Chapter 2
International Experiences

2.1 Iron and Steel Industry in Western Europe

2.1.1 Post-War Reconstruction Driving the Rapid Development of the Iron and Steel Industry

After the end of the World War II, with the promotion of the Marshall Plan, Western European countries introduced funds and advanced technologies from the USA, which, together with the accelerated process of European integration, boosted rapid economic recovery and growth in those countries.

In 1951, six countries including France and the Federal Republic of Germany signed the *European Coal and Steel Community Treaty* for a period of 50 years (1952–2002) in Paris, which determined that its basic task is to create a single common market for coal and steel in order to eliminate relevant tariff restrictions and make intervention in production, circulation, and distribution [1]. At the beginning of the establishment of the European Coal and Steel Community (ECSC), it was responsible for coordinating the coal and steel production, investment, price, and raw material distribution within ECSC, so as to ensure effective internal competition. At the same time, ECSC had a say in the development or shutdown of certain enterprises and was in charge of the relationship of ECSC with the third countries and relevant international organizations.

Western Europe is the cradle land of the modern iron and steel industry. In the two decades after the World War II, the two most important strategic materials of steel and coal at that time had achieved planned complementary advantages in production and circulation among ECSC members, and effective coordination of resources and capacity allocation was realized. Together with the research and development and application of technical equipment such as oxygen top-blown converter, continuous casting machine, hot tandem strip rolling mill, and cold tandem rolling mill, the steel production capacity in Western Europe was greatly improved, which had effectively

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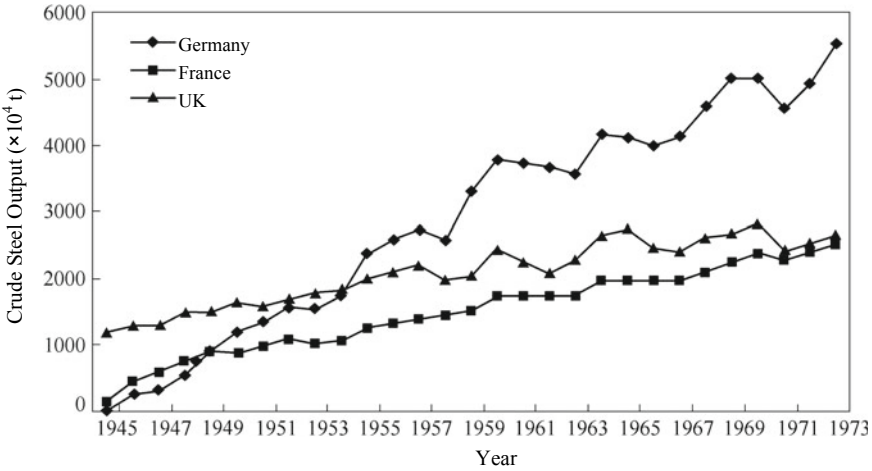

Fig. 2.1 Growth of crude steel output in Germany, France, and the UK during the reconstruction period after World War II

supported the basic needs of those countries in capital construction and economic development.

For example, the crude steel output in the Federal Republic of Germany was increased from 2.55 million tons in 1946 to 41.19 million tons in 1965 and 55.41 million tons in 1973; that in France was increased from 4.41 million tons in 1946 to 19.6 million tons in 1965 and 25.26 million tons in 1973; that in the UK was increased from 16.55 million tons in 1950 to 27.44 million tons in 1965 and 26.59 million tons in 1973. The growth of crude steel output in Germany, France, and the UK during the reconstruction period after World War II is shown in Fig. 2.1.

2.1.2 Structural Adjustment of the Iron and Steel Industry in Western Europe

After the 1970s, the iron and steel industry in Western Europe entered an adjustment period. In 1973, the first oil crisis directly led to a declining demand in the steel market. Due to the rapid growth of the production capacity of the iron and steel industry during the expansion period and the increasing competitiveness of the iron and steel industry in Japan, the original export market of the iron and steel enterprises in Western Europe was impacted and squeezed, and the iron and steel industry of the European Community was caught in a crisis of severe overcapacity. From 1974 to 1985, the steel output of the European Community fell by 30%, and the operating rate was once only 60%. Most iron and steel enterprises in Western Europe were subject to stubbornly high production costs, and their products were not competitive, leading to very serious losses. In the process of restructuring of the iron and steel industry,

the governments in Western Europe had played a huge role and adopted various measures such as increasing subsidies, limiting production, and nationalization.

