Japan's Steel Industry Strives for Technical Innovation

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Today, the Japanese steel industry stands equal to, and in some aspects ahead of the steel industries of the United States, the Soviet Union, and major European countries. The rapid development of the Japanese steel industry, which was devastated during World War II, has been the subject of much study in recent years. After World War II, Japan's steel industry began rebuilding itself despite the handicap of heavily damaged equipment and facilities, a scarcity of domestic raw materials for steelmaking and a limited number of qualified workers. I believe the success formula of the Japanese steel industry can be found by tracing the struggle the industry went through to rebuild itself after the devastation of the war. In this sense, I would like to first discuss briefly the development of the Japanese steel industry since 1945, then to examine the improvements the industry has made in terms of productivity.

The Formula for Success

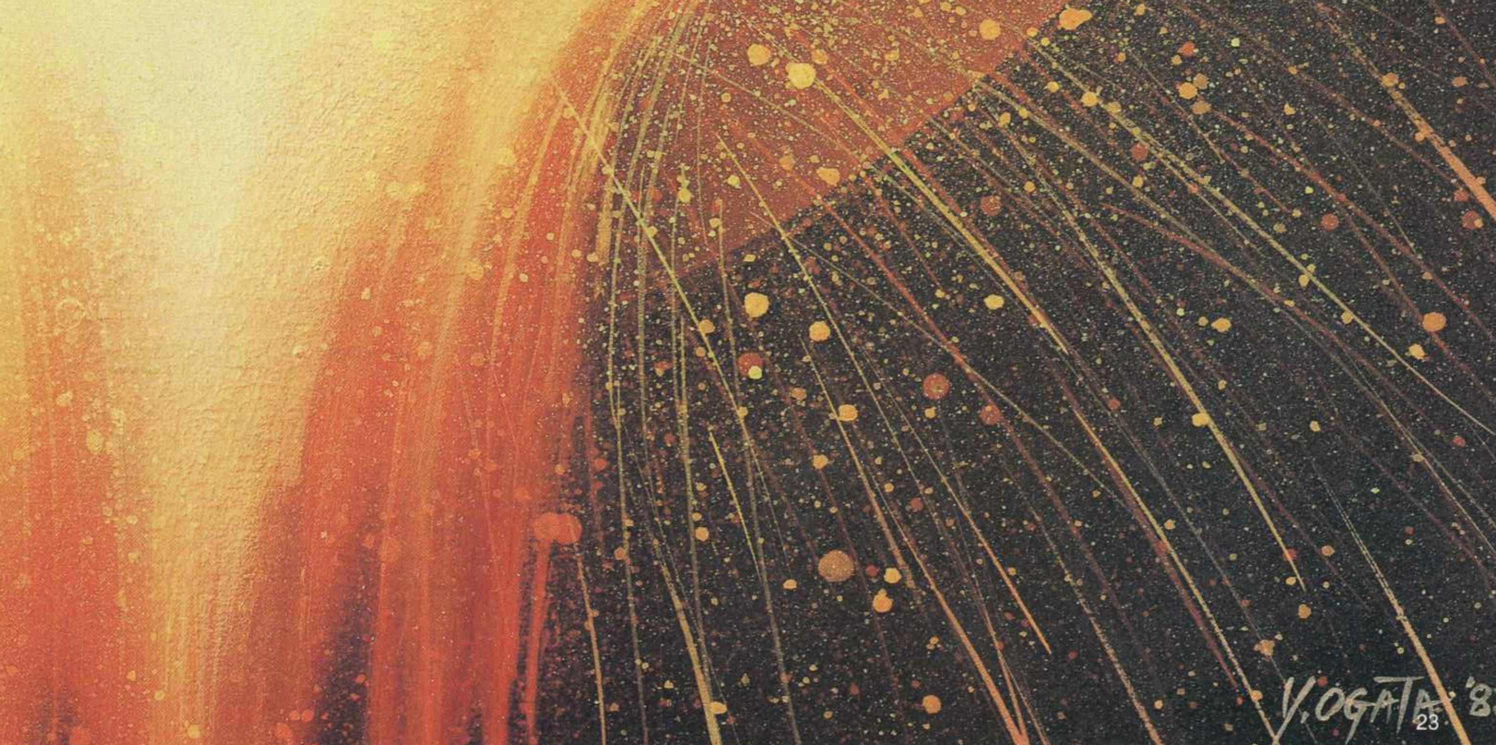
Several factors together have combined to catapult the Japanee steel industry into its present position of preeminence among the steel industries of the world. Chief among them have been the maintenance of world peace and free trade which have enabled the free international exchange of steelmaking raw materials and steel products.

