 (B)	0.452(A) 1.062(B)	- -	0.479(A) 1.127(B)	0.12 (A) 0.28 (B)
Average order	Hypothesis A: 0.607			Hypothesis B: 1.172	

DOSSIER VII

COSTS AND FINANCING

1. Iron and steel is a heavy industry involving the mass production of heavy products: in order to operate it requires very costly and large installations. The iron and steel industry forms part of the group of "capital intensive" industries.

2. The iron and steel industry is also a low profit industry; losses, accumulated during the last few years by some European steel companies, have given rise to the idea of a declining industry from which no substantial contribution can reasonably be expected - certainly not quickly - towards creating an economic surplus.

The iron and steel industry therefore raises questions of costs and financing, the weight of which falls particularly heavily on the majority of developing countries.

A. COSTS PER TONNE INSTALLED

3. Unit costs have increased very rapidly; they have accelerated during recent years.

4. Fifteen years ago, the average cost per tonne installed for an integrated plant was about US$ 350[1].

In 1975-1976, it was estimated that the cost of an integrated plant on a virgin site was approximately US$ 800 per tonne[1].

In 1977, the approximate cost per tonne was considered by experts to be as follows:

- US$1000/tonne in the case of integrated plants, (1 million tonnes annual capacity)
- US$ 700 to 800/tonne in the case of extension investments,
- US$ 300 to 350/tonne in the case of small semi-integrated plants[2].

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(1) In current dollars.

(2) W.T. Hogan: "Future Steel Plants in the Third World" - Association of Iron and Steel Engineers Yearly Proceedings, 1977.

In fact, since that date, the above data probably correspond more to investment costs in industrialized countries than to effective investment costs in the developing countries.

5. In fact, it has been observed that the average cost of new installations in the Brazilian iron and steel industry reached the following levels in 1978:

- on average : US$ 1460/tonne
- breaking down as follows: US$ 883/tonne for light and long products
  : US$ 1677/tonne for flat products
  : US$ 1850/tonne for special steels[3]

Although in February 1980 the Japanese expert T. Kono[4] estimated the installation cost of an integrated plant as US$ 1200/tonne[5] in the industrialized countries, and US$ 1500/tonne in the developing countries, these estimates were largely exceeded by escalating costs.

In 1978 the cost of the Brazilian ACOMINAS project, evaluated at US$ 900/tonne in 1973, exceeded US$ 1700 (including working capital and initial establishment costs)[6]: the cost per tonne of the Pakistani PIPRI project rose from approximately US$ 1200 in 1973 to US$ 1750 by the end of 1978.

At the beginning of 1981 US$ 1700 and 1800 per tonne installed were minimum figures for the construction of integrated plants: an estimate of US$ 1730/tonne may be noted for the PARADIP project in India[7], where know-how in the steel industry is already advanced, and an estimate of nearly US$ 1700/tonne for an extension of the SOMISA plant in Argentina[8].

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(3) Congress of the Brazilian Steel Institute, Rio de Janeiro, April 1980.

(4) OECD: "L'acier dans les années 80", Paris Symposium, February 1980.

(5) In accordance with AISI estimates in the United States, the installation costs (hypothetical) would be of the order of US$ 1,175/tonne. See AISI: "Steel at the Crossroads, The American Steel Industry in the 1980s."

(6) Financial Times, 14 September 1978.

(7) Metal Bulletin, 5 December 1980.

(8) Metal Bulletin, 18 March 1980.

Costs exceeding US$ 2000/tonne tend to become the rule, in such projects as:

- ZULIA in Venezuela: approximately US$ 3000/tonne (including coal mine)(9)
- MISURATA in the Libyan Arab Jamahiriya: about US$ 2600/tonne(10)
- AJAOKUTA in Nigeria: from US$ 3000 to 4000/tonne(11).

The costs of semi-integrated or integrated plants using the electric furnace/direct reduction route have followed the same progression; this is shown by the following projects:

- DEKKHEILA in Egypt : approximately US$ 1250/tonne (direct reduction process and electric furnace steelworks)(12)
- JUBAIL in Saudi Arabia: approximately US$ 1000/tonne (direct reduction process and electric furnace steelworks)(13)
- JIJEL in Algeria : approximately US$ 2000/tonne (direct reduction process and electric furnace steelworks up to production of billets)(14)

6. The increase in unit costs results primarily from the rapid increase in capital goods for the steel industry from 1970: 35% increase between 1960 and 1970, and more than 65% increase between 1970 and 1975.

(15)

1960	1970	1975
100	135	218

This upward movement continued after 1975: according to a study carried out in 1979, capital goods for the basic industries (including capital goods for the iron and steel industry) would have increased

(9) Metal Bulletin 8 August 1978

(10) Marchés Tropicaux, 2 January 1981, for a capacity of 1.3 m tonnes

(11) Revue de Métallurgie, December 1980

(12) Moyen-Orient Sélection, 28 September 1979

(13) Metal Bulletin

(14) Proche Orient Economie, 9 April 1980

(15) EEC "Investment in Community Coal-minery and Iron and Steel Industries" and P.F. Marcus "World Steel Supply Dynamics", New York, March 1975.

between 1973 and 1979 at an average annual rate three times greater than the inflation rate, that is to say about 30% per year[16].

In fact, capital goods for the iron and steel industry originate in the main from industrialized countries which, in spite of competition, are able to impose their prices. The manufacturing capacities available in India, Brazil and some other countries have not yet reached a level which permits them to effectively extend the competition and thus influence prices.

7. The cost of equipment has a direct influence on total amortizations and financial costs. This introduces a differentiation between (new) iron and steel industries in the developing countries and (old) iron and steel industries in the industrialized countries; on the one hand between entirely new investments and on the other between investments on extensions.

It has been estimated that in 1976 amortization and financial costs in the United States represented on average US$ 21.9 out of a total cost per tonne of US$ 346.8 (6.3%), and in Japan US$ 37.1 out of a total cost per tonne of US$ 248.3 (14.9%).

By contrast it was estimated that in 1978 amortization and financial costs relating to an entirely new unit had risen to US$ 177 per tonne in the United States and US$ 199 per tonne in Japan, for costs per tonne installed of US$ 1,050 and US$ 700 respectively.

In the developing countries the average cost per tonne installed tends to exceed US$ 2,000. This is reflected in amortization and financial costs which oscillate between US$ 200 and US$ 400 per tonne[17], and hence reach a total which is equivalent to the cost of ordinary steel on the international market.

8. The increase in costs also reflects the impact of conditions in the developing countries, where the construction of a steel plant:

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(16) North American British Committee - Basic Industries - London 1979.

(17) Mr. Astier, SEAISI Quarterly, (last quarter 1980) estimates the total of amortizations and financial costs as 15% of the cost per tonne installed. Cf. also the paper by S. Gerdau Johann Peter at the ILAFA Congress in September 1980 (ILAFA Review, December 1980).

- implies the construction of harbour, road and rail infrastructures and housing and social facilities;
- must count on additional costs involved in delays on future programmes, these being likely to affect the amount of investment by 0.5% to 3% per month of delay. The greater part of this surcharge generally involves a transfer in foreign currency(18),
- involves modes of the "turnkey" or "product in hand" type of project, leading likewise to surcharges (for the supply of additional services and for actual or extended cover of "risks") varying from 33% to 100%(19);
- assumes systematic and costly operations for training young inexperienced personnel, i.e. US$ 100 per tonne installed for the Libyan project at MISURATA(20).

Developing countries pay for the experience gained with costly construction periods and the purchase of training, technical or administrative assistance.

9. In this context, where large size signifies increased construction difficulties, and increasing costs of coordinated operations to obtain technical and administrative expertise, the law of scale economies based on a simple relationship between volumes and surfaces tends to be brought into question, and no longer operates automatically and in a linear manner in every case.

The consequences of increasing unit costs

10. It is the developing countries which principally bear the weight of installation cost increases. The iron and steel industries of the industrialized countries, which were developed during the period 1965 - 1975 in Japan, and in Europe, have benefitted from costs per tonne installed which were very much lower than the costs currently borne by the developing countries. In addition they are able to increase their capacities at

(18) and (19) Note from Mr. Benbouali, UNIDO, November 1980.

(20) Marchés Tropicaux, January 1981, First evaluation.

relatively reduced costs in the form of:

- modular extensions (20 million tonnes possible in Japan),
- simple extensions (30 million tonnes in the United States and 20 million tonnes in Japan)[21]

whilst the developing countries cannot escape the more costly unit investments.