Although the *European Coal and Steel Community Treaty* explicitly prohibits governments from granting financial subsidies to their coal and iron and steel industries, in the face of the development difficulties of the iron and steel industry, most countries in Western Europe had given large-scale subsidies and even adopted measures such as price limits to their iron and steel industry in the 10 years from 1975 to 1985. From 1980 to 1985, the governments in the European Community subsidized the iron and steel industry by as much as 83 billion West German marks. Part of the government subsidy funds was used to adjust the industrial structure, resettle the unemployed persons, strengthen environmental protection, etc., and a considerable part of the funds was used for price subsidies, which to some extent concealed the problems of backward technology and poor management in some enterprises, thus artificially extending the life of uncompetitive enterprises.

In 1980, in order to coordinate the interests of member states, EC implemented a crude steel output quota system, which required the government to gradually reduce their financial subsidies to iron and steel enterprises and stop subsidies by the end of 1985. However, they were allowed to provide subsidies to enterprises that reduce production capacity. Moreover, the maximum total production quota and the maximum trade volume quota of most varieties of steel products among the EC member states were stipulated. The quotas were allocated according to the actual production capacity of each iron and steel enterprise, and the indicators can be sold among them after the approval by the EC Commission. That measure had somewhat eased the contradiction between supply and demand in the internal market of the European Community. However, since the quota allocation was made based on the actual production capacity of enterprises, all iron and steel enterprises were encouraged to maintain their existing production capacity in an effort to obtain as many quotas as possible, making the production capacity reduction more difficult.

At the beginning of the crisis, the countermeasures taken by Western European countries were to put the iron and steel industry under state control. By the mid-1980s, the crude steel output of the state-owned companies in Europe had accounted for half of Europe's total output. With the end of the steel production quota system applied by EC in 1988, the governments' control measures for the iron and steel industry in Western Europe had been gradually reduced [2], and the iron and steel industry could receive government funding only in a few special cases. For example, in 1993, EC approved the rationalization programs of six state-owned enterprises in Germany, Spain, Italy, and Portugal. The governments provided a subsidy of 6 billion European currency units (7.7 billion US dollars) to reduce their production capacity by 5.5 million tons. But overall, the subsidies received by the iron and steel enterprises in Western European countries from their governments had been greatly reduced.

With the relaxation of government regulation, the privatization of iron and steel enterprises in Western Europe began to rise. For instance, British Steel Corporation was privatized in the late 1980s. France, Italy, and Spain carried out privatization of state-owned iron and steel enterprises in the mid-to-late 1990s. By 1998, the steel output of the state-owned iron and steel enterprises in European Union (EU) accounted

for less than 5% of the total output. The privatization and the enhanced market competition had led to the merger and reorganization of iron and steel enterprises. For example, in the late 1980s, two French steel companies—Usinor and Sacilor—were reorganized, and two German steel companies—Thyssen and Krupp—were reorganized in the late 1990s. It should be noted that the merger and reorganization of the iron and steel industry in Western Europe at that time were not carried out under the influence of administrative forces but rather the autonomous behavior of enterprises.

2.1.3 Iron and Steel Action Plan of Europe in the Post-International Financial Crisis Era

After the international financial crisis, the steel demand in Europe fell sharply, enterprises had to reduce production due to operation difficulties, and even, production capacity was reduced to reduce job posts. In order to improve the competitiveness and sustainable development capability of the iron and steel industry in Europe, the European Commission issued the "Steel Action Plan" in June 2013, which is different from the tough measures taken during the adjustment period in the 1980s and 1990s. The "Steel Action Plan" is relatively mild. The main contents include:

(1) Rebuilding the regulatory framework. That is to say, to reform the management system in order to optimize and improve the existing systems through the reassessment of relevant laws and regulations, policies, and control frameworks, so as to make them more suitable to the actual development of the iron and steel industry in Europe.
(2) Promoting the upgrading of steel products and carrying out research and promotion of Sust Steel. The purpose was to formulate and establish new standards and norms by upgrading and updating steel products, aiming at forming standard barriers and safeguard their own interests while promoting market demand.
(3) Creating a fair market environment. This includes the EU internal market and the international market. In the internal market, EU focused on combating tax evasion to safeguard the legitimate interests of taxpaying enterprises. In the international market, the essence of this measure was to implement trade protection for EU's iron and steel enterprises and enhance the competitiveness of EU's steel products in the international market.
(4) Promoting the reduction of production costs. It includes adjusting the structure of raw materials, increasing the proportion of scrap application to reduce the demand for expensive iron ore, expanding the recycling, improving the quality of scrap by optimizing the design of end products, setting standards for final steel wastes, and combating illegal export of scrap. In addition, reducing the cost of electricity in steel production was also taken into account.

