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05274

United Nations Industrial Development Organization

Distr.
LIMITED
ID/WG.146/102
30 July 1973
ORIGINAL: ENGLISH

Third Interregional Symposium
on the Iron and Steel Industry
Brasilia, Brazil, 14 - 21 October 1973
Agenda item 1

CHANGING FEATURES OF THE WORLD IRON AND STEEL INDUSTRY[1/]

by

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id.73-5311

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SUMMARY

To set up and estatlish an iron and steel industry, to form the industrial backbone of a nation is an extremely important and challenging task for both the developed and the developing countries of the world.

The fact that the demand for iron and steel on the world market is increasing steadily is stimulating the developed countries to expand and modernize their iron and steel industries and the developing countries to set up their own modern iron and steel industries. The map of the world's iron and steel industry is constantly changing in this way.

In the past 25 years, Japan has achieved one of the most remarkable rates of progress in the world. The way this has been brought about in Japan in the postwar period is very different from the progress in the Japanese industry in the pre-war period. It has been observed elsewhere in the world that the factors required for the development of the industry have changed significantly since World War II. If these changed circumstances are properly understood and appropriate measures are taken, it will be possible to establish in various parts of the world new iron and steel industries that are fully viable economically and able to grow in capacity.

The iron and steel industry can be considered to be capital-, labour-, and technology-intensive; it is also a highly developed industry, in the sense that it has a long history of high-level complex technology. Nevertheless, since the industry is dependent upon technology and bacuse technological innovation in the industry is now continuous, it is deduced that stagnation in technological development and application might cause the iron and steel industry of a country to drop behind in terms of competition at the international level.

Introduction

Looking back over the history of the iron and steel industry in the world in the post-Second World War period, it can generally speaking be described as a significant development period for the industry. In every country, the iron and steel industry has shown a steady growth. The examination of the development history of the industry in the post-war period reveals what changes have taken place in various factors related to the industry in each part of the world.

One of the iron and steel industries in the world which has achieved an outstanding transformation as an example of development is the Japanese industry. By examining the reasons for the remarkable progress of the Japanese industry, it may become possible to analyse the factors or requirements for the progress or decline of the iron and steel industry in general.

Generally speaking, an industry consists of four elements - capital, labour, material resources, and technology. Certain types of industry - the textile industry, for example - are highly labour-intensive and require a comparatively small amount of capital, technology, or resources. This kind of industry cannot be profitable unless a considerable number of well trained workers is secured at low cost. Let us take the chemical industry as another example. This industry is characterized by the fact that technology is the most important element, followed by resources and capital, while labour is considered as the least important element.

Analysis of the iron and steel industry from a similar point of view reveals that the industry is particularly capital-intensive and that, unless an industry is located very close to its raw materials resources, it cannot be successfully operated. Another significant feature of the iron and steel industry is that, although it has a long history of technology, even today revolutionary technologies are emerging one after another, and are changing the course of the industry as a result. The technological requirements of the industry are so severe that, if an industry cannot keep pace with technological development, it immediately finds itself in a position where it cannot compete with others on the international level.

Capital and technology are not the only elements required for the industry; it requires labour as well. Since the iron and steel industry plays a very important role in each country, its labour force represents a by no means negligible portion of the total labour force. Because of such complex features, in spite of the fact the industry has a long history, it cannot be described summarily as a capital-intensive or a labour-intensive industry.

Another noticeable feature in the history of the iron and steel industry is that the element of economic scale has become an important one. In the years immediately after the war, the most appropriate production scale for an iron and steel plant was considered to be 1,500,000 ingot tons per year. In the 1960's 5,000,000 ingot tons became the acceptable basis, whilst in the 1970's the ideal scale is considered to be 10,000,000 ingot tons. It is true that the economic scale also changes from time to time in other types of industry. Nevertheless, the increase in economic scale in the iron and steel industry seems to be more drastic than in other industries. In the light of these conditions, those iron and steel works or industries which possessed advantageous features in the past are no longer well situated when compared with other iron and steel industries in the world. It is found today that fairly new works or industries are achieving a greater development than the well established works or industries.

An attempt is made here to examine various elements that constitute the iron and steel industry taking the Japanese iron and steel industry as the example. In the past, Japan depended on China as the major supplier of its resources. At that time, coal from the United States and iron ores from Australia, India, and South America were of no significance for the Japanese iron and steel industry. This situation has changed entirely in the past 25 years and today coal and iron ores from various parts of the world are extensivel used by the industry.

With regard to technology, in the pre-war period blast-furnace productivity was rather low for various reasons connected with the availability of raw materials and the fact that the industry was based on an old production technolog However, the post-war industry has achieved enormous developments in the field of technology, covering the processes of blast-furnace ironmaking, steelmaking, and rolling. In order to utilize the newly developed techniques effectively, many mo engineers and technical specialists have to be employed than in the pre-war peric

It has become clear that only those countries that are able to utilize these new techniques can maintain a favourable position in the world.

It was fortunate for the Japanese iron and steel industry that the technologically most advanced industries, such as aircraft, atomic power, and electronics, did not emerge until sometime after the war, and so well qualified technological staff were available for the iron and steel industry. This factor was responsible for consolidating the technological capacity of the Japanese industry and the establishment of a superior position for the iron and steel technology in Japanese industrial circles. This point is considered to be an important element in the development of the Japanese iron and steel industry.

With regard to capital, in the 20 years following the end of the war, large-scale capital investment was directed towards such projects as the expansion of the electric power industry and the rationalization of the iron and steel industry. The availability of capital enabled the Japanese industry to enlarge its economic scale rapidly.

Favourable conditions also existed in the field of labour. Japanese manpower has remained very abundant by comparison with the USA and European countries. With the development of automation and progress in technology, it is likely that the manpower requirements could be considerably reduced. Thus, in spite of the fact that the iron and steel industry requires a large number of personnel, the Japanese industry could successfully expand its production scale. Examination of such factors may be useful in understanding the changes that the iron and steel industries in the world have been undergoing.

In the history of the iron and steel industries of the world, the countries which have a long history in the industry and which started modernization first of all are the USA and certain European countries. The US industry has been a powerful world ruler in the post-war period. It has derived benefit both of the domestic and foreign resources. Nevertheless, since it is obliged to utilize the existing plants, which were originally designed to have direct access to the location of resources, construction of new plants has not proceeded as extensively as in Japan. So far as labour is concerned, because of the increase in the wages of the workers, the ratio of the labour cost in the production cost has been sharply increasing by comparison with other countries. Thus, various factors which once favoured the effective control by the USA of the world industry have not developed as satisfactorily as in the past.

Among European industries, there are those of the UK, France, and the Federal Republic of Germany, each with a well established history based on domestic supplies of resources such as iron ore and coal. By reason of the fact that they have long traditions, they are not conveniently located to utilize the resources available in other parts of the world. These factors seem to be the reasons for the dispersed nature of iron and steel plants in these countries and for the difficulty in securing concentrated capital investment, as well as their inability to exploit various changes in the world iron and steelmaking industries to the full extent.

On the other hand, in the Netherlands, where the iron and steel industry emerged comparatively recently, the plants are constructed on the coast, and this factor led to steady growth of the industry in the country, since it means that world resources can be obtained cheaply and easily. In addition, coastal plants are convenient for delivery of products, not only to domestic markets but also to the world market. Thus, the Dutch iron and steel industry has expanded by adopting the most suitable facilities and is extremely competitive.

New plants equipped with advanced facilities have been constructed in Africa, India, South America, and Australia. As far as resources and capital are concerned, these industries are in a favourable position, but they have not experienced satisfactory growth when the utilization of developing iron and steel technology is taken into account. This factor has placed these new industries in a disadvantageous position for competition at the international level in spite of their favourable plant locations and availability of markets.

Figures 1 and 2 and Tables 1 and 2 give data on current world steel production.

Some of the major common problems of the iron and steel industries of the world mentioned earlier illustrate the changes that have taken place in the world iron and steel industry in the post-war period.