11. The increase in unit costs is making iron and steel investment a massive outlay which is incompatible with the financial capabilities of a large number of developing countries: the construction of a 1.5 million tonne integrated plant requires capital assets equal to US$ 3 billion, whilst the construction of a new steel capacity of 20 million tonnes in 10 years assumes that Brazil is capable of devoting to it US$ 3b, then gradually US$ 4b, and possibly even US$ 5b, per year.

12. The increase in unit cost has repercussions on the industry's operating costs. An installation cost per tonne of US$ 2,000 results in an approximate charge of US$ 200 per tonne of steel produced (approximately 10%). This magnitude is being approached by some costs and prices specified by the Brazilian iron and steel industry for the year 1978:

- production costs : from US$ 243 to 340/tonne
- export prices : from US$ 240 to 290/tonne
- domestic selling price (long and flat products) : from US$ 420 to 480/tonne

It can be seen that such high costs upset the balance, if one may speak of a balance, in an operation where profitability has become a problem.

13. A negative consequence of the increase in cost of repayments and interest is that these tend to become a determining cost factor, whilst

(21) "Brownfield" or "Rounding out", see Steel Industry Economics, by H. Mueller and Kiyoshi Kawahito, Japan Steel Information Center.

a reduction in operating costs of a few dollars requires a sustained and considerable effort[22]. This trend involves the risk of discouraging efforts to promote growth in enterprises in the developing countries.

(22) Article by S. Gerdau Johann Peter (ILAFA) - doc. cit.

B. STEEL INDUSTRY OPERATION: COSTS AND PROFITABILITY

14. The iron and steel industry is one which has been particularly affected by the crisis; major European steelworks accumulate losses, whilst the Americans complain that they are caught between prices and squeezed by competition after having been held at too low a level by administrative pressures, and increasing costs. This is also the complaint and claim of European or Brazilian steel manufacturers.

Trends in prices and costs

15. Prices have suffered the impact of the crisis and fierce international competition on the open markets, even if domestic prices have been less affected than export prices. In real terms prices at the end of the seventies had hardly caught up with the level reached in 1974[23], while costs on the other hand had never ceased to increase. In the developed countries the average annual rate of increase of the main iron and steel inputs rose during the period 1965-1976 to 10.5% in Europe, 8.5% in the United States and 7.5% in Japan. Increases accelerated during the last period, 1970-1978, the rates then being 18%, 12% and 12.5% respectively.

16. In the developing countries the rate of increase in costs was even faster. In India, between 1965 and 1969, production costs increased on average by 9% per year[25]; in Turkey production costs leapt from US$ 393 per tonne of flat products and US$ 460 per tonne of long products in 1978 to US$ 636 per tonne of flat products and US$ 526 per tonne of long products in 1979[26].

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(23) Revue de Métallurgie - December 1980

(24) H. Mueller and Kiyoshi Kawahito: cf. doc. cit.

(25) National Productivity Council of India "Productivity trends in iron and steel industry in India", 1974

(26) D.P.T. "La structure de la sidérurgie en Turquie et ses problèmes" - 1979. Average production costs in Latin America rose to US$ 443 per tonne in 1978.

17. Cost trends are the result of highly differentiated trends for each of the main factors structuring these costs:

- the price of iron ore, in spite of a recent delayed recovery, has undergone a relatively marked reduction. Between 1965 and 1979 the average price of iron ore and the average price of merchant bars changed as follows:

	1965	1979[27]
Iron ore	100	189
Merchant bars	100	415

- the price of labour and energy underwent a rapid increase during the last two decades, and in particular during the most recent period:

	1960			1976 US$/tonne of steel[28]		
	USA	JAPAN	EEC	USA	JAPAN	EEC
1. Labour	62	27	23	128	50	91
2. Iron ore and scrap	20	43	24	52	44	44
3. Energy	18	20	17	59	61	70

- data has already been given relating to the trend of repayment and interest costs.

18. The appended graph "Evolution of the structure of production costs by principal inputs" (in annex to this dossier) shows the increasing influence of labour and energy with respect to the relative "weight" of scrap/iron ore. It will be noted in this respect that production costs are affected by similar trends in the developing countries:

- the same trend towards a reduction in the relative cost of iron ore;
- the same trend towards a rise in the relative cost of energy when coking coal and oil products are used. On the other hand, the availability of natural gas constitutes an increasingly remarkable advantage for countries which produce it in abundance;

(27) Review "Acier Arabe" No. 3 - 1980

(28) H. Mueller and Kiyoshi Kawahito: cf. doc. cit.

- the same trend towards a rise in labour costs, the relatively low level of salaries being largely offset by low labour productivity;
- a highly pronounced trend towards a rise in amortization and financial charges. Personnel and amortization costs are rising, now representing more than 55% of production costs in certain new steel industries instead of the 40% in certain European steel industries.

Profitability in question

19. As a result of the trends in costs and prices, the "profitability" of the iron and steel industry is brought into question. Profits only appear at the end of a long period. The first dividend was only distributed in 1975 to shareholders of the Brazilian company USIMINAS which started in 1956. Today the iron and steel industry is regarded as being a business with little profit, and even as an unprofitable business which should be treated as a public service. According to the World Bank, "few new iron and steel projects are today likely to satisfy reasonable criteria of economic profitability"[29].

20. Nevertheless, it is noted that the results obtained by the various steel companies are not all negative. Whilst French, British and Italian companies accumulate losses, the main German companies maintain their financial equilibrium and the Japanese companies are increasing their profits despite operating levels of 70% or less.[30]

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(29) J.W.P. Jaffé at the IISI Congress on behalf of the World Bank in October 1977.
- Report of proceedings, page 107.

(30) The results of the German companies became worse in 1981, and again at the beginning of 1982, whilst the profits of the Japanese companies tended to crumble away.

Table 1

	Financial year 79/80 compared with 78/79		
	Turnover	Profit before tax	Net profit
Nippon Steel	+ 17.9%	+ 122%	+ 134%
Nippon Kokan	+ 13.4%	+ 156%	+ 144%
Kawasaki Steel	+ 19.5%	+ 131%	+ 187%
Sumitomo Metal	+ 19.0%	+ 140%	+ 156%
Kobe Steel	+ 15.9%	+ 55%	+ 87%

21. The German and Japanese iron and steel industries have a common feature in that they are strongly or very strongly integrated downstream with the market on the one hand, and with the converting of steel products on the other.

The five large Japanese steel manufacturers, like the German Thyssen, Krupp, Mannesmann or Klockner companies, are also large engineering firms, engineering suppliers and industrial groups whose steelmaking activity is made use of and whose profitability is closely linked with downstream activity. The control which is exerted from one end of the route to the other also permits control of the value transferred from upstream to downstream, from the production of iron ore to the production of steel on the one hand, and from the production of steel to the production of machinery and equipment on the other.

A study of the development of the French productive system between 1959 and 1972[31] identified this same general transfer process from upstream to downstream, and in particular from intermediate industries (including steelmaking) to capital goods industries.

22. The evaluation criteria proposed by various people (e.g. the head of the Algerian steel company and a spokesman for the World Bank) come within this perspective of valorization (profitability) through the downstream link.

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(31) INSEE: "Fresque historique du système productif" - Series E, October 1974 - pages 135-142.

The former General Manager of the National Steel Company stated[32] that "the Steel Industry in Algeria is not ashamed that it is a "non-profitable" industry. It refuses to make a secret of the fact or to hide it by price manipulations. On the other hand, it knows that its mere existence, by the upheaval which it implies, and which it requires to ensure its survival and development, creates a new and ever more integrated industrial world, expanding under its own weight, in which its usefulness and profitability (since this is the end-product of usefulness for us) will be undisputed ..... The most important aspect of the steel industry phenomena is the industrial drive which it engenders. Thus, we have no fear of seeing the steel industry divert part of the national income for its own benefit, and we feel that an investment in steelmaking is an investment in all sectors".

On the other hand, before the Congress of the International Iron and Steel Institute, Mr. Jaffé recognized that "the main justification for building an iron and steel project in a developing country today is the desire of the country to become self-sufficient in the production of basic materials required for the engineering industry and to provide protection against sharp fluctuations in the export price of steel. All of this is based on the certainty that a national steel industry will contribute to the acceleration of industrial development in general and to the growth of steel consuming industries in particular"[33].

23. These analyses allow a connection to be made between the trend in costs, profitability, economic transfers between sectors and financing problems. The rapid increase in costs and low or non-existent profitability explains the difficulty in ensuring the financing of projects. Nevertheless, it will be noted that money-lenders are interested in numerous projects, regardless of the difficulties involved: this would be incomprehensible if steelmaking did not make downstream operations profitable, thus ensuring the commercial (and finally profitable) nature of the iron and steel industry.