(5) Supporting technological innovation. It includes the research and development and application of low-carbon technology, new processes, new technical equipment, etc., in order to build the cornerstone for the competitiveness of the iron and steel industry of Europe in the future.

2.2 Iron and Steel Industry in the USA

2.2.1 Development History

The development of the modern iron and steel industry in the USA can be dated back to as early as 1868. During the industrial revolution in the US from 1868 to 1880, the steel output in the US was increased at an average annual rate of about 40%. While the production capacity was expanding rapidly, complete varieties of steel products in good quality had been developed, and its production technology was at a relatively advanced level in the world at that time.

During the initial industrialization process from 1881 to 1920, the steel output in the USA was increased at an average annual rate of 10%, faster than that in the European countries such as the UK, Germany, and France. In 1899, the annual crude steel output in the USA reached 10.81 million tons.

In the middle stage of industrialization from 1920 to 1955, the steel output in the USA grew at an average annual rate of 7%. In 1953, the annual steel output in the USA broke through the mark of 100 million tons for the first time, far higher than that in other major steel-producing countries in the world.

In the late stage of industrialization from 1956 to 1975, the steel output in the USA was increased slightly at an average annual rate of 0.5% only. During that period, the steel output in the USA reached 136.8 million tons in 1973, making a record in the history of the iron and steel industry in the USA. Since then, the crude steel output in the USA has begun to fall, and it has never recovered to that level.

2.2.2 Restructuring of the Iron and Steel Industry in the USA

In the long period from the end of the nineteenth century to the 1970s, the USA had been the largest steel producer in the world. Due to impact of the oil crisis, the competitiveness of the iron and steel industry of the US gradually declined in the 1970s. In the 1980s, large-scale technological transformation and restructuring began in the USA. From 1980 to 1989, the crude steel production capacity in the USA was reduced from 153.7 million tons to 105.1 million tons. At the same time, the production capacity utilization rate was increased from 66% to 85%, and the number of employees decreased from 500,000 to 210,000. The US government's control over

the iron and steel industry during the industrial restructuring period mainly includes the following aspects.

(1) Laying emphasis on trade protection and creating a good environment for the restructuring of the domestic iron and steel industry. The iron and steel industry in the USA has powerful trade unions. In order to smoothly promote industrial restructuring and reduce the impact on employment, the US government often implemented steel trade protection through tax adjustment, quotas, and anti-dumping litigations.
(2) Revising taxation, depreciation, and financial policies to accelerate the accumulation of funds in iron and steel enterprises improve their financing capacity, and promote the transformation and upgrading of the iron and steel industry. For instance, the depreciation period of iron and steel production facilities was shortened from 12 to 5 years, tax reduction and exemption were implemented for iron and steel enterprises, and the duration for tax reduction and exemption could be extended according to the situations.
(3) Emphasizing support given by advanced technologies to industrial restructuring, transformation and upgrading; considering varied factors comprehensively such as the market, resources, industrial base etc; encouraging the enterprises to strive to achieve the leading level in terms of process flow and technical equipments; promoting the enterprises to carry out modernization in order to improve productivity.
(4) Supporting and subsidizing enterprises and scientific and technological institutions to carry out major fundamental research, application of advanced technical equipments, and training of researchers.
(5) No longer implementing stricter standards and regulations on iron and steel enterprises in terms of environmental protection.
(6) In the late 1990s, the USA once again adjusted the structure of the iron and steel industry, with a focus on promoting mergers and acquisitions to make the output of top three iron and steel enterprises accounting for 60% of the national total.

2.2.3 Development of Short Process Steel Making by Electric Arc Furnace

From the perspective of the production process, the iron and steel industry in the USA is dominated by short process of electric arc furnace. In recent years, the proportion of electric furnace steel in the USA has been maintained at around 60%. The proportion and the development speed of the steel output of electric furnaces are closely related to the adequacy of scrap resources. This feature is quite obvious in the development history of electric furnace steel in the USA.