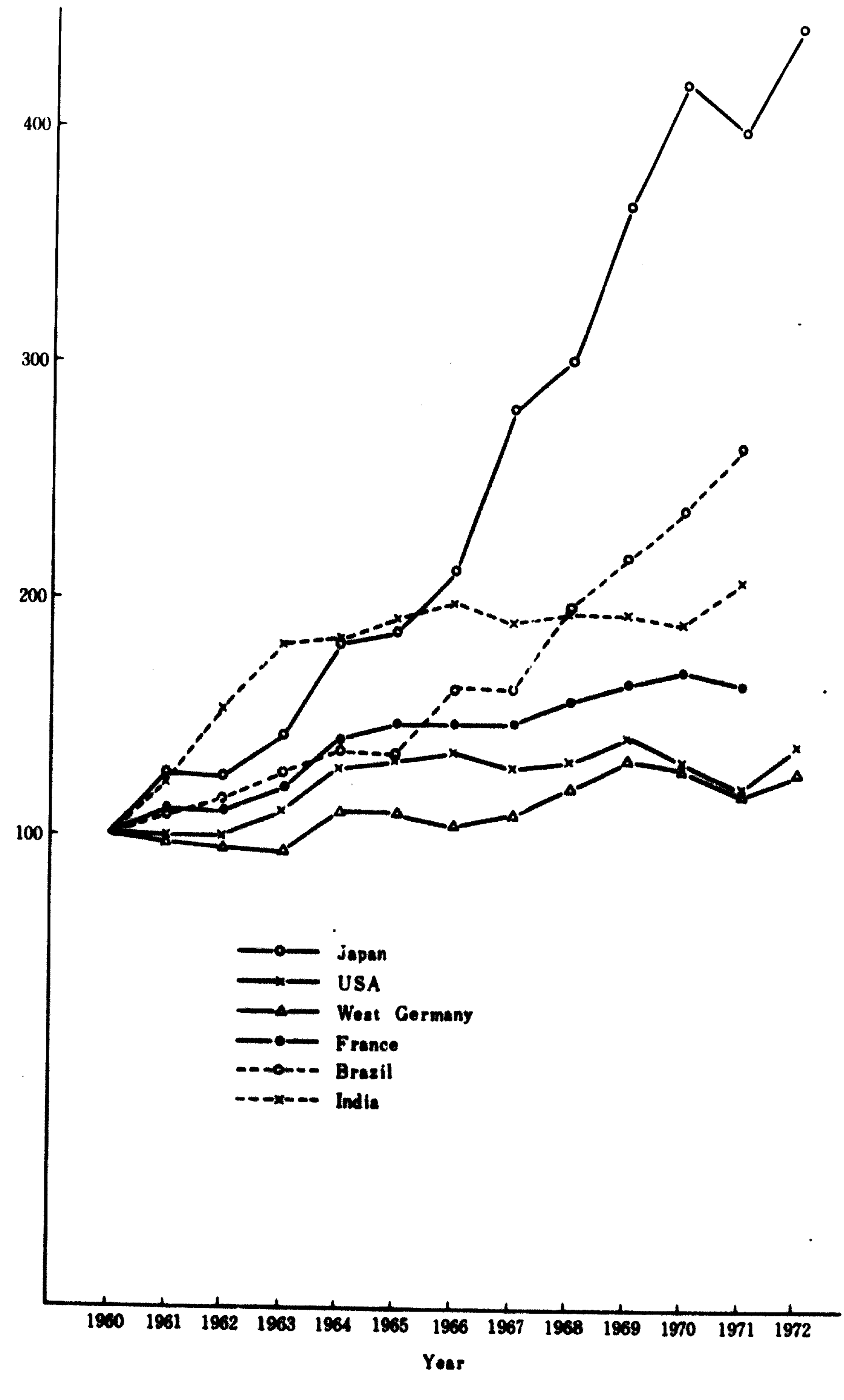

Fig. 1. Crude Production Index (1960=100)

Table I. Crude Steel Production Index

(1960 = 100)

	Japan	USA	F.R. Germany	Sweden	Brasil	India
1960	100	100	100	100	100	100
1961	127	99	98	111	108	122
1962	124	99	95	112	113	153
1963	142	110	93	121	126	181
1964	180	128	109	138	136	182
1965	186	132	108	147	133	192
1966	216	135	104	148	164	198
1967	281	128	108	148	162	190
1968	302	132	121	158	197	195
1969	371	142	133	165	218	194
1970	421	132	132	171	238	186
1971	400	121	118	164	266	209
1972	438	139	128	+	+	+

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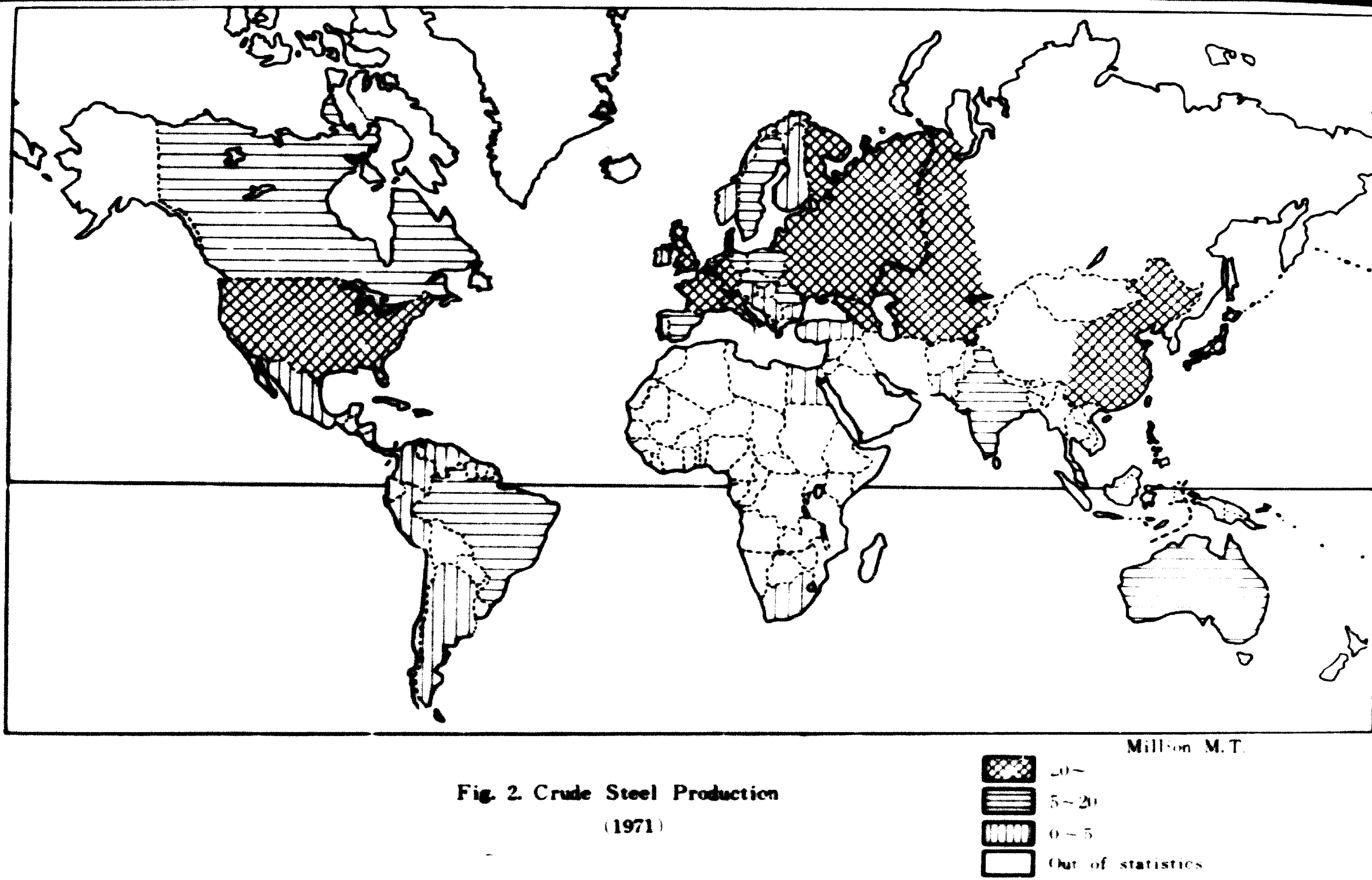


Fig. 2. Crude Steel Production
(1971)

Table 2. Crude Steel Production

(1000 Mt)