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(32) M. Liassine: Paper at the 1st Seminar of Arab steelmakers, Algiers December, 1970.

(33) M. Jaffé: XIth Annual Conference of the International Iron and Steel Institute (IISI) - October 1977 - cf. doc. cit, p. 108.

C. FINANCING THE IRON AND STEEL INDUSTRY: CONSTRAINTS AND PROBLEMS

Preliminary note: self-financing and indebtedness

24. The history of the iron and steel industry during the last twenty years shows that the performance of the various national steel industries has been very different as far as the structure and origins of financing are concerned. From 1961 to 1971 Northern European countries and the United States based the vitality of their growth mainly on their self-financing capabilities: 62.9% and 55.2% respectively in the United States and the Federal Republic of Germany: Japan and Italy however preferred to borrow, and their percentages were 26.4% and 20.4% respectively[(34)]. This has not prevented either the Japanese or Italian steel industries from making great progress. It is true that the historical and economic context of these steel industries is very different from the context of steel industries created or projected today in developing countries. In fact, steel industries are rarely sufficiently advanced to possess appreciable self-financing capability. It is estimated, for example, that the self-financing capacity of the Mexican iron and steel industry was of the order of 26.8%, while that in Argentina did not exceed 12.7%[(35)]. In the case of Japan the borrowing mode of financing is typical of the national economy; it is administered and directly fed by the national bank system. On the other hand, where the financing of iron and steel industries in the developing countries is concerned, the absence of self-financing capabilities means not only recourse to sources of financing outside the industry, but in general means obligatory recourse to foreign sources of financing, using a foreign financing system, with respect to which the margins of manoeuvre and freedom are narrow and sometimes non-existent.

25. The <u>weight of the financial constraint</u> already weighs heavily on the iron and steel industries of the developing countries, and it will be even heavier in the coming years. The order of magnitude of the cost of realising iron and steel projects launched or studied in the developing countries up to 1990 will be <u>US$ 170 billion</u>.

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(34) "Le Financement des investissements dans la sidérurgie mondiale de 1961 à 1971" - IISI Brussels, 1974.

(35) Siderurgia Latino Americana - No. 221 - September 1978.

26. The implementation alone of development plans for the Brazilian and Mexican steel industries will involve respective costs of approximately US$ 40b to 50b and US$ 30b to 40b, corresponding to an average annual expenditure of US$ 4b to 5b in the case of Brazil and US$ 3b to 4b in the case of Mexico, with a total of US$ 9b to 11b per year for the whole of Latin America. In 1977 US$ 2,630b was devoted to iron and steel investment in this continent(36). This highlights the level of capital which has to be mobilized and, consequently, the weight of the constraints which must be removed to permit such mobilization.

27. Numerous recent examples provide evidence of the weight of the financial constraint and the transfer of decision-making capabilities to the money-lender, who finds himself effectively in a position to halt, delay or advance a project.

Because of lack of financing, numerous steel projects have been cancelled: the Itaqui I and II projects in Brazil, the Nador integrated steel project in Morocco, the Tika project in Zambia, the integrated plant project in the Philippines, etc. Others have been delayed or postponed from one year to another: in Argentina the extension projects of Somisa and Sidinsa, in Brazil the Acominas, Tubarao projects, in Venezuela the Zulia project, etc.(37).

28. Other projects encounter fewer financial difficulties: this is generally the case with projects started in hydrocarbon producing countries, in particular the Libyan project which will obviously be a unique example of a steel project built without borrowing. However certain projects are moving forward, including some in non-oil producing countries, and the possibilities and modes of financing are analysed below.

(36) Metal Bulletin 25 July 1980.

(37) The same financial reasons explain the abandonment of:
- the CONNEAUT project in the United States
- the STEELWORK '80 project in Sweden, etc.

Participation of firms and direct investment

29 The participation of foreign firms in the capital of new projects launched in developing countries is an established process, currently characterized by simultaneous advance, stagnation and withdrawal.

30. The process tends to expand into the field of iron mines: the majority of the mining projects being implemented or studied generally include direct financial participation by public or private foreign groups: in Argentina, Australia, Gabon, the Ivory Coast, Liberia, Mexico and Senegal. It is the systematic policy of the large Brazilian state mining company, Companhia Vale Do Rio Doce (CVRD) to enter into joint-ventures with various foreign companies.

Table 2[38]

Participating company	% shareholding	Subsidiary	Field of activity
CVRD KAWASAKI (Japan)	51 49	Minas Da Serra Geral SA	Iron ore
BOZZANO SIMONSEN (Brazil) MARUBEN (Japan) KOKAN MINING (Japan)	60 20 20	Mineraçao Hime Ltd.	Iron ore
CVRD US STEEL (USA) (withdrawn from project)	50.9 49.1	Amazonia Mineraçao SA	Iron ore
CVRD MAJOR JAPANESE STEELMAKERS (Japan) NISSHO-IWA TRADING Co. (Japan)	51 49	Nibrasco	Pelletization
CVRD FINSIDER (Italy)		Itabrasco	Pelletization
CVRD INI (Spain)	51 49	Hispanobras	Pelletization
CVRD	100	Carajas[39]	Pelletization

(38) Source: H. Erdemli "Stratégie d'une entreprise d'Etat minière, le cas de la CVRD" - IREP, Grenobles, September 1978

(39) With loans from the World Bank, EEC, Japan, FRG, etc.

31. This procedure is also frequently used for special steel projects, for example MAHINDRA in India and MEXINOX in Mexico with the participation of the French PUK Group (Ugine Acier), or the special steels plant projected in Nigeria with the participation of the Indian Company BIRLA, whilst NISSHIN STEEL (Japan) has a share in the capital of ACERINOX in Spain and Creusot-Loire has a share in the capital of ACEROS DE LLODIO, also in Spain.

32. On the other hand the situation is ambiguous in the field of standard steel production (medium or large projects); whilst certain firms are increasingly withdrawing, for example US STEEL with respect to Spain or Brazil, others continue to show an active interest in steelmaking in developing countries. This applies in particular to the following:

- German and Luxembourg firms, i.e. Ath, Mannesmann, Klockner, Korf and Arbed in Brazil (Mannesmann, Belgo-Mineira and Cosigua extensions) in Malaysia and in the Gulf.
- Japanese firms in Argentina, ASEAN, Brazil, Egypt, the Gulf, Mexico, etc.
- Italian firms in Brazil, Zaire, etc.

Firms interested in direct investment overseas are, in general, large firms, but it is noted that initiatives are also taken by smaller firms, for example in Cameroun, Liberia or Nigeria where medium or small projects are involved.

Certain developing countries reject proposals for direct acquisition of holdings. Others, on the other hand, seek such proposals, but refuse or are reticent with firms whenever the latter consider that the risks are too high or that the guarantees are inadequate.

Financing and guarantees: The role of the State and international organizations[40]

33. The first reaction of investors and finance companies is, in fact, a demand for solid guarantees against the risks incurred. Two types of organization provide such guarantees.

34. The first is the national State and its own organizations. "The success of an iron and steel project started in a developing country assumes, in fact, total support of the Government in particular in respect of financing" .....[41]. Thus, it is not surprising that State control of an iron and steel industry should be rapidly extended: States controlled 23% of world steel production in 1950 and 53% in 1980. In the Third World this proportion rose, during the same period, to 80%, majority State control operating in countries with political regimes as different as Algeria, Brazil or the Republic of Korea. State guarantees facilitate financing arrangements: they also facilitate participation in joint-ventures with foreign firms. Examples of this are numerous, i.e. in Argentina (SOMISA and SIDINSA projects), in Brazil (USIMINAS and TUBARAO projects), in Egypt (the DEKKHEILA project), in Mexico (Japanese-Mexican project), and in Nigeria (special steels project).

35. The second comprises international financing organizations and, in particular, the World Bank group to the extent where ".... even if contributions from the World Bank to Third World steel industry financing are on a relatively small scale, the approval of this organization is regarded by other lenders as a guarantee ...."[42]. In fact, in this field, the World Bank group plays several roles:

(40) For an analysis and details of the various financing funds, see A.R. Parish and O.J. Zeman "Financing the steel industry in developing countries" in 'The Steel Industry in the 80s', Metal Society, 1980.

(41) Communication from M. Jaffé, op. cit.

(42) M. Jaffé, op. cit. page 107.