In the 1950s, the scrap adequacy in the USA remained at around 0.3, which was at a low level. At that time, the steel output of electric furnaces was less than

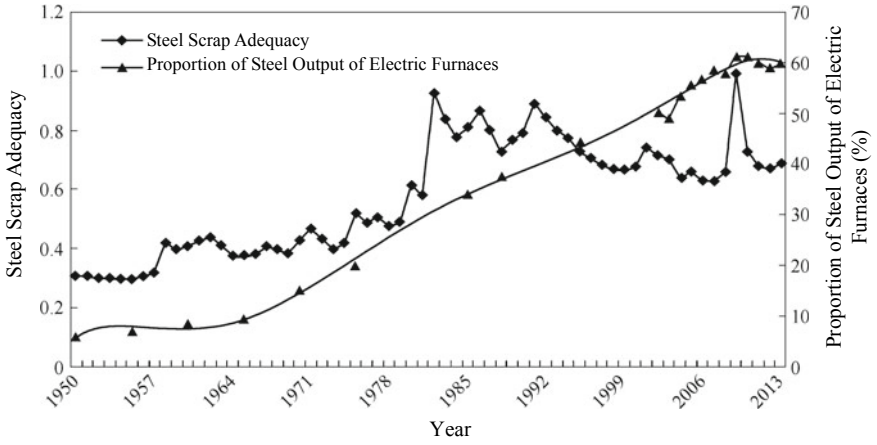

Fig. 2.2 Scrap adequacy and the proportion of steel output of electric furnaces in the US

10 million tons, and the proportion of electric furnace steel was less than 10%. From the late 1950s to the early 1960s, the scrap adequacy in the USA reached 0.4 or more, and it remained at that level for about 15 years. During that period, the steel output of electric furnaces in the USA gradually increased to nearly 20 million tons, and the proportion of the steel output of electric furnaces was also over 15%. The scrap adequacy and the proportion of the steel output of electric furnaces in the USA are shown in Fig. 2.2.

In the mid-to-late 1970s and early 1980s, the scrap adequacy in the USA showed a "W" trend, rising fluctuated up to 0.5. During that period, the steel output of electric furnaces in the USA continued to grow steadily, reaching 25 million tons. The proportion of the steel output of electric furnaces was close to 30%. In the 1980s, due to the decline in crude steel output in the USA, the scrap adequacy surged to 0.9 and has been remaining at a high level of 0.6 or above till now. During that period, the scrap resources were sufficient in the USA, the steel output of electric furnace climbed to nearly 60 million tons, and the proportion of the steel output of electric furnaces was 60%.

Looking back at the development of the steel production by electric furnaces in the USA, it can be roughly divided into three stages according to the scrap adequacy, as shown in Table 2.1.

In summary, scrap resources are an important external condition for the development of steel production by electric furnaces. When the scrap resources of a country or region are inadequate (scrap adequacy <0.3), the development of steel production by electric furnaces is slow with a low proportion. When the scrap adequacy rises above 0.3, the development of steel production by electric furnaces begins to accelerate (there is a lag of 5–7 years, mainly due to market response, technological development, and engineering construction). When the scrap adequacy rises above 0.6, a further rapid development of steel production by electric furnaces will come.

Table 2.1 Relationship between the scrap adequacy and the development of steel production by electric furnaces

No.	Scrap adequacy X	Scrap resources	Development of steel production by electric furnaces	Proportion of the steel output of electric furnaces
1	$X < 0.3$	Inadequate	Slow	Low
2	$0.3 < X < 0.6$	Adequate	Fast	High
3	$X < 0.6$	More adequate	Faster	Higher

The development of steel production by electric furnaces in a country is closely related to the development stage of its iron and steel industry. Taking the USA as an example, the development of the crude steel output and the proportion of steel output of electric furnaces are shown in Fig. 2.3.

The overall situations of the crude steel output and the development of steel production by electric furnaces shown in the above figure indicate that, during the crude steel output growth stage from the World War II to the early to middle 1950s, the proportion of steel production by electric furnaces was very low; with the crude steel output entering the peak arc zone in the middle to late 1950s, the proportion of steel production by electric furnaces began to gradually increase to 20–30%; after the peak zone of crude steel output, the steel production by electric furnaces was developed rapidly, and its steel output was increased to about 60% in more than 20 years.