Furthermore, in the postwar era, the Japanese steel industry was favored with a healthy world economic environment that triggered an enormous increase in steel demand both at home and abroad. The Japanese steel industry took advantage of this favorable business environment by making timely investments in modern, state-of-the-art steelmaking facilities. In addition, the Japanese steel industry managed to tide over such difficulties as the rising cost of resources and energy and adjusted itself quickly to the changes in market structure brought about by the 1973 oil crisis. The following is a discussion of the important contributing factors which have determined the success of the Japanese steel industry.

(1) Overcoming the disadvantage of the scarcity of resources and energy

Because it possesses hardly any steelmaking raw material resources, Japan is by no means an advantageous site for the development of a large steel industry. But this fundamental disadvantage has been overcome by a combination of factors: a transportation revolution in ocean-going ore carriers, the building of deep-draught port facilities in Japan, and the construction of modern integrated steelworks on reclaimed land along the coast. To reduce the cost of freighting raw materials over long distances, specialized iron and coal carriers were built as were large unloading berths to accommodate such vessels.

Moreover, the energy consumption of the Japanese steel industry, which is primarily coal, is now the world's lowest



thanks to active technical development programs aimed at resources and energy savings. These factors will be discussed in more detail later.

(2) Adaptability to market requirements through high quality, sophisticated products

It is often said that the source of Japan's rapid industrial development was the dynamism shown by industry in adapting to competitive markets. Needless to say, the Japanese steel industry has done well in adapting itself to market requirements, particularly, through technical innovation. Close technical cooperation between the steel industry and steel-consuming industries has resulted in the development of many new types of steel products, and it has also contributed much to raising the technical level of steel-consuming industries themselves. These close technical tie-ups are a major force acting to assure the high technical level of today's Japanese steel industry. This cooperation has also benefited steel users in terms of product delivery as exemplified by the system of "just-in-time delivery" of steel products for the automobile industry in Japan.

(3) Labor cooperation

Unlike in the United States and European countries, labor unions in Japan have usually been very cooperative with corporate management, except for a while during the immediate postwar period. In the course of industry rationalization, technical innovations have been introduced one after another, radically changing the work environment. When a new integrated steelworks come into operation, several thousand workers are transferred to it from existing works throughout the Japanese archipelago. These changes, of course, cannot be made without the full cooperation of labor.

The technological achievements of the Japanese steel industry depend largely on the cost-reduction, technical-improvement and other efforts made by small teams of workers, who voluntarily organize themselves into problem-solving groups. This labor-participation-in-management scheme is known as *Jishu-Kanri* (J-K).

Efforts to Increase Productivity

Productivity improvement is vital to the development of the steel industry. This was aptly stated by Mr. Frederick G. Jaicks, chairman of the International Iron and Steel Institute, at the organization's Sixteenth Annual Conference in October 1982, in Tokyo, when he said "what has become clearly evident is an unsatisfied need to achieve greater productivity.".