- firstly, by direct participation through the International Financing Company, it offers a guarantee to direct investors: cf. the participation of the IFC in capital for DALMINE (Argentina), COSIGUA (Brazil), the AHWAZ projects (Iran), MEXINOX (Mexico) and the KOC and BORUSAN projects (Turkey), etc.
- secondly, through agreed loans, the Bank opens the way to other public and private lenders. Loans from the World Bank to the iron and steel industry, which were rare, have increased during recent years to US$ 563 million over a period of six years, financing more than 10% of the cost of eight large steel projects in Brazil, Egypt, Iran, Mexico, Turkey, etc. A question arises regarding the possibility of an even more pronounced undertaking by the Bank to finance the iron and steel industry during the eighties in order to permit an improvement in the general financing conditions (duration of loans and interest rate) and to offset the probably increasing reticence of "commercial" money lenders.

Financing iron and steel production: structure of loans and lenders

36. Borrowing is thus the essential requirement for financing new iron and steel industries in developing countries. Installations based on project financing involve not only the World Bank group but a series of actors ranging from foreign states to Euro-market lenders.

37. The limiting case is a Saudi State loan of US$ 220 million to the Syrian Arab Republic for the construction of a pipe-making unit: the loan was granted in 1975 and was to be repaid, free of interest, over thirteen years, starting in 1983.

38. Certain arrangements involving public and private actors represent a deliberate policy of cooperation by a foreign State. For example the Japanese State is arranging an external loan totalling approximately US$ 300 m for constructing the first integrated steel plant in the Republic of Korea under the following conditions:

Japanese Government	: US$ 31 million
Overseas Economic Cooperation Fund	: US$ [illegible] million
Eximbank of Japan	: US$ 5[illegible].5 million
Bank credits arranged by the Japanese suppliers (i.e. Nippon Steel, Nippon Kokan, etc.)	: approximately US$ 170 million

Financial arrangements made within the framework of Soviet cooperation (with India, Iran, Pakistan, etc.) are similar to the above.

Table 3. Some examples of Japanese loans to the Brazilian Steel industry

Steel company	Date of loan agreement	Amount of loan (Millions ¥)	Period of repayment (years)	Period of grace (years)	Interest rate	Notes
CSN	4.10.1972	16,500	15	3	7%	used completely
	26.5.1976	65,000	15½	3½	8%	not spent
COSIPA	4.10.1972	20,000	15	3	7%	used completely
	26.5.1976	40,000	15½	3½	8%	not spent
USIMINAS	4.10.1972	20,000	15	3	7%	used completely

Source: JETRO, Economic Cooperation of Japan, 1979

Table 4. Some examples of loans from the World Bank

Steel company	Country	Date of loan	Amount of loan (US$m)	Interest rate
CSN	Brazil	February 1972	64.5	9%
USIMINAS	Brazil	April 1972	63.0	9%
ERDEMIN	Turkey	April 1972	76.0	8 3/4%
COSIPA	Brazil	June 1972	64.5	9%
SICARTSA	Mexico	September 1973	70.0	9%
CSN	Brazil	August 1975	95.0	10%
COSIPA	Brazil	August 1975	60.0	10%

Source: Federal Trade Commission - Bureau of Economics, November 1977

39. "Supplier credits (or "purchaser" credits) are linked to the overseas supplies which they are designed to promote(43). Credits granted by the "Eximbanks" (of the United States or Japan) are also associated with equipment exports. It will be noted that, in both cases, these two credit categories benefit from official cover, coming directly or indirectly from the supplier's country (through its banks, insurance companies or Administration).

40. Credits granted by commercial banks, generally grouped in consortia or in syndicates (the 98 banks controlled by Morgan Grenfells for financing the Brazilian ACOMINAS plant - US$ 505 million), are sometimes negotiated by the main equipment supplier or group of suppliers. It is certain that a loan agreement is facilitated by the presence of States, the World Bank or an International Organization (Inter-American Development Bank).

41. From credit granted by commercial banks, we pass to credits contracted on the European market or its "periphery" where the contractor (the country) plays a more decisive role than interest in the project itself or the prestige of his sponsors.

42. In all cases it is found that financing conditions have tended to become more rigorous in respect of the duration of loans, periods of grace and interest rates, particularly during the recent period.

The financing conditions which predominated ten years ago were an average loan period of fifteen years, a period of grace of 3 or 3½ years, and an interest rate of 7%. Today the tendency is towards medium-term loans of less than 10 years, whilst interest rates have escalated to above 10%.

43. This is a dangerous development for the future of steelmaking in numerous developing countries, especially as the demand for essential credits

(43) On this subject, see the compromise reached between the USA and the EEC regarding the more favourable conditions of credit granted by certain countries (see Le Monde of 5 July 1982).

involves linked credits, and hence competition with the expansion of local capital goods production and services. In addition, the demand for additional credits on the Euro-market risks compromising the financial balance of new steelworks, due to the credit period being totally unsuited to the effective rate of entry into full production.

44. Finally, considerable attention will be given to the fact that States and International Organizations become key-actors in financing arrangements for Third World steel companies, either directly as a result of the funds which they provide, or indirectly because of the guarantees which they offer. The role played by Banks is obviously not negligible, but it tends to become secondary to the extent that the banks concerned are governed most of the time by the positions taken by the public actors concerned.

The financing of steel production: new openings and possibilities ?

45. The financing constraint does not have a uniform impact on all developing countries; it is of little consequence in countries rich in hydrocarbons, and has no effect at all in countries with a low population which are oil exporters such as the Libyan Arab Jamahiriya, Saudi Arabia, the United Arab Emirates, etc.

46. The increase in the price of oil between 1979 and 1980 gave oil exporting countries a new financial capability. For the moment, apart from financing national steel installations in Algeria, Gabon, Indonesia, Iran, Iraq, the Libyan Arab Jamahiriya, Malaysia, Mexico, Nigeria, Oman, Saudi Arabia, Trinidad and Tobago, the UAR, etc., oil capital, and in particular Arab capital, has only exceptionally participated in financing steel installations in foreign countries.

47. The only existing projects financed by the latter are as follows:

- a pelletization project in Bahrein (for supplying direct reduction plants in the Gulf) based on Kuwaiti, Iraqi and Saudi capital).
- a mining project at Guelb, in Mauritania, financed jointly by the Arab, Saudi, Kuwaiti and Abu Dhabi Funds, the Islamic Bank and OPEC, and a rolling mill project at Nouadhibou financed by the Abu Dhabi Fund. (Information supplied by the Secretary for Arab Funds' Coordination in Kuwait);
- a pipe production project in the Syrian Arab Republic, based on Saudi capital.

48. For the moment the developments are therefore limited, but the financial potential of oil exporting countries is considerable. This certainly constitutes a possible broadening of financing sources for new iron and steel projects in the developing countries (44).

49. Meanwhile the main money lenders in the industrial countries show sustained interest in a certain number of countries or regions which they consider promising for more global cooperation. It is obvious, for example, that Brazil, the Gulf region, Indonesia, Malaysia and Mexico are included in these areas, since technical aid and financial participation is able to encourage profitable reciprocal arrangements, for example in terms of supplies of hydrocarbons and raw materials, or in terms of outlets for industrial products and services. From this point of view steel projects will probably obtain approval and financing in Brazil and Mexico rather than in Africa South of the Sahara, in Indonesia and Malaysia rather than in the Philippines, etc.

Large reservoirs of raw materials, large producers of hydrocarbons and large markets of today and tomorrow possess advantages which will make them interesting and even sought-after borrowers during the eighties.

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(44) OPEC development funds now being constituted could, if necessary, become an adequate institutional framework for such operations.

50. The Second World Study also drew attention to the more global and complete forms of cooperation starting with an analysis of the Brazilian example of TUBARAO[45] which, simultaneously, involves: a national state (SIDERBRAS, 51% of the capital) and foreign steel firms (i.e. KAWASAKI STEEL and FINSIDER with 24.5% of the capital each). The demand for capital is met by the State and by firms wishing to expand their field of operations, but which are also on the lookout for supplies of raw materials as well as outlets for their techniques and equipment. The resulting cooperation is not free of contradictions, to the extent that the additional capital supplied by the Japanese party (loan of US$ 700 million) is linked to the Brazilian party purchasing Japanese equipment which the Brazilian industry has the means of producing. But the project proceeds within a framework of cooperation which involves more extensive reciprocal arrangements and more global interests.