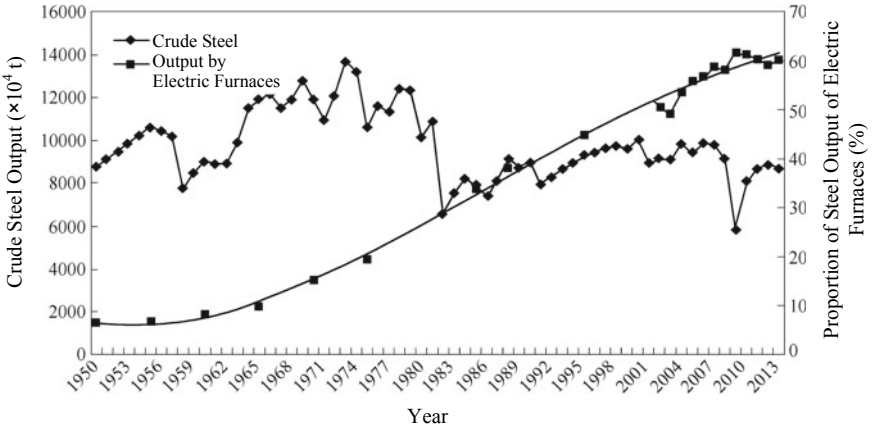

Fig. 2.3 Crude steel output and proportion of steel output of electric furnaces in the US

2.2.4 Layout Evolution

1. Resource-Based Layout Features in the Early Stage

The early development of the iron and steel industry in the USA was characterized by typical resource-based layout. There were charcoal and small iron ore resources distributed along the Atlantic coast in the northeastern USA [3], and the early iron and steel enterprises in the USA was developed using these resources. With the discovery of anthracite resources in Bethlehem and Scranton and its gradual replacement of charcoal in iron and steel smelting, the focus of the iron and steel industry began to move westward to get close to anthracite-producing regions. Later, the coking coal-based ironmaking technology was successfully developed, and the focus of the iron and steel industry in the USA continued to move westward to the Pittsburgh region which was rich in coking coal resources, building up Pittsburgh's position as the "Steel Capital" in the development history of the iron and steel industry in the USA. At the beginning of the twentieth century, after the development of iron ore mines in the Lake Superior region, some iron and steel enterprises were established in the cities along the lake, such as Chicago, Detroit, Cleveland, and Buffalo. Meanwhile, some steel plants had also been built in the largest steel consumption area in the USA, i.e., the Atlantic coast in the north.

2. Transformation from Resource-Based Layout to Consumer-Oriented Layout

During and after the World War II, the iron and steel industry in USA showed a trend of concentration along lakes and coastal consumption regions. Most of the newly built steel plants were located in Chicago and along the Atlantic coast. During that period, the position of the Pittsburgh's iron and steel industry was clearly weakened, and some iron and steel enterprises in the region even closed down. The main reason was that the development of transportation infrastructures, especially cheaper water transportation means, allowed long-distance, low-cost, and large-scale transportation of the raw materials like coal and iron ore required for steel production. However, the price of steel product transportation by railway was very high. In addition, after the 1950s, the production of high-grade iron ore in the Lake Superior region continued to decrease, and the quantity of high-quality and cheaper iron ore imported from Canada, Venezuela, and other countries was increased. To facilitate the use of imported iron ore, the USA built the Burns Harbor Steel Plant and the Fairis Steel Plant in the coastal region and expanded the Sper Roth Steel Plant near Baltimore. In addition, with the increase in the proportion of steel production by electric furnaces in the USA, most of its main raw material—scrap—came from the main consumption areas of steel products. After the 1950s, some mini-steels that emerged in the USA were mainly built in important steel consumption areas.

2.3 Iron and Steel Industry in Japan

2.3.1 Development History

Japan is a traditional steel power. Before China, it was ranked as the largest steel producer in the world. Its steel complexes like Nippon Steel and Sumitomo Metal and JFE and special steel companies like Aichi Steel, Sanyo Steel, and Daido Steel have strong market competitiveness, enjoying a good reputation in the global iron and steel industry. Together with several pillar industries such as the automobile industry and the shipbuilding industry, the iron and steel industry in Japan plays an important role in Japan's economy.