Country	1936	1960	1971
F.R. Germany	17,149	34,100	* 43,703
Belgium	3,184	7,181	* 14,530
France	6,708	17,300	* 24,054
Italy	2,025	8,462	* 19,784
Luxembourg	1,981	4,084	5,241
Netherlands	32	1,950	5,070
UK	11,974	24,695	24,173
Austria	418	3,163	3,958
Sweden	991	3,218	5,271
Spain	373	1,920	7,720
Yugoslavia	125	1,442	2,440
Bulgaria	-	251	1,910
Poland	1,141	6,680	* 13,500
Rumania	226	1,806	6,750
DDR	-	3,787	5,700
Czechoslovakia	1,492	6,768	* 12,600
Hungary	553	1,886	3,080
USSR	▲ 16,300	65,292	*125,000
China	340	11,000	* 23,000
India	880	3,339	6,070
Japan	5,223	22,138	* 96,917
Korea, Dem. Pp. Rep.	87	641	1,850
Canada	1,134	5,270	* 11,720
USA	48,534	91,920	*125,000
Mexico	136	1,474	3,860
Brazil	74	3,260	6,020
Argentina	10	277	2,110
South Africa	302	2,114	4,860
Australia	834	3,740	6,820

▲ Estimated

* 1972 crude steel production

Origin "Iron and Steel Annual", Eds. 1972 and 1958

1. <u>Changes in Raw Materials</u>

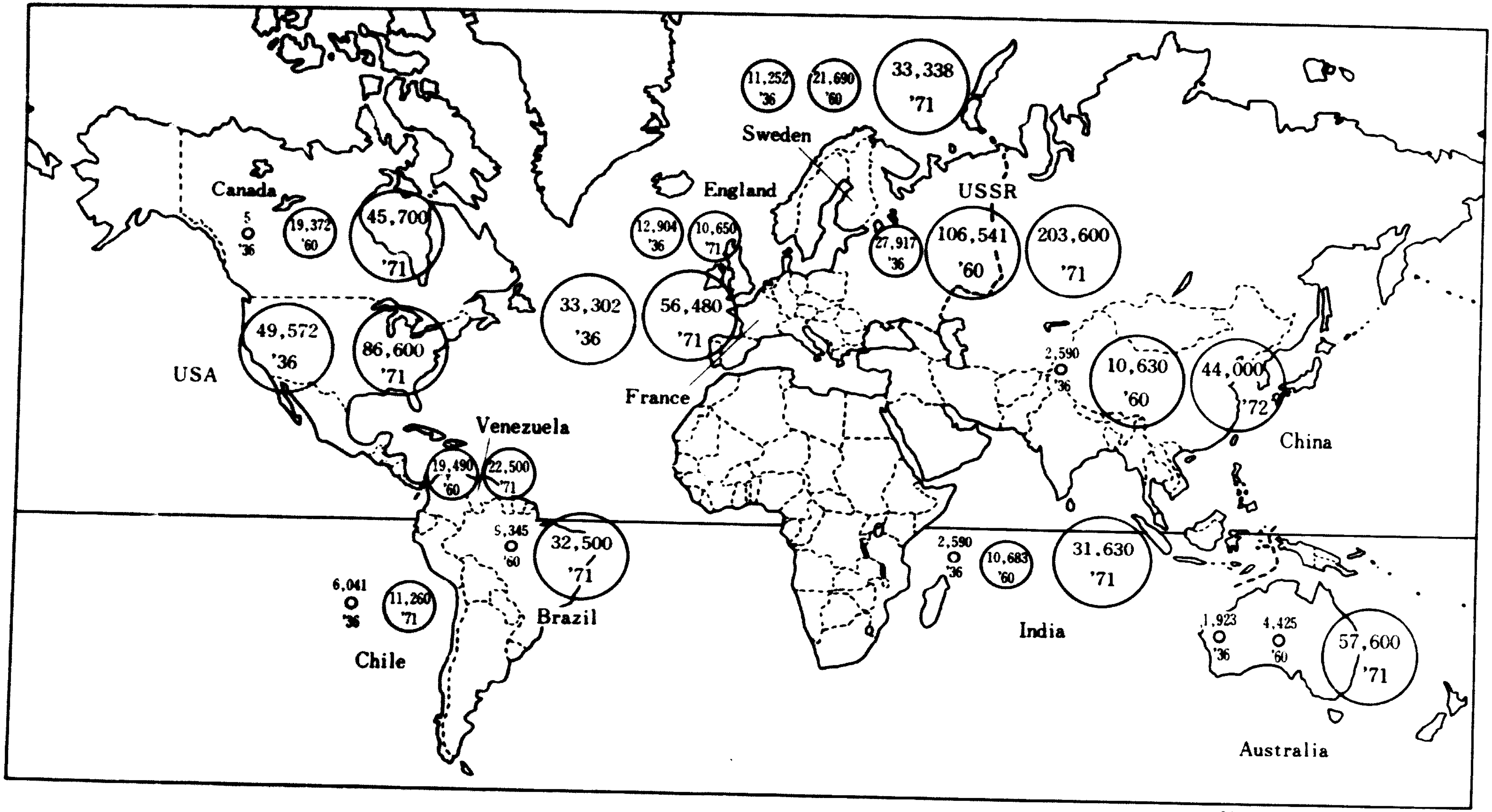
Two major raw materials essential to the iron and steel industry are iron ore and coal. The sources of iron ore are widely spread throughout the world. In the pre-war period, most of the iron and steel plants were constructed in relation to the domestic supply of iron ores.

Coal deposits are distributed over a comparatively limited area of the world. The USA, Federal Republic of Germany, the UK and the USSR were able to rely on their domestic supply, while industries in other countries had to depend on imported coal.

A look at the history of the iron and steel industry in the past 25 years reveals that development of new iron-ore mines has been so remarkable that once-flourishing iron-ore sources are losing their advantages to the new supply sources. A new trend is emerging for the industries of the world generally to prefer sources of abundant and high-grade ores. Thus, the principle of economic scale is appearing in the field of mining development and a new method of transportation has been developed as one means of modernizing the mining industry. This has been an influential factor in lowering the value of the old mines, the deposits of which have been completely explored, and of the iron and steel industries with close access to these mines. This means that the iron and steel industries with close access to newly developed mines are today in a more advantageous position.

Data on world iron-ore resources and production are given in Figure 3 and Table 3.

As for coal, along with the expanded scale of the iron and steel industry in the post-war period, the unit productivity of blast furnaces has increased considerably. This has created new coal quality requirements. Today, the trend towards the use of high-quality coal is increasing in the world. This means that there are only a limited number of sources capable of supplying this important raw material. The coal supplied to the iron and steel industries throughout the world or that utilized as a common raw material mainly comes from large deposits in the USA and Australia; the coal of the USSR is an important material source for the industry of the USSR.



Unit 1,000 M.T.

Fig. 3. Iron Ore Production

Table 3. Production of Iron Ore by Countries

(1000 Mt)

Country	1936	1960	1971
F.R. Germany	7,073	18,86[illegible]	6,391
o France	33,302	67,724	56,480
Italy	858	2,138	1,030
Luxembourg	4,806	6,978	4,540
o UK	12,904	17,362	10,650
Norway	847	1,892	3,820
Austria	1,024	3,542	4,100
o Sweden	11,252	21,690	33,338
Spain	2,266	5,493	7,080
Yugoslavia	451	2,199	3,790
Bulgaria	6	412	2,760
Poland	469	2,182	2,600
Rumania	109	1,460	3,360
DDR	-	1,642	400
Czechoslovakia	1,653*	3,120	1,560
o USSR	27,917	106,541	203,600
o China	5,273	30,000	44,000
o India	2,590	10,683	31,630
Japan	841*	2,459	1,420
Korea, Dem. Pp. Rep.	630	3,389	8,500
Malaya	1,681	5,731	1,100
Philippines	539	1,130	2,240
o Canada	5	19,372	45,700
o USA	49,572	90,209	86,600
Mexico	79	870	5,400
o Brasil	112	9,345	32,500
o Chile	1,462	6,041	11,260
Peru	-	6,984	9,500
o Venezuela	-	19,490	22,500
Algeria	1,884	3,444	2,750
Liberia	-	3,275	25,720
Sierra Leone	579	1,563	2,220
South Africa	360	3,071	10,700
o Australia	1,923	4,425	57,600

* Production in 1937
o Explained in Fig. 3
Origin: "Iron and Steel Annual", Eds. 1958 and 1972

World coal resources and production are illustrated in Figure 4 and Table 4.