51. The participation of the Soviet Union in the construction of steel plants in several developing countries apparently shows both analogies and special features:

- EL HADJAR project (second stage being completed) in Algeria
- HELOUAN project (second stage completed) in Egypt
- BOKARO (second stage) and VISHAKHAPATNAM (negotiations on first stage) projects in India
- ISPAHAN project (second stage) in Iran
- AJAOKUTA project (first stage) in Nigeria
- PIPRI project (being completed) in Pakistan
- ISKENDERUN project (second stage) in Turkey

The agreements concluded for implementing these projects involve Soviet participation in financing and the supply of equipment and technical assistance; they sometimes include the repayment of loans (in general partial repayment) but, and, this is a special trait, sometimes payment in kind, starting from the time a plant enters into full production.

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(45) UNIDO - Deuxième étude mondiale sur la sidérurgie, 1978. (Second Study on the World Iron and Steel Industry)

52. These agreements are included in the more global cooperation undertakings which generally exceed the strict framework of steel manufacturing, made in general with countries (cf. above list and Table 5) whose weight, evaluated in terms of mining or oil riches, existing markets or potential, or strategic positions, is not negligible.

53. Finally it will be noted that South-South relationships are starting in the steel manufacturing domain, for example:

-	between Algeria	and Guinea	: for the supply of iron ore to the direct reduction unit at JIJEL
-	between another Asian country	and Nigeria	: for the construction of a small plant in a joint venture
-	between Brazil	and Paraguay	: supply of capital, equipment and technical assistance for the new ACEPAR plant
-	between the Republic of Korea	and India	: agreement linking technical cooperation to the supply of iron ore
-	between India (Kudremukh iron ore)	and Iran	:
		then USSR Trinidad and Tobago Pakistan	
		and Middle East (Abu Dhabi, Oman, etc.)	
		and Nigeria, with the participation of the BIRLA Group in the capital for a special steels unit.	

54. These relationships also seem to offer advantages to zones having mineral resources (iron ore) or hydrocarbons; their development hence reinforces the polarization and differentiation phenomena which have already been noted.

D. A SUMMARY OF THE POSITION OF THE DEVELOPING COUNTRIES IN REGARD TO EXTERNAL FINANCING(46)

55. The data given in Dossier No. 1 "1990 projects in the developing countries" has been reclassified in order to facilitate analysis of the financing (see Table 6). Only those countries have been retained here for which economic and financial ratios are available. The sample established in this way comprises 45 countries, whereas 55 countries have iron and steel projects. This sample is, however, representative since it totals 91,287,000 tonnes of projected capacity out of the 116 million tonnes included in the projects of the 55 countries. The projects have been classified by production capacities into five groups:

Group 1 :	1,000 to 100,000 tonnes
Group 2 :	101,000 to 250,000 tonnes
Group 3 :	251,000 to 600,000 tonnes
Group 4 :	601,000 to 1,100,000 tonnes
Group 5 :	1,101,000 to 3,500,000 tonnes.

The mean capacity of the projects has been calculated by countries. The breakdown of the countries within the groups is as follows:

Group 1 :	13 countries
Group 2 :	8 countries
Group 3 :	12 countries
Group 4 :	7 countries
Group 5 :	5 countries
	45 countries

It will be noted that 40 developing countries (Group 0) do not have any iron and steel projects.

56. The following financial and economic ratios have been established for each country:

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(46) This chapter follows up the request from the small group of experts (2nd Meeting - Vienna, 12-13 March 1981) to produce adequate basic documentation concerning the financing of the iron and steel industry. This documentation has been collected by the Sectoral Studies Department - Industrial Studies Division, UNIDO - Original: English.

EIS/GDP = Estimated investment costs of iron and steel projects up to 1990 as a percentage of 1975-79 GDP
DOD/GDP = Total debt outstanding as percentage of 1975-79 GDP
DS/EXP = Total debt service as percentage of 1975-79 exports
GDI/GDP = Gross domestic investment as percentage of 1975-79 GDP
GDS/GDP = Gross domestic savings as percentage of 1975-79 GDP
EXP/GDP = Exports of goods and services as percentage of 1975-79 GDP
CREDRAT = Ratio of credit-worthiness 1981, published by Institutional Investor

The position of the countries in regard to these ratios is summarized in Table 7 (see Annex).

The position of the groups of countries, classified according to the projected mean production capacities, and in regard to each of these ratios, is set out in Figures 1 to 8 (in Annex).

57. This table and the figures call for the following comments:

- Grouping according to the mean capacity of the project does not necessarily lead to homogeneous grouping in terms of relative investment costs (see Table 7).

In particular in Groups 2 and 3 the relative investment costs differ considerably from the point of view of the GDP (in Group 2 between 0.4% and 45.9%, in Group 3 between 1.2% and 73.8%), whereas the differences in the relative investment costs are much smaller in the other groups, established according to the mean capacities of the projects.

The <u>mean</u> of the relative investment costs differs little between Groups 2, 3, 4 and 5 (between 15% and 18%), but is considerably lower in Group 1 (4%), in this way justifying the differentiation between two capacity-groups up to a capacity of 250,000 tonnes.

Comparing now the relative investment costs with the levels of indebtedness (debt outstanding as percentage of GDP) reveals that, in general, countries in groups with <u>higher</u> relative investment costs are at a <u>lower</u> level of indebtedness. Countries with a lower level of investment (especially the countries in Group 1, the newcomer countries, generally planning mini-projects) are in an unfavourable situation.

Looking at the actual debt burden (measured by the debt service ratio) the picture changes considerably. With one important exception the share of debt service in exports of goods and services is higher in those groups where investment levels are also higher. Only Group 2 combines a high investment level with a low debt servicing level as a percentage of exports.

Figure 3 relates the relative investment costs of the metallurgical and iron and steel projects with the general level of investment (gross national investments as percentage of gross domestic product). In this case no clear picture emerges on the basis of mean capacity groups, unlike the results observed with the level of the country. Figure 3 shows that the investments in iron and steel seem to increase with the level of gross national domestic investment (Groups 0, 1 and 2). In contrast to this the group with the mean capacity presenting the highest relative investment costs (Groups 4 and 5) are at lower levels in regard to gross domestic investment.

Figures 4 and 6, comparing relative investment costs to internal financing capacity, determined by the contribution of gross domestic savings to the GDP and with the credit-worthiness capacity, give a clearer pattern. In both cases the relative investment costs in the iron and steel industry are higher in the capacity groups at higher levels at the level of domestic savings and credit-worthiness.

Taking exports, goods and services into account (figure 5), there seems to be a negative correlation (with the exception of Group 2). The contribution of exports, goods and services to the GDP becomes higher when the level of the estimated costs of the project is lower. Only Group 2 (mean capacity of iron and steel projects of 101,000 to 250,000 tonnes) associates high project costs with a high level of exports[47].

(47) If values linked to the GDP are replaced by absolute investments and exports the estimated costs of the projects increase with the exports.

Considering the external financial flows Figures 7 and 8 show that groups with a higher mean capacity of the projects and higher relative investment costs have greater access to the international financial markets. Only Group 2, with relatively higher investment costs, is to a large extent dependent on official financial sources.

Summarizing, therefore, the positions of the groups of countries seem to be more or less balanced. In general groups with higher relative investment costs are found in the more "favourable" positions, and vice-versa. Debt servicing and exports are exceptions to this rule. In both cases the groups with lower relative investments are found in rather favourable positions.

Group 2 (101,000 to 250,000 tonnes) is the only group with mean project capacities which falls outside this "balanced" profile. This is the case with debt servicing (Fig. 2), exports (Fig. 5), credit-worthiness and the distribution of external flows. The deviation of this group in the case of debt servicing and exports seem to be rather "positive" (relatively low debt servicing, relatively high exports), whereas this is not so for credit-worthiness and access to international financial markets. In both cases investment costs in the iron and steel industry are too high in comparison with the given level of credit-worthiness and the inflow of private financial resources.

However the heterogeneity found within the five groups considered suggests that stratification by groups is not the most adequate criterion.

58. The various ratios do not have the same weight in the decision-making process: it is probable that, in the coming years, that is to say the period where the investment decisions will have to be taken for the 1990 iron and steel projects, the capacity of countries to pay interest on the debt and the solvency ratio established by the Institutional Investor will be taken into consideration.

59. It is therefore country by country, and project by project, that the financing problem presents itself. The developing countries find themselves in different conditions, both in regard to the attraction which they can exercise on foreign investments and also on the financial total of their iron and steel projects, an estimate of which is given in Table 8.