As early as 1901, Japan had established steel complexes integrated with iron-making, steelmaking, and steel rolling. After the World War II, the demand for steel products due to Japan's reconstruction and the outbreak of the Korean War was very strong. The Japanese government, by taking the advantage of the opportunities, adopted the policies for supporting the prior development of the iron and steel industry, which made its iron and steel industry develop rapidly in the several decades after the war. The iron and steel development in Japan highly focused on the technology introduction and re-innovation, such as liquid steel refining technology, which, together with the implementation of delicacy management, had promoted rapidly increasing of the competitiveness of Japan's iron and steel industry. In 1973, the crude steel output in Japan reached 100 million tons. After the dissolution of the Soviet Union, Japan's crude steel output ranked first in the world in the early and mid-1990s. There are hundreds of iron and steel enterprises in Japan, which can be roughly divided into three categories: the first one is large steel complex groups, such as Nippon Steel and Sumitomo Metal and JFE; the second one is independent steel companies, such as Tokyo Steel Manufacturing Co., Ltd., Sanyo Special Steel Products Co., Ltd., Daido Steel Co., Ltd., and Kobe Steel, Ltd.; the third one is small professional production companies, which generally only produce or process single- and special-purpose steel products.

2.3.2 Government Control Measures

The Japanese government has always attached great importance to the development of the iron and steel industry, and its guidance and intervention in the iron and steel industry are highly targeted and highly efficient. The competent authority of the iron and steel industry in Japan is the Ministry of Economy, Trade, and Industry (former Ministry of Commerce and Industry), the specific responsible institutions are the Manufacturing Industry Bureau and the Trade Policy Bureau, of which the former is a professional institution (bureau), and its Steel Division is responsible for the specific matters concerning the iron and steel industry; the latter is a comprehensive institution (bureau) responsible for macroeconomic regulation and control, as well

as policy formulation in various industries in terms of restructuring, development environment, and enterprise reform. In addition, the Japan Iron and Steel Federation also plays an important role as a corporate legal person in the management of the iron and steel industry in Japan.

The Japanese government's control over the iron and steel industry during the industrial restructuring period mainly includes the following contents.

(1) Promoting and approving enterprises to form a coordinated consortium, proposing the guiding output for the iron and steel industry on a quarterly basis, supervising its implementation and making coordination, and controlling the price adjustment of some varieties when necessary. Coordinating steel exports, including adjusting tax rates, and coordinating relevant iron and steel enterprises to carry out concerted actions on certain steel product varieties (or certain target markets) in terms of price and quantity.
(2) Conducting temporary interventions and adjustment on the varieties of steel produced by the enterprises or controlling the trade of certain steel product varieties according to market changes if necessary.
(3) Adjusting the prices of raw materials and energy such as scrap and electricity and conducting trade control on the quantity of imported scrap.
(4) Controlling the new projects and investments in the iron and steel industry; issuing the "Provisional Measures for Stabilizing Specific Depressed Industries" for the elimination of excess facilities in the sluggish industries such as iron and steel industry.
(5) Coordinating financial institutions such as banks to provide financial support for enterprises to reduce or transfer equipment capacity and support enterprises that join the coordination consortiums to implement production reduction; increasing preferential policies for enterprises in terms of the relief funds for employment adjustment.
(6) By relying on the intermediary organization, coordinating the iron and steel industry and its downstream industries to formulate and revise standards and norms for related products, building a steel product quality assurance system, and implementing it in parallel with the plant certification system.
(7) Promoting the concentration of production capacity to large enterprises in combination with the compression of excess facilities.
(8) Giving tax preferences for enterprises to invest in environmental protection equipment and allowing accelerated depreciation; encouraging the banks to provide strong financing supports for the frontier technologies and basic researches in the iron and steel industry; allocating government subsidies to major projects.