Along with the change from traditional sources of raw-materials supply for the industry to new sources, geographical and other requirements for the location of iron and steel plants have been changing considerably, as shown by the above discussion of raw materials.

Examining the changes in the iron and steel industry from the viewpoint of markets, a new feature is also to be observed in the consumption of iron and steel. In developing areas, where the consumption of iron and steel was negligible in the past, populations are increasing more rapidly than in other countries. The countries that formerly had a limited economic capacity for utilizing iron and steel have been achieving tremendous economic progress and are also growing in population. These new economic factors indicate that the time has come for the countries with abundant iron and steel materials to be capable of designing their industrial structure centred around an iron and steel industry. Changes in distribution of the demand for iron and steel and changes in the location of raw-materials supplies lead us to conclude that it may become possible to draw an entirely new map of world iron and steel production. Such a map would emphasize the role of new suppliers and consumers of resources rather than the old-established industries of the USA, Europe, the USSR, and Japan, the countries which dominated the former world iron and steel industry.

2. <u>Changes in Locational Requirements and Transportation</u>

It was mentioned earlier that a new feature has appeared in the distributi of raw materials in recent years. This change is closely related to other fact It seems to be necessary to examine the geographical requirements of the indust and the changes in its transportation system, which has a major bearing on the geographical requirement.

In the past, the iron and steel industries have selected their sites so as to have easy access to iron ore and coal. Furthermore, other industries related to the iron and steel industry, such as automobiles, engineering, and shipbuilding industry used to be established in locations related to the iron and steel industries. Thus, taking into consideration the availability of raw materials, industries grew up in inland areas far from the coast.

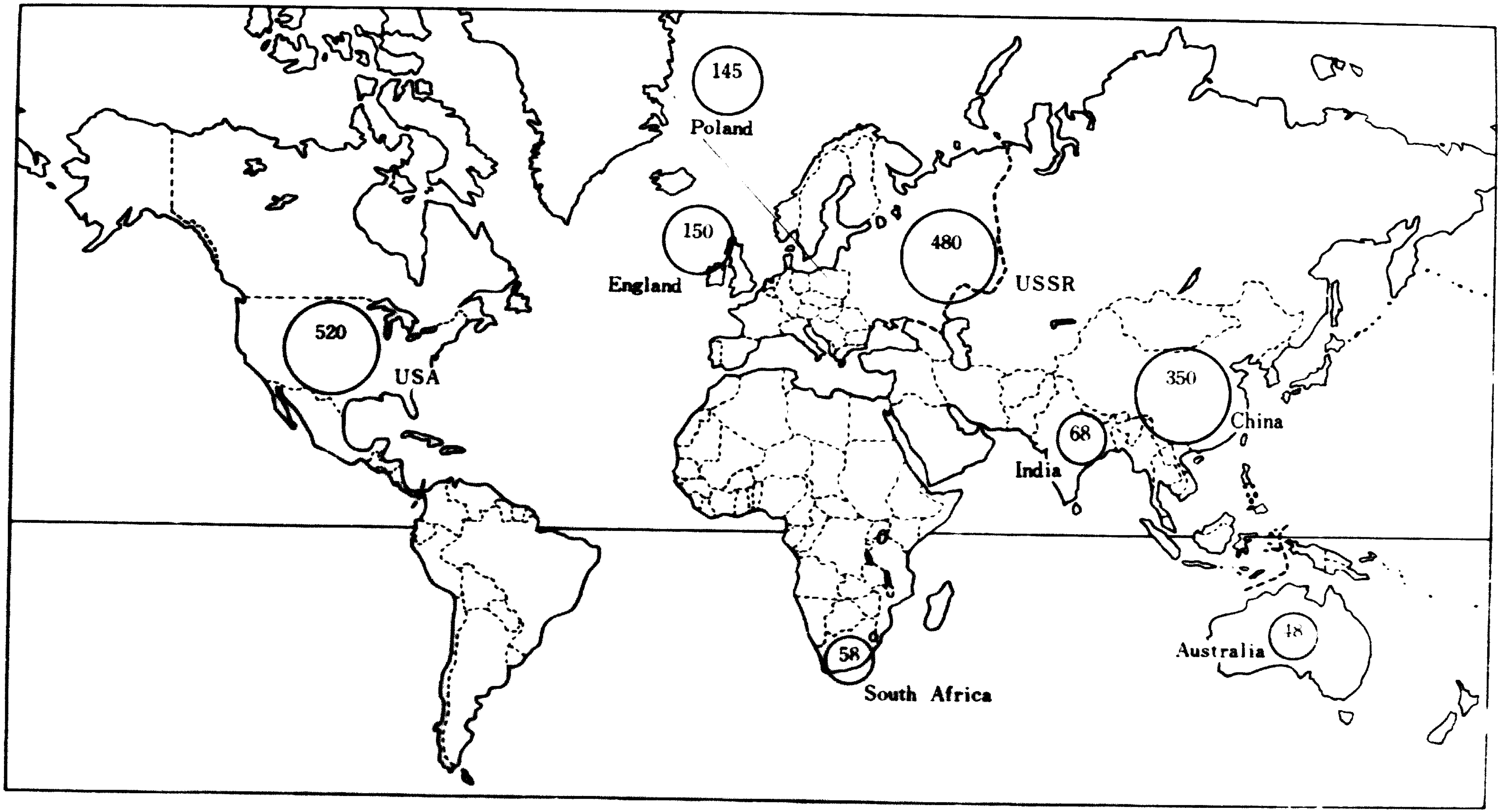


Fig. 4. Coal Production
(1971)

Table 4. Coal Production and Population in 1971

Country	1000 Mt *Coal Production	Millions **Population
F.R. Germany	480,300	59.18
Belgium	10,960	19.67
France	33,009	51.25
Italy	242	54.08
Luxemburg		0.34
Netherlands	3,609	13.19
o UK	149,873	55.57
Austria		7.46
Switzerland		6.31
Denmark		4.96
Spain	10,549	34.13
Portugal		△ 9.95
Sweden		8.11
Norway	438	3.90
Finland		4.68
Ireland		2.97
Greece		8.85
Turkey	4,560	36.11
Israel		3.01
Yugoslavia	706	20.55
Bulgaria		8.54
o Poland	145,491	32.75
Rumania	6,793	20.47
DDR	1,000	15.96
Czechoslovakia	28,870	14.50
Hungary		10.35
o USSR	480,330	245.09
o China	350,000	787.18
Japan	33,431	104.66
o India	68,506	550.37
Korea, Dem. Pp. Rep.	20,500	14.28

Country	1000 Mt *Coal Production		Millions **Population
Korea, Rep. of	12,540		31.92
Pakistan		△	126.74
Thailand			35.34
Philippines			37.96
Viet-Nam	3,000		18.81
Indonesia			124.89
USA	520,000		207.05
Canada	13,900		21.60
Mexico			50.83
Brazil	2,400		95.41
Argentina			23.55
Venezuela		△	10.04
Chile	1,380		8.99
Colombia			21.77
Peru			14.01
A.R. Egypt			34.13
Algeria			14.77
Liberia			1.57
Mauritania			1.20
Tunisia		△	5.03
o South Africa	58,781		22.09
o Australia	48,989		12.73
New Zealand	420		—

Origin: * "Statistical Handbook of Iron and Steel", Ed. '72

** "Monthly Bulletin of Statistics", United Nations, January, 1973

o Explained in Fig. 4

△ Statistics in 1969

However, in the last 25 years, new sources of iron ore of better quality have been discovered and explored. In addition, improvements have been made in marine transportation that have provided effective means of long-distance transportation. The development of carriers designed especially for iron ore, characterized by the appearance of the so-called mammoth ore carriers, have made it possible to carry ores economically to iron plants from any part of the world. This feature, which is related to the geographical aspect of the industry, is one of the most significant differences as compared with the past. Thus, by comparison with iron and steel industries established in inland areas or having direct access to the mines or other resources of inland or geographica isolated areas, those having a direct access to world-wide high-quality resource are gaining greater advantages today.