A N N E X

TABLES AND DIAGRAMS

Evolution of the structure of production costs by main inputs

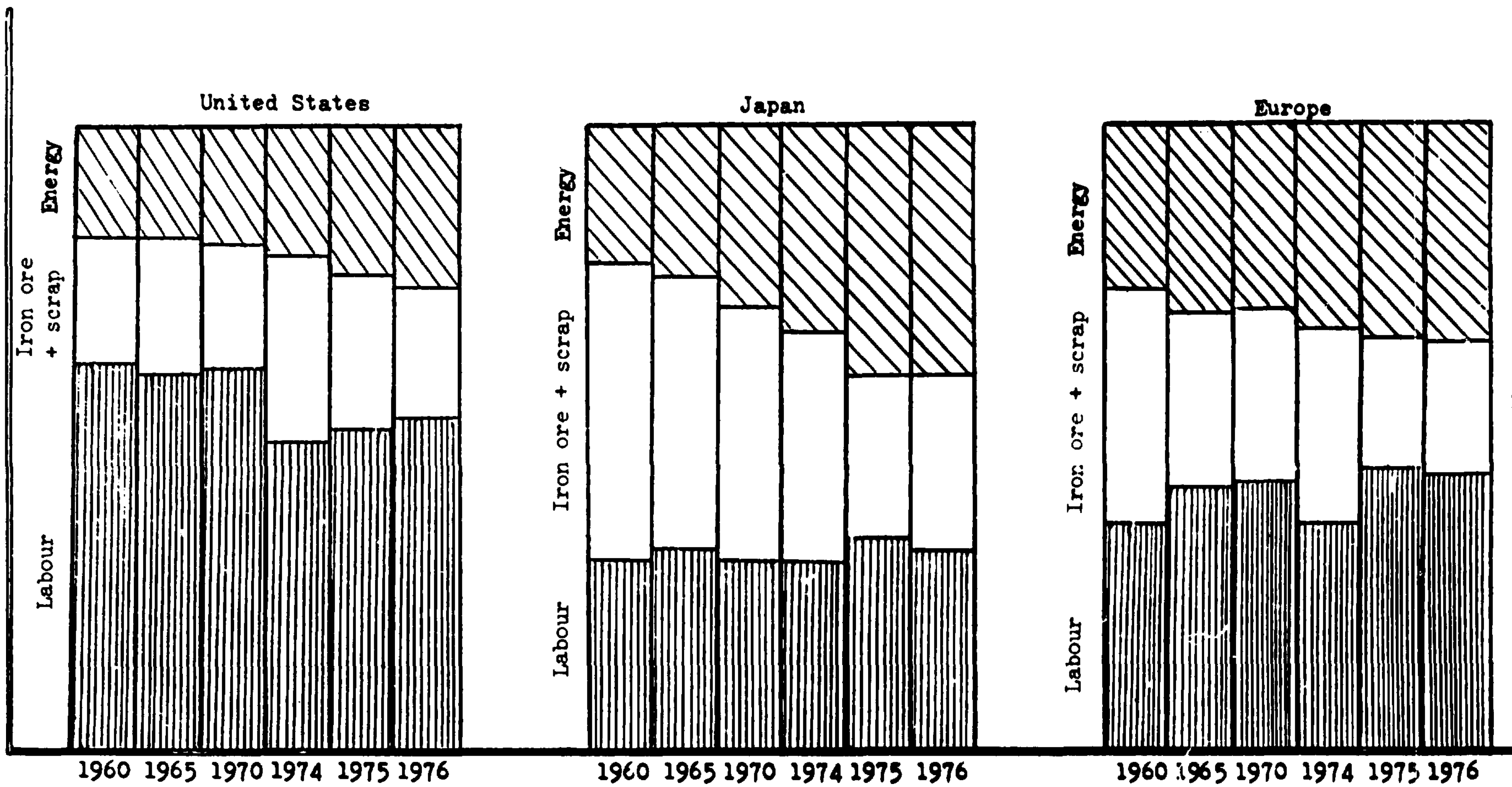

Table 5. Financing structure of some iron and steel and mining projects

(UNIDO - Finance for Steel - BSC (Overseas Services Ltd.)

Project	Country	Estimated cost of the project (in US$)	Financing structure		Notes
ACOMINAS	Brazil	3,037 million	Company capital	33%	Brazilian state
			Eximbank	2	
			European suppliers' credits	16	12 to 15 years except Eurocredit (5, 6 to 7 years)
			European credits for covering local costs	2	
			Euromarket loan	16	7 to 9%
			FINAME loan	29	
			National Housing Bank loan	2	
				100%	
AHMSA Extension	Mexico	222 million (1976)	Suppliers' credits	45%	
			Euromarket loans	37	
			Other loans	18	
				100%	
SICARTSA First phase	Mexico	678 million (1973)	Company capital	44%	Mexican state
			World Bank loan	10	
			Inter-American Bank	8	In general 15 year loans
			Foreign bilateral credits	27	7 to 9%
			Other loans	11	
				100%	
IRON AND STEEL UNITS					
ANTARA	Malaysia	13 million	Company capital	28%	State of Johore (Dev. Corp.) 35% Malaysian Development Bank 20% Islamic Development Bank 20% Klockner 20% Others 5%
			Loans	72%	7 to 8 years at about 9%
				100%	

(continued)

Iron and steel units - continued

DALMINE-SIDERCA	Argentina	1,536 million (1974)	Company capital 23% Eximbank loan 15 Eximbank guarantee on commercial loans 20 European suppliers' credits 17 SFI loans 10 Argentinian loan 10 Others 5 100%	Duration of loans 10 + 4 years 7 + 4 years 5 years
IRON ORE MINES				
SAMARCO	Brazil	594 million	Company capital : US$ 288 million 51% SAMITRI 49% Mutali International Corp. Loans : US$ 312 million, of which - US$ 194m from a consortium of banks US$ 100m from another consortium (inc. Eximbank) US$ 18m from the Caisca Economica Federal	
MOUNT KLAHOYO	Ivory Coast	1,278 million (1975) = in effect 2,135 million	Capital envisaged : US$ 640 million 45% Japanese group 45% Europan group 5.5% Ivory Coast Mining Development Company 4.5% Others Suppliers' credits : US$ 772 million Local loans : US$ 100 million Bank consortium : US$ 623 million	
KUDREMUKH	India	780 million (1980)	At the start : 51% NMDC (India) 25% Marcona Corp. 8% Mitsui Co. 8% Nissho Iwai 8% Okura Trading Co. Then NMDC alone with Iranian financing Then NMDC alone	

Table 6. Iron and steel projects up to 1990

Average project capacity group	Country	Total number of individual projects	Total capacity of projected iron and steel investments up to 1990	Average project capacity	Number of iron and steel projects in the different production capacity groups						Installed capacity 1980	New-comers
					(0)	(1)	(2)	(3)	(4)	(5)(*)		
0	Afghanistan	0	0	0	0	-	-	-	-	-	0	-
4	Algeria	2	2 050	1 025	-	1	-	-	-	1	2 000	-
4	Argentina	5	4 380	970	-	-	1	1	1	2	6 000	-
2	Bahrain	2	430	215	-	1	-	1	-	-	0	x
3	Bangladesh	2	600	300	-	1	-	1	-	-	250	-
0	Barbados	0	0	0	0	-	-	-	-	-	-	-
1	Bolivia	1	100	100	-	1	-	-	-	-	0	x
0	Botswana	0	0	0	0	-	-	-	-	-	-	-
4	Brasil	15	15 050	1 000	-	-	2	4	5	4	18 000	-
1	Burma	2	40	20	-	2	-	-	-	-	30	-
0	Burundi	0	0	0	0	-	-	-	-	-	0	-
1	Cameroon, U.Rep.of	1	36	36	-	1	-	-	-	-	12	-
1	Cent African Rep.	1	10	10	-	1	-	-	-	-	0	x
0	Sri Lanka	0	0	0	0	-	-	-	-	-	120	-
0	Chad	0	0	0	0	-	-	-	-	-	0	-
3	Chile	1	350	350	-	-	-	1	-	-	1 000	-
3	Colombia	3	850	280	-	2	-	-	1	-	500	-
1	Congo	1	20	20	-	1	-	-	-	-	0	x
2	Zaire	1	120	120	-	-	1	-	-	-	120	-
0	Costa Rica	0	0	0	0	-	-	-	-	-	0	-
0	Benin	0	0	0	0	-	-	-	-	-	0	-
0	Dominican Rep.	0	0	0	0	-	-	-	-	-	70	-
3	Ecuador	1	430	430	-	-	-	1	-	-	190	-
0	El Salvador	0	0	0	0	-	-	-	-	-	125	-
0	Ethiopia	0	0	0	0	-	-	-	-	-	0	-
0	Fiji	0	0	0	0	-	-	-	-	-	-	-
1	Gabon	1	50	50	-	1	-	-	-	-	0	x
0	Gambia	0	0	0	0	-	-	-	-	-	-	-
2	Ghana	1	215	215	-	-	1	-	-	-	35	-
0	Guatemala	0	0	0	0	-	-	-	-	-	15	-
0	Guinea	0	0	0	0	-	-	-	-	-	0	-
0	Guyana	0	0	0	0	-	-	-	-	-	0	-
0	Haiti	0	0	0	0	-	-	-	-	-	0	-
1	Honduras	1	100	100	-	1	-	-	-	-	0	x
0	Hong Kong	0	0	0	0	-	-	-	-	-	400	-
5	India	10	11 210	11 210	-	-	2	1	2	5	12 000	-
5	Indonesia	4	4 450	1 110	-	-	1	-	-	3	750	-
1	Ivory Coast	1	34	34	-	1	-	-	-	-	26	-
0	Jamaica	0	0	0	0	-	-	-	-	-	0	-
2	Jordan	3	402	130	-	1	2	-	-	-	120	-
3	Kenya	1	350	350	-	-	-	1	-	-	50	-
5	Korea, Republic of	4	8 100	2 025	-	-	-	-	2	2	10 000	-
0	Lebanon	0	0	0	0	-	-	-	-	-	250	-
0	Lesotho	0	0	0	0	-	-	-	-	-	-	-
3	Liberia	2	700	350	-	-	1	1	-	-	0	x
	continued											