2.3.3 Development Experiences

Looking at the development of global iron and steel industry, the Japan's iron and steel industry is a model of both "big" (scale) and "strong" (competitiveness). Its development experiences are as follows:

The first is to pool the funds to introduce foreign advanced technologies and equipments, make continuous improvement and innovation in addition to steel production to further optimize their technologies and processes, and then promote the secondarily developed technologies, equipments, and processes as commodities to the market;
The second is to actively carry out laboratory research and industrialization pilot tests of various new technologies through steel alliances, so as to accumulate a large number of practical basic technologies to continuously enhance the competitiveness of the iron and steel industry;
The third is to strengthen the coordinated development with the steel product consuming industries and improve the technical level and production level to meet the ever-changing requirements of customers;
The fourth is to enhance product quality and attach importance to establishing the brand image of enterprises and products, boosting the improvement of product grades and strengthening the premium effect;
The fifth is to speed up the adaptation of the company's shareholding structure, organization, and personnel composition to the market and technology and adjust and optimize them in a timely manner.

2.3.4 Industrial Layout

The layout and distribution trend of the iron and steel industry in Japan has undergone a transformation from raw material-oriented to consumption-oriented [4]. The use of raw materials was mainly considered in the establishment of the earliest steel plants in Japan such as Kamaishi Steel Works and Muroran Steel Works. For instance, the first "imported blast furnace" in Japan was built in Kamaishi in order to make use of the local iron ore, fuel charcoal, clay raw materials, and stone materials; Muroran Steel Works, which was built in 1907, was an iron and steel enterprise relying on coking coal from Shikun coalfield in Hokkaido. The general layout of Kashima Steel Works of Sumitomo Metal is shown in Fig. 2.4.

With the use of raw materials and fuels outside Japan, the steel plants in Nagoya, Kimitsu, Oita, and Fukuyama, had considered to get close to consumption areas to facilitate the use of imported iron ore and coke and the export of steel products. Large-scale steel complexes in Japan generally make use of port conditions to build coastal plants on the land reclaimed from the sea. They are generally concentrated in the metropolitan circles and surrounding areas, namely the belt region in the Pacific

Fig. 2.4 General layout of Kashima Steel Works of Sumitomo Metal

Ocean formed by the five major industrial areas of Keihin, Hanshin, Chukyo, Seto Inland Sea, and Kitakyushu, and the steel output in that region once accounted for more than 80% of the total in Japan. The general layout of Oita Steel Works of Nippon Steel is shown in Fig. 2.5.

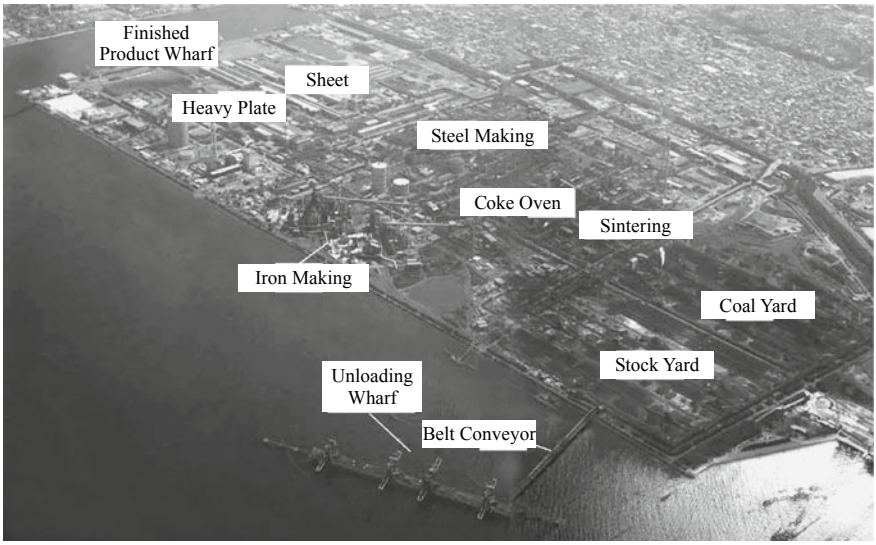

Fig. 2.5 General layout of Oita Steel Works of Nippon Steel

References

1. (2005, September) Development Policy Guideline for iron and steel industry. Beijing: Economic Science Press.
2. KarI-UCh Koehler. Lessons from Mergers and Acquisitions and Globalization in the Iron and Steel Industry of Europe. China Iron and Steel Industry, May, 2006.
3. Analysis of the Transfer Characteristics of Iron and Steel Industry in Typical Countries. Metallurgical Management, September, 2013.
4. A summary report made after the delegation of the Chinese Society for Metals attending the 12th Japan-China Bilateral Steel Academic Conference visited the Japanese and Korean companies, April, 2011.