As mentioned before, the main element in the change in geographical conditions is the development of large-size carriers. Today, it is generally accepted that a modern iron and steel industry requires a coastal works equipped to receive iron-ore or coal carriers of over 100,000 tons. The coastal works are advantageous from the viewpoint of the despatch of products as well, since they are able to utilize sea transport to deliver heavy consignments of iron and steel products to places where the consumers are located. Such works can operate flexibly, as supplier to domestic consumers as well as to markets abroad. The establishment of works along the sea coast is an outstanding achievement of the Japanese industry in the post-war period and has been accepted in the world as a new and effective way of selecting plant sites.. It has made it possible for the Japanese industry to adopt larger production units ahead of other industries in the world, to utilize low-cost yet better-quality iron ores and coal, and to act as a supplier of iron and steel during a period of world steel shortage. Thus, the construction of coastal works was an influential factor for the Japanese iron and steel industry in carrying out modernization and expansion simultaneously.

In addition to iron ore and coal, water resources must be mentioned as another essential factor in the iron and steel industry. The fact that Japan is favourably situated for water resources has not been given such attention in the past as other geographical factors. Japan's abundant water supply seems to have given the country another advantage in increasing its iron and steel production.

Figure 5 shows how the cost of iron-ore transportation has decreased in recent years.

3. Changes in Production Processes

Modern iron and steel plants are broadly classified into integrated plants which carry out all the operations from production of pig iron with iron ores and coal through to the production of finished products, and non-integrated plants, which use scrap as raw material to be melted in an electric furnace and produce finished products in rolling mills. It is a serious issue for any new iron and steel industry in any country of the world to decide whether to start as an integrated or a non-integrated steel plant.

Since production of iron and steel using scrap as a basic material is restricted by the availability of scrap, the general trend in a period when the demand for iron and steel is growing is to construct additional integrated steel plants to produce sufficient pig iron for steel production. This trend of establishing integrated steel plants as major units in the industry while increasing the number of non-integrated steel plants using scrap as a raw material to supplement the integrated plants appeared in the USA, Europe, the USSR, and Japan during the period of expansion of the industry. It was difficult to follow any other course.

However, in countries such as the USA and those European countries where the production scale has reached an adequate level to meet the demand and where the demand has already reached its maximum growth, the ratio of scrap output is increasing every year. Thus, these countries have reached the transitional stage of development where an industry based on scrap as raw material could be more profitable.

At the present time, the USA, the industries of which are producing enough iron and steel to meet the demand and where scrap is available in large quantities, is a large supplier of scrap to the world market. Major iron and steel producers in Europe are also exporting their surplus scrap to the rest of the world.

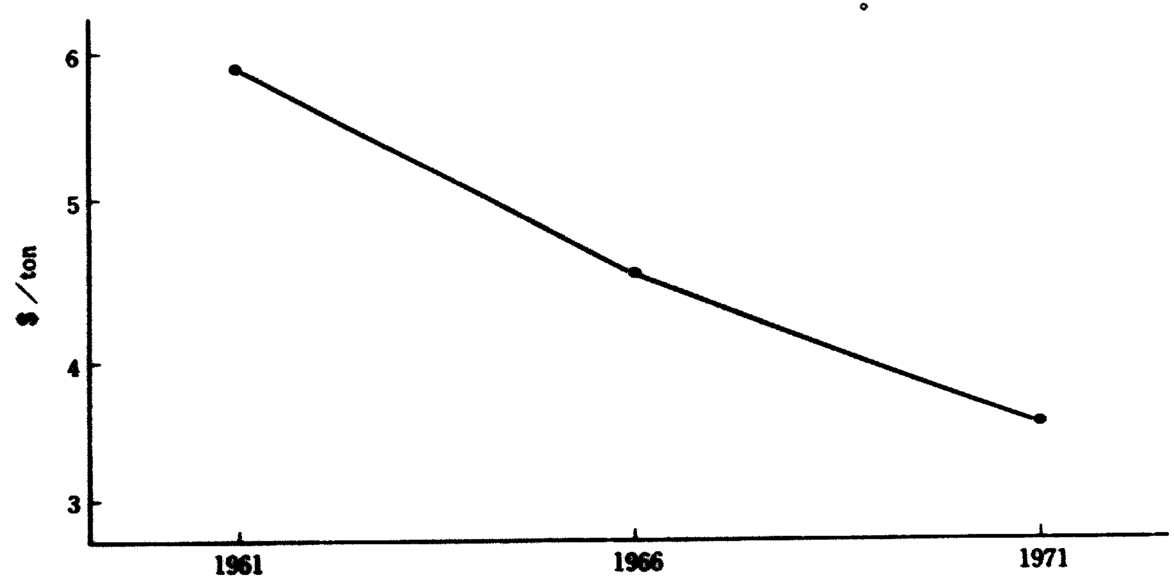


Fig. 5. Iron Ore Transportation Cost

However, scrap prices have not been decreasing on the world market owing to the fact that demand has been sustained at a high level. From the international point of view, therefore, it cannot be concluded that an iron and steel industry using scrap as its raw material is the most economical system.

If world iron and steel production expands further and integrated steel plants are constructed in all parts of the world, the decision as to whether to start an iron and steel industry using the integrated steel plant system or the non-integrated steel plant system would be a difficult one to make.

In the case of the integrated plant, all the production processes starting from treatment of raw materials are performed in a single plant. It requires an enormous amount of capital, high-level technology, and a very large production system in order to operate successfully.

In the case of the non-integrated steel plant, the capital requirement is not so large. It requires a considerably simpler technology and the production scale needs not be enormous. Accordingly, a non-integrated steel plant can easily be established anywhere. Nevertheless, the problem of scrap supply cannot be overlooked, and so the iron and steel industry cannot depend entirely on this type of plant.

In order to change the geographical distribution of the world iron and steel industry, it would appear to be necessary to install integrated steel plant in various parts of the world, at the same time establishing small-scale industries based on these plants, so as to have a well balanced and uniform supply of iron and steel throughout the world.

4. Advancement of Iron and Steel Technology

The history of the iron and steel industry is an extremely long one. In the early period, charcoal was used for ironmaking. In the 19th century, the industry entered into the stage of using coal as a major material, and this new material became the most influential source of progress of the industry itself. The energy source of industry in general made a further transition from coal to oil and from oil to atomic power. This change in energy source is an outstanding feature today. The major problems faced by the iron and steel industry are also related to it.

The transition from charcoal to coal in the iron and steel industry took place at a slower pace than in other industries. In comparison with other energy sources and the methods of utilizing them, the transition was not effected so quickly. For example, in the earlier period, charcoal was extensively used as a fuel for domestic use as well as for locomotives and other industrial uses, while in the 19th century the importance of charcoal as a common energy source disappeared and it was replaced by coal, followed by petroleum. However, in the iron and steel industry, the period of utilization of charcoal as an energy source lasted considerably longer. Today it is still in the coal period, with coking coal as the most important material. In spite of the fact that most other energy-using industries have entered the age of petroleum, the iron and steel industry is still relying on coal to a very large extent.

The iron and steel industry is one of the most advanced industries, and so it is natural to expect that in the field of energy sources it would adopt the most advanced system. The reality is contrary to this expectation, and the industry has always been slow to adopt a new energy source. The reason for the slow process of transition in this field is that iron and steelmaking requires extremely high-level technology. Iron and steel production is always inherently based on a complex technological system. Because of this complexity, the change from charcoal to coal could not be adopted straight away, merely because coal became available.

Existing blast-furnace technology using coke made from coal is a very large-scale process, resulting from technological achievements accumulated over 100 years. Such an achievement cannot simply be discarded and replaced by petroleum as its energy source merely because the power cost of petroleum is less than that of coal. This is a serious problem that the industry faces today.

The fact that the industry has been based on well established technology and is forced to maintain the use of such technology illustrates the extremely complex nature of the technological system it has built up.

The Utilization of Oxygen

One of the major reasons for the tremenduous advancement of the iron and steel industry, particularly the technological development in the past 25 years, is the utilization of oxygen. The development of the pure oxygen converter (LD process) was principally responsible for the extensive utilization of oxygen. The emergence of this method has reduced the importance of such major facilities of the past as the open-hearth furnace and the Bessemer and Thomas converters. The utilization of oxygen contributed greatly to lowering process costs in the iron and steel industry.