(*) project capacities in thousands of tonnes :

(0) = 0
(1) = 1 - 100
(2) = 101 - 250
(3) = 251 - 600
(4) = 601 - 1 100
(5) = 1 101 - 3 500

Table 6. (continued)

Average project capacity group	Country	Total number of individual projects	Total capacity of projected iron and steel investments up to 1990	Average project capacity	Number of iron and steel projects in the different production capacity groups						Installed capacity 1980	New-comers
					(0)	(1)	(2)	(3)	(4)	(5)		
0	Madagascar	0	0	0	0	-	-	-	-	-	-	-
3	Malawi	0	0	0	0	-	-	-	-	-	0	-
3	Malaysia	4	1 680	420	-	-	2	2	-	-	500	-
0	Mali	0	0	0	0	-	-	-	-	-	0	-
0	Mauritania	0	0	0	0	-	-	-	-	-	15	-
0	Mauritius	0	0	0	0	-	-	-	-	-	15	-
5	Mexico	11	14 955	1 360	-	-	-	3	1	7	9 500	-
3	Morocco	4	1 210	300	-	1	1	2	-	-	105	-
2	Oman	1	125	125	-	-	1	-	-	-	0	x
0	Nepal	0	0	0	0	-	-	-	-	-	0	-
0	Nicaragua	0	0	0	0	-	-	-	-	-	0	-
0	Niger	0	0	0	0	-	-	-	-	-	-	-
4	Nigeria	7	7 040	1 000	-	2	-	1	-	4	170	-
4	Pakistan	3	2 500	830	-	-	-	1	2	-	250	-
0	Panama	0	0	0	0	-	-	-	-	-	125	-
0	Papua New Guinea	0	0	0	0	-	-	-	-	-	0	-
1	Paraguay	1	100	100	-	1	-	-	-	-	0	x
3	Peru	2	550	275	-	-	1	1	-	-	400	-
3	Philippines	3	1 230	410	-	1	1	-	1	-	450	-
0	Rwanda	0	0	0	0	-	-	-	-	-	0	-
1	Senegal	1	40	40	-	1	-	-	-	-	0	x
0	Sierra Leone	0	0	0	0	-	-	-	-	-	0	-
2	Singapore	1	250	250	-	-	1	-	-	-	500	-
0	Somalia	0	0	0	0	-	-	-	-	-	-	-
[illegible]	Democratic Yemen	1	100	100	-	1	-	-	-	-	0	x
0	Sudan	0	0	0	0	-	-	-	-	-	10	-
0	Swaziland	0	0	0	0	-	-	-	-	-	-	-
3	Syrian Arab Rep.	2	1 180	590	-	-	1	-	1	-	120	-
4	Thailand	3	2 300	770	-	-	-	2	-	1	500	-
1	Togo	1	20	20	-	1	-	-	-	-	20	-
3	Trinidad & Tobago	1	600	600	-	-	-	1	-	-	600	-
2	Tunisia	1	225	225	-	-	1	-	-	-	175	-
0	Uganda	0	0	0	0	-	-	-	-	-	15	-
4	Egypt	2	1 565	780	-	-	-	-	2	-	1 800	-
2	Tanzania, Untd. Rep.	2	390	195	-	1	-	1	-	-	25	-
0	Upper Volta	0	0	0	0	-	-	-	-	-	0	-
0	Uruguay	0	0	0	0	-	-	-	-	-	0	-
5	Venezuela	3	5 100	1 700	-	-	-	1	1	1	5 700	-
0	Yemen	0	0	0	0	-	-	-	-	-	0	-
1	Zambia	1	50	50	-	1	-	-	-	-	0	x
Sub-total 85 developing countries		121	91 287	750	-	25	20	27	19	30	73 058	12
Sub-total: Abu Dhabi, another Asian country, Cuba, Dubai, Iran, Iraq, Libyan Arab Jamahiriya, Qatar, Saudi Arabia, Viet Nam		21	24 270	1 160	-	4	1	4	2	10	5 495	1
TOTAL		142	115 557	810	-	29	21	31	21	40	78 553	13

Table 7

FINANCIAL RATIO FOR A SAMPLE OF DEVELOPING COUNTRIES WITH IRON AND STEEL PROJECTS

Country	EIS / GDP	DOD / GDP	DS / EXP	GDI / GDP	GDS / GDP	EXP / GDP	CRED RAT	CROSS FLOW % OFFICIAL	CROSS FLOW % PRIVATE
Group 1: 1-100 (100 T)									
* Bolivia	5.6	37.6	26.0	21	15	19	21.9	36.8	63.2
Burma	1.5	14.0	17.6	15	11	6	-	72.6	27.4
Cameroon, United Republic of	1.1	24.6	6.9	22	16	27	-	55.6	44.4
* Central African Republic	4.1	24.3	3.5	22	7	18	-	53.2	46.8
* Congo	3.4	70.1	9.7	22	-1	40	15.3	67.0	33.0
* Gabon	4.9	45.8	10.4	65	59	52	35.3	20.6	79.4
* Honduras	6.5	33.8	12.8	24	17	36	-	65.3	34.7
Ivory Coast	1.2	32.3	10.5	26	23	39	44.2	19.7	80.3
* Paraguay	4.4	17.9	10.8	26	19	14	46.0	57.8	42.2
* Senegal	3.5	23.2	7.8	19	6	34	25.4	54.0	46.0
Togo	6.9	45.8	10.6	34	11	32	-	40.3	59.7
* Yemen, Democratic	-	39.2	0.7	-	-	-	-	100.0	-
* Zambia	3.6	54.1	15.0	27	23	39	16.3	54.5	45.5
Group 1 Total	3.9	35.6	10.9	27	17	30	29.2	53.6	46.4
Group 2: 101-250 (1000 T)									
* Bahrain	-	-	-	-	-	-	-	100.0	-
Ghana	45.9	10.1	4.8	-	-	-	-	97.8	2.2
Jordan	25.8	32.9	3.5	43	17	46	41.9	61.5	38.5
* Oman	-	21.4	5.5	-	-	-	46.7	51.7	48.3
Singapore	0.4	13.4	1.2	38	28	160	78.6	27.6	72.[illegible]
Tanzania, United Republic of	21.6	29.0	7.2	21	12	18	16.8	97.2	2.[illegible]
Tunisia	4.8	33.4	9.2	31	23	32	48.3	56.9	43.[illegible]
Zaire	3.7	60.5	10.3	24	15	29	6.8	42.9	57.1
Group 2 Total	17.0	28.7	6.0	31	19	57	40.0	67.0	33.0
Group 3: 251-600 (1000 T)									
Bangladesh	1.2	30.4	12.5	8	2	6	-	96.2	3.8
Chile	5.3	44.2	41.6	11	[illegible]	20	54.4	15.1	84.9
Colombia	8.1	16.9	12.8	21	21	16	5[illegible].1	39.2	60.8
Equador	7.6	17.6	11.8	26	26	26	52.3	15.9	84.1
Kenya	10.2	21.1	6.2	22	18	30	42.5	62.5	37.5
* Liberia	73.8	-	-	-	-	-	21.0	52.0	48.0
Malaysia	7.3	16.1	5.5	24	30	51	72.7	24.5	75.5
Morocco	10.3	32.2	10.6	26	11	19	39.7	37.0	63.0
Peru	4.2	38.0	29.0	16	14	18	43.[illegible]	42.6	57.4
Philippines	7.3	23.2	18.3	30	24	19	44.4	36.3	63.7
Syrian Arab Republic	31.4	20.5	10.9	30	12	21	32.2	90.5	9.5
Trinidad & Tobago	17.8	8.5	2.6	24	34	49	56.5	14.3	85.7
Group 3 Total	15.4	24.4	14.7	22	18	25	47.1	43.8	56.2
Group 4: 601-1100 (1000 T)									
Algeria	19.7	42.1	16.6	49	40	32	57.4	10.3	89.7
Argentina	11.7	8.6	19.9	24	27	12	63.4	12.9	87.1
Brazil	14.4	22.3	47.6	24	19	7	49.[illegible]	11.2	88.8
Egypt	11.6	51.9	20.7	27	13	21	36.0	69.4	30.6
Nigeria	26.0	3.4	1.9	30	30	30	[illegible]5.8	15.0	85.0
Pakistan	28.7	42.5	13.9	18	7	10	22.1	90.4	9.6
Thailand	13.8	11.1	12.8	27	22	21	52.2	54.5	45.5
Group 4 Total	18.0	26.0	19.1	28	23	19	48.1	37.7	62.3
Group 5: 1101-3500 (1000 T)									
India	16.9	13.8	10.8	22	20	6	50.0	92.2	7.8
Indonesia	8.6	27.6	10.6	21	23	24	57.1	41.7	58.3
Korea, Republic of	6.3	27.0	11.6	29	25	33	55.4	27.2	72.8
Mexico	34.6	24.2	43.4	25	23	10	71.4	7.3	92.7
Venezuela	23.7	13.1	6.6	34	36	32	69.3	3.4	96.6
Group 5 Total	18.0	21.1	16.6	26	25	21	51.6	34.4	65.6