With the increased use of oxygen by the industry, a significant change has taken place in the method of oxygen production. Large-scale reduction of the production cost of oxygen is a result of technological achievements of the post-war period.

Figure 6 shows that the iron and steel industry has entered into the age of extensive utilization of oxygen, with consequent reductions in the production cost of oxygen.

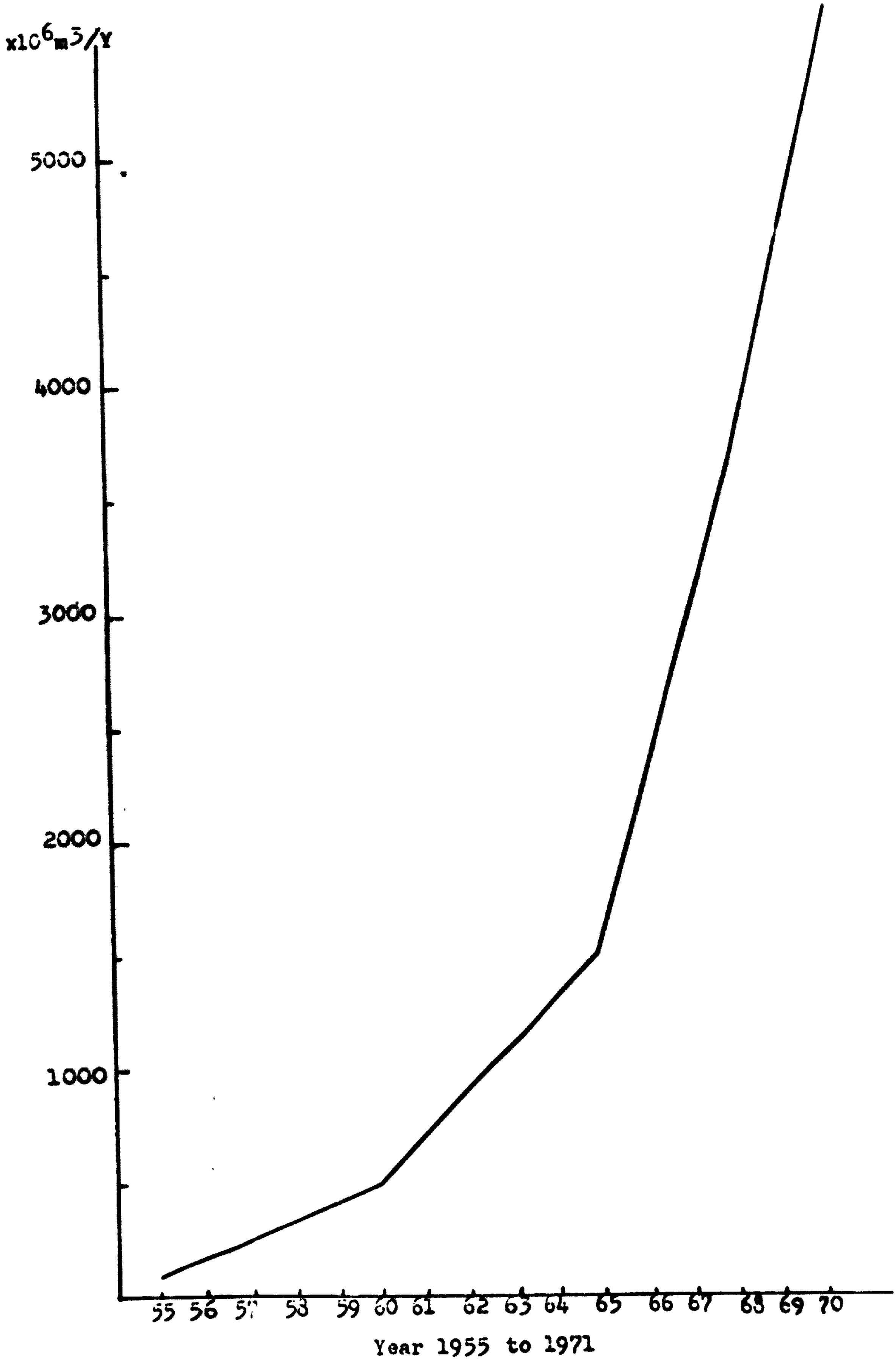
Automation

Automation can be singled out as a new technological feature which all the industries of the modern world are adopting. The iron and steel industry is characterized by the enormous size of its production activities, and at the same time by the increasing requirements in terms of precision and accuracy. It is rapidly becoming the industry which applies automation using computers most widely.

Automation is becoming a central feature of iron and steel technology, and has been employed throughout the process sequence of handling and treating raw materials, ironmaking in the blast furnace, converter steelmaking, and rolling. The field in which the use of computers is most advanced is that of rolling. The use of computers is an influential factor in increasing unit production per plant. Today the figure of 10,000,000 tons is considered to be the most suitable production scale for iron and steel plants; the reasons for this are that the output of modern slabbing mills exceeds 5,000,000 tons per year and is expanding to 6,000,000 to 7,000,000 tons, and that the unit production

Fig. 6.

Oxygen consumption by Japanese Steel Mills



scale of blast furnaces is in excess of 3,000,000 tons per year and is approaching the 4,000,000 tons level. The expansion in blast-furnace production and the increased capacity of rolling facilities are the reasons for the remarkable increase in the production of the industry. These developments are largely the results of automation using computers, which ensure steady and continuous production activities on a large scale.

Continuous Casting

One outstanding technique which has caused great changes in iron and steel production processes is continuous casting. Continuous casting technology advanced significantly in the 1960's and began to be used extensively in the 1970's. Continuous casting has had a very significant effect in improving the economic value of small-scale plants based on scrap.

Continuous casting cannot, however, be employed for all types of product. It is not suitable for the production of rimmed steel, which is demanded for most steel and strip products. In addition, the method is not efficient for the production of high-carbon steel materials. Most continuous-casting facilities are for the production of ordinary carbon steels, principally in the production of sections, bars, and plates. As far as the capacity of these facilities is concerned, even the world's largest plate mill does not exceed 1,000,000 tons per year, and there are not many section or bar mills capable of outputs of over 1,000,000 tons per year. Since most existing rolling mills are designed to produce 1,000,000 tons, large slabbing mills are not needed, and this is why the role of continuous casting is a significant one.

In electric arc furnace steelmaking, it is noticeable that large-size units have come into wide use in recent years. The production capacity of electric furnaces is 500,000 to 1,000,000 tons per year. If greater output is required, the number of units has to be increased. If the capacity of a plant is expanded, an increase in scrap supply to meet such an expansion is not easy to obtain.

In the light of these factors, continuous casting is the most appropriate process for a plant based on electric arc furnaces using scrap as raw material. Thus, continuous casting is an influential factor in increasing the value of non-integrated plants based on scrap as raw material by comparison with integrated steel plants.

Continuous casting technology is still at the stage of requiring further improvement. When these have been perfected, the role of the non-integrated steel plant will become more important, and great attention will have to be paid to the supply of scrap in the world, which will become a serious problem for the industry.

Direct Reduction

It was mentioned earlier that continuous casting is closely related to the world supply of scrap and changes in the world market. With further development and expansion of continuous casting technology, a world shortage of scrap will present an unavoidable problem for the industry. There seem to be two ways of dealing with this problem: by promoting the construction of integrated steel plants or by inventing a new method of ensuring the supply of a raw material to replace scrap. In the latter respect, attention must be directed to direct reduction, which has been and is still being developed as a new technology.

In comparison with the existing complex iron and steelmaking processes of smelting iron ores to produce pig iron in the blast furnace and transforming the iron into steel in the converter, the direct reduotion method consists of selecting high-quality iron ores to manufacture reduced iron with reducing agents under high-temperature conditions. The product of the processes is sponge iron which is not wholly free from impurities nor completely reduced. If such material could be produced at a lower cost than that of pig iron production, it would be an extremely advantageous source of iron for small-scale plants, such as those based on electric arc steelmaking and continuous casting. Thus, it might become possible for each steelmaking plant using continuous casting to install ironmaking facilities of its own to meet the material requirements arising from expansion of its production capacity. This would ensure a steady supply and make it unnecessary to depend on the unstable supply of scrap.

At present, natural gas is considered to be a useful reducing agent for the practical application of direct reduction. Although direct reduction has not been developed to such a degree as to ensure economic production everywhere in the world, there is the possibility that this stage will be attained in the future. This is why direct reduction justifies a world-wide attention as a future major production process of the industry.

5. Training of Personnel

There are various requirements for successful operations in the iron and steel industry. One of these requirements is related to the fact that the industry has been operated at a high technological level and that advanced technology has to be constantly introduced and adopted by the industry.

Even if such requirements as resources, markets, labour, and capital are assured, not all iron and steel industries are able to compete successfully in the world. This indicates how important the problem of technology is for the successful operation of the industry.

One major factor in the outstanding development of the Japanese iron and steel industry over the past 25 years was the fact that it was able to obtain a large number of qualified men; another factor is related to the fact that the industry has constantly absorbed and applied all the advanced technologies in the world.

A characteristic feature of iron and steel technology is that it can be more freely exchanged and applied at an international level than the technologies of other industries. This liberal attitude enabled the Japanese iron and steel industry to achieve its large development in the post-war period. If the technology developed in other parts of the world had not been available, it would not have been possible for the Japanese industry to attain the stage of progress it has reached today: whatever efforts the Japanese industry might have made in training men within the country could not have been effective in achieving the same level of development.

Absorption and improvement of iron and steel technology require simultaneous efforts in three directions - training of personnel, the introduction of the most advanced technology in the world, and the development of technology within the country. How efforts in these three directions have been successfully carried out in Japan is shown in Figures 7 and 8 and Tables 5 and 6. The figures also illustrate the flow of specialists in metallurgy from universities into the industry each year and the introduction of world technology into Japan.

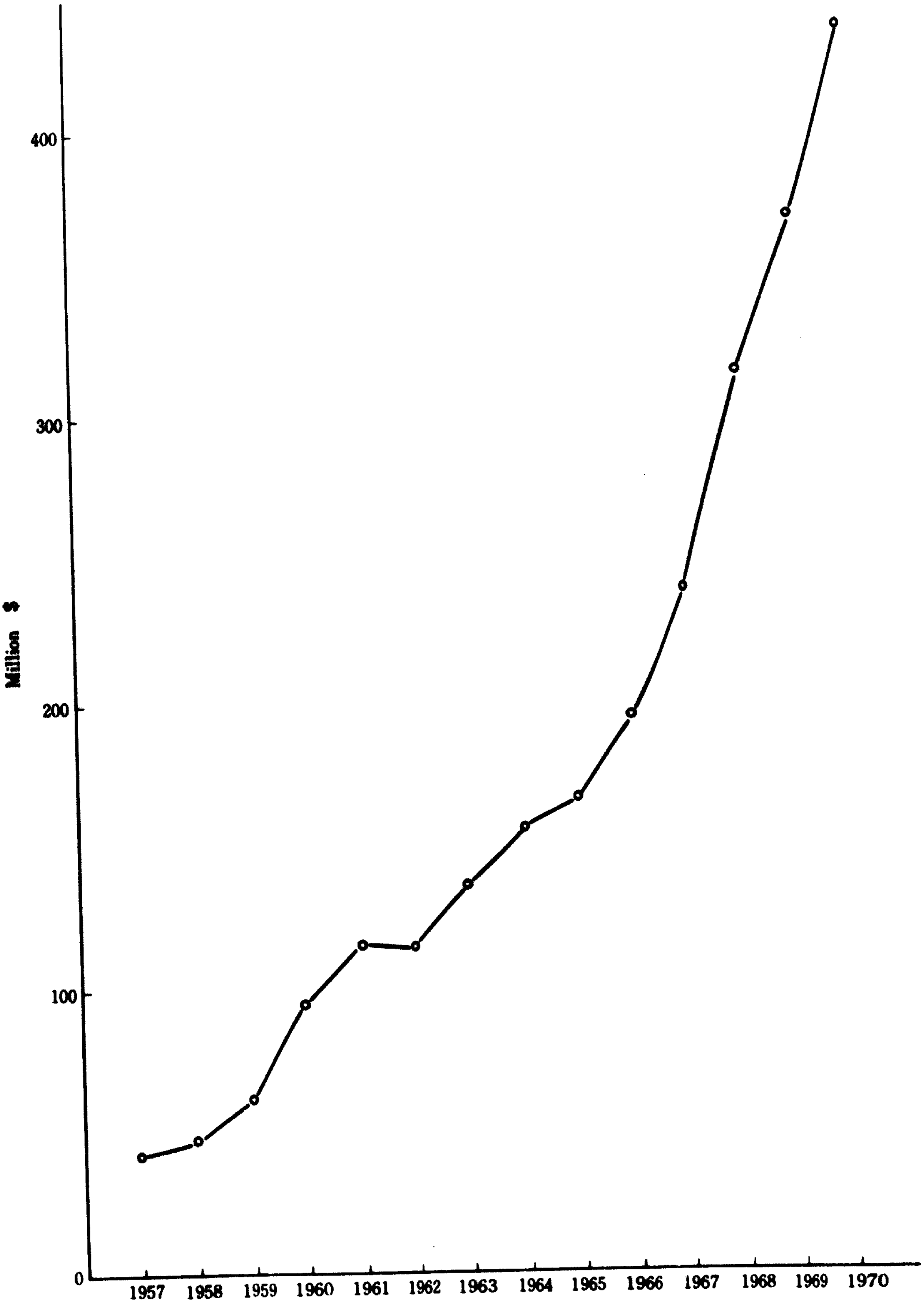


Fig. 7. Foreign Techniques introduced into Japan Iron and Steel Industry

Table 5. University Graduate Engineers Employed by Iron and Steel Industry

	Iron and Steel Industries					
	Science Faculty		Engineering Faculty		Total	
	Man-power	%	Man-power	%	Man-power	%
1956	11	0.6	291	2.6	302	2.5
1957	19	1.0	317	2.3	336	2.2
1958	22	1.0	536	3.6	558	3.3
1959	33	1.4	535	3.5	568	3.2
1960	48	1.8	719	4.6	767	4.2
1961	66	2.3	871	5.2	938	4.8
1962	104	3.7	1,196	6.1	1,200	5.3
1963	53	1.7	857	4.0	910	3.7
1964	49	1.5	750	3.1	799	2.9
1965	41	1.2	747	2.8	788	2.6
1966	51	1.3	830	2.8	881	2.7
1967	45	1.2	740	2.3	785	2.4
1968	51	1.2	756	2.2	807	2.4
1969	52	1.1	718	1.9	770	2.1
1970	52	1.0	983	2.3	1,035	2.2
1971	94	1.6	1,123	2.3	1,217	2.4

Origin: "Report on Basic School Statistics"

Table 6. Foreign Techniques introduced into Japanese Iron and Steel Industry

Year	Case	1,000$
1957	254	42,620
1958	242	47,848
1959	378	61,854
1960	588	94,888
1961	601	115,670
1962	757	114,966
1963	1,137	135,393
1964	1,041	155,309
1965	958	165.645
1966	1,153	194,354
1967	1,295	238,700
1968	1,744	314,000
1969	1,629	368,000
1970	1,768	433,000