* Newcomer country

EIS/GDP = Estimated investment costs of iron and steel projects up to 1990 in % of GDP 1975/79.
DOD/GNP = Total debt outstanding disbursed in % of GNP, 1975/79
DS/EXP = Total debt service in % of exports, 1975/79
GDI/GDP = Gross domestic investment in % of GDP, 1975/79
GDS/GDP = Gross domestic savings in % of GDP, 1975-79
EXP/GDP = Exports of goods and services in % of GDP, 1975-79
CRED RAT = Ratio of credit-worthiness 1981, published by Institutional Investor
OFFICIAL FLOWS = Share of official flows in total external gross flows, 1975/79
PRIVATE FLOWS = Share of private flows in total external gross flows, 1975/79
Groups of countries by average capacity per project (total of 45 countries)

Figures 1 to 8

Relative position of average-project-capacity groups with regard to relative investment costs of iron and steel projects up to 1990 and a number of selected characteristics

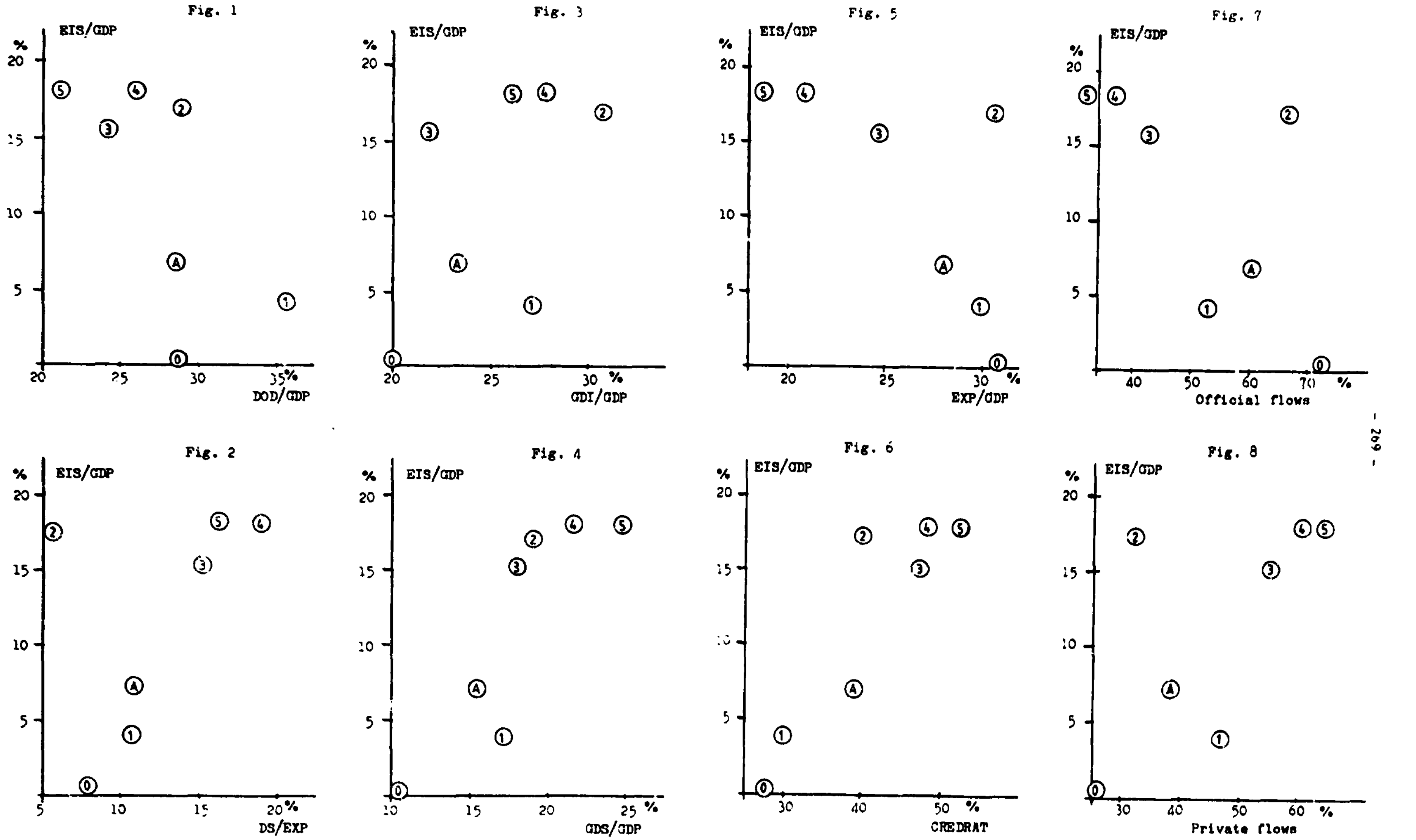

Table 8. Total cost of the iron and steel projects forecast up to 1990
(in US$ millions)

Rank		Total costs	Rank		Total costs	Rank		Total costs
1	Mexico	30,950	19	Philippines	1,565	37	Abu Dhabi	200
2	Brazil	24,300	20	Morocco	1,180	38	Bolivia	200
3	India	17,220	21	Malaysia	1,020	39	Qatar	200
4	Nigeria	12,300	22	Cuba	900	40	Democratic Yemen	200
5	Venezuela	8,750	23	Chile	750	41	Zaire	180
6	Iran	8,000	24	Saudi Arabia	750	42	Bangladesh	100
7	Argentina	7,650	25	Untd. Rep. of Tanzania	750	43	Gabon	100
8	Other Asian country	6,075	26	Trinidad & Tobago	600	44	Honduras	100
9	Pakistan	4,775	27	Peru	575	45	Paraguay	100
10	Iraq	4,500	28	Ecuador	500	46	Zambia	100
11	Algeria	4,050	29	Liberia	500	47	Ivory Coast	75
12	Indonesia	3,650	30	Kenya	450	48	Oman	75
13	Libyan Arab Jamahiriya	3,000	31	Ghana	385	49	Senegal	72
14	Thailand	2,750	32	Jordan	375	50	Burma	60
15	Republic of Korea	2,400	33	Bahrein	250	51	Dubai	50
16	Syrian Arab Republic	2,180	34	Singapore	250	52	Togo	50
17	Egypt	2,000	35	Tunisia	250	53	Untd. Rep. Cameroon	43
			36	Viet Nam	250	54	Congo	30
						55	Central African Rep.	20