Origin: "Statistical Handbook of Iron and Steel" Eds. '68 and '72

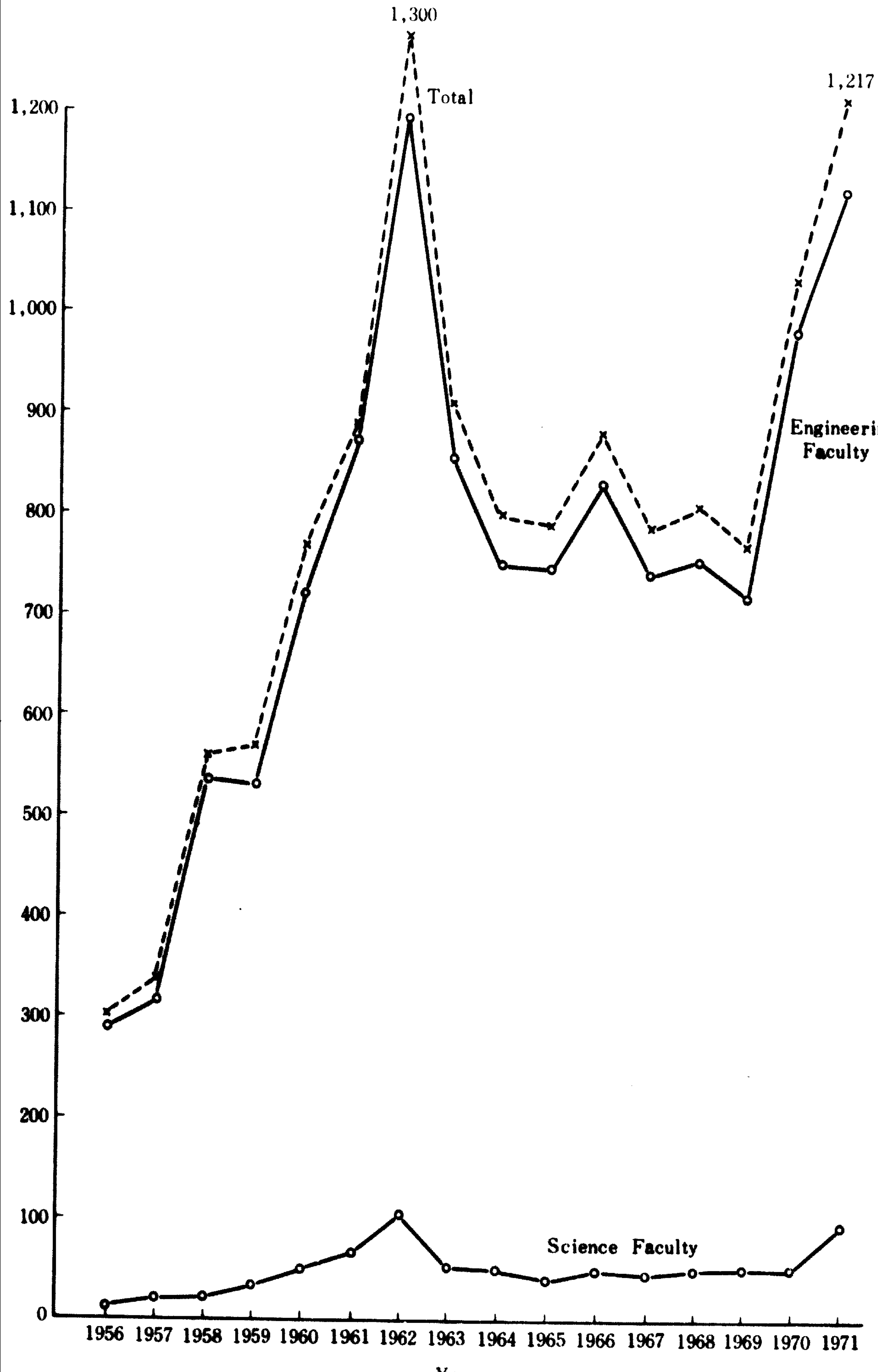


Fig. 8. University Graduate Engineers and Scientists Employed by Iron and Steel Industry

6. Financing

By comparison with other industries, the iron and steel industry is considered capital-intensive. In Japan the industry has been the object of large investments, along with the electric power industry. Whether the financing activities are conducted steadily or not determine the course of normal growth of the iron and steel industry.

It was fortunate for Japan that the policy of the Government to place emphasis on the iron and steel industry was successfully promoted. The industry received large-scale investment in accordance with the economic capacity of the country. In considering factors determining the development of the iron and steel industry, it is important to examine how so large an investment was possible in a country as poor as post-war Japan, and how such financing routes were provided.

The expansion of the Japanese iron and steel industry is intimately bound up with the publication of the Economic White Paper, which the Japanese Government prepared and circulated carefully and judiciously. It presented a detailed analysis of the economic activities of the country. The distribution of the White Paper among financial and industrial circles (and particularly among those in charge of the iron and steel industry) contributed greatly in deepening the knowledge and understanding of the nature of the Japanese economic structure. The value of the publication was such that it received much acclaim in various circles. The availability of this publication meant that whenever the iron and steel industry was planning expansion, rationalization, the installation of new plants, etc., it could carry out its financial planning within the framework of the existing economic capacity of the country. Rational planning by the industry led to understanding and co-operation on the part of bankers, financial circles, etc. Furthermore, the industry could work out its production on the basis of the actual demand. For this reason, financing for the industry has been secured without much difficulty and to an adequate extent.

An examination of the financing of iron and steel industries in other parts of the world indicates that this has not always been easy, even in countries with a higher level of economy than Japan. This is due to various unfavourable conditions, such as the fact that financing of the iron and steel industry is of necessity on a gigantic scale, that the industry cannot expect a high profit ratio, and that the demand for iron and steel is not always a predictable one.

Consequently, for those countries that intend to develop the iron and steel industry in the future, financing will be the most troublesome issue and requires careful handling. These countries have to adopt all measures that will ensure that the financing proceeds without much difficulty. It may be necessary to prove that the locational requirements of a new iron and steel industry are very important in the light of new world raw-materials resources. Other requirements that need satisfying to ensure a steady flow of funds include basing the production capacity of the industry on the economic size, employing a production technology that permits the absorption and utilization of the world's most advanced technology, a long-range development plan, consideration of the balance between demand and supply, etc.

If the various conditions for favourable financing are achieved successfully, the result will be an iron and steel industry of great benefit to the country. It will also mean that the world iron and steel industry is augmented by a rationally established industry. This represents a step forward for the world economy in general.

It is my sincere wish that the present Interregional Symposium of UNIDO will make a major contribution in promoting efforts in the industry to meet various requirements, creating steady financing activities, encouraging efforts for the adoption and development of rationalization throughout the world, and enlarging the world supply and demand situation.

United Nations Industrial Development Organization

Distr.
LIMITED

ID/WG.146/102 Corr.1
27 September 1973

ORIGINAL: ENGLISH

Third Interregional Symposium
on the Iron and Steel Industry

Brasilia, Brasil, 14 - 21 October 1973

Agenda item 1

CHANGING FEATURES OF THE WORLD IRON AND STEEL INDUSTRY

by

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The Iron and Steel Institute of Japan

Corrigendum 1

Page 28 — Figure caption should read :

"Fig. 7 Foreign techniques introduced into Japanese industry as a whole"

Page 30 — Title of table should read :

"Table 6 Foreign techniques introduced into Japanese industry as a whole"

id.73-6584

Distr. LIMITEE
ID/WG.146/102 RESUME
31 juillet 1973
FRANCAIS
Original : ANGLAIS

Organisation des Nations Unies pour le développement industriel

Troisième Colloque interrégional
sur la sidérurgie
Brasilia (Brésil), 14-21 octobre 1973
Point 1 de l'ordre du jour

RESUME

EVOLUTION DE LA SIDERURGIE DANS LE MONDE[1]

par
Shintaro Tabata
Iron and Steel Insitute of Japan
(Japon)

Créer une industrie sidérurgique, clef de voûte de l'industrie d'un pays, est une entreprise aussi importante que difficile, quel que soit le niveau de civilisation technique de ce pays.

L'augmentation constante de la demande de produits sidérurgiques dans le monde incite les pays industrialisés à développer et à moderniser leur industrie sidérurgique, et les pays en voie de développement à en créer une, et la carte de la sidérurgie mondiale ne cesse de se modifier.

Au cours des 25 dernières années, le Japon a atteint l'un des taux d'expansion les plus remarquables du monde, par des méthodes très différentes de celles qui avaient été appliquées avant la Seconde Guerre mondiale. On a constaté dans d'autres pays que les facteurs de progrès industriels ont sensiblement changé depuis. Si l'on analyse

1/ Les opinions exprimées dans le présent document sont celles de l'auteur et ne reflètent pas nécessairement les vues du Secrétariat de l'ONUDI.

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correctement la situation nouvelle, et qu'on prenne des mesures appropriées, il est possible de créer dans diverses régions du monde de nouvelles industries sidérurgiques économiquement viables et capables de se développer.

La sidérurgie est une industrie à forte intensité de capital et de main-d'oeuvre. Elle a derrière elle une longue histoire de développement technologique, et les procédés qu'elle met aujourd'hui en oeuvre sont très complexes. Mais l'innovation technique est une loi de l'évolution industrielle moderne, et une stagnation du progrès des techniques et de leurs applications condamnerait l'industrie sidérurgique d'un pays à cesser d'être compétitive sur le plan international.

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