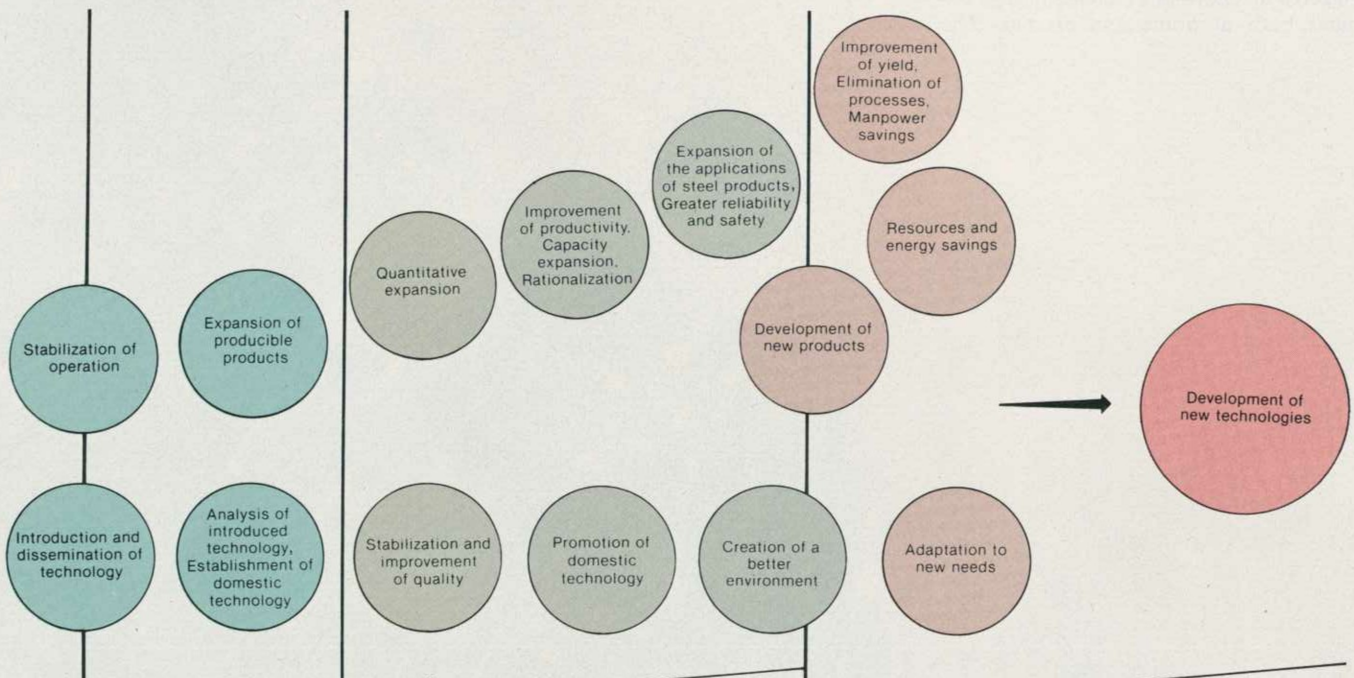
In the 1950s, the Japanese steel industry tried to improve its productivity mainly by importing technology and equipment from abroad. In the 1960s and early 1970s, the industry shifted its emphasis to the expansion of equipment capacity. After the 1973 oil crisis, however, capital investment dropped sharply for a time. But, since 1976, productivity has been rising steadily as a result of heavy investments in equipment rationalization plans and improvements in operating practices. The following is a brief history of the Japanese steel industry since World War II.

Postwar Reconstruction

World War II damaged the Japanese economy so heavily that raw steel production in 1946 was only 560,000 tons, less than one-tenth of the wartime peak of 7,650,000 tons recorded in 1943. The industry rebuilt itself with heavy emphasis on imported equipment and technology from abroad, especially from the United States. As a result, raw steel production began to rise rapidly, registering 7,660,000 tons in 1953, surpassing the 1943 wartime record. With the development of heavy and chemical industries in Japan, steel production increased steadily. Then the construction of new, large steelworks began.

It is sometimes said that the postwar reconstruction of the Japanese steel industry began when a team of American engineers came to Japan to offer technical guidance to the industry shortly after the war. About the same time, a survey team of Japanese steelmaking engineers was dispatched to the United States. Between 1949 and 1950, Mr. W.G. Walk from U.S. Steel and Mr. R.S. Coulter from Bethlehem Pacific Coast Steel provided technical guidance in steelmaking and heat control, and Messrs. E.G. Hill, F.N. Hayes and J.T. MacLeod from U.S. Steel gave the Japanese steel industry assistance in the operating techniques for open-hearth and reheating furnaces. Mr. Hayes pointed out the backwardness of Japan's steelmaking operations in those days when he said, "Japan's steel industry faces serious and difficult problems with raw materials and fuel. The situation of Japan's steel industry is much like that

Transitions of technical targets in the Japanese steel industry



faced by the U.S. steel industry after World War I."

Under the guidance of those American engineers, Japan's steelmaking technology slowly began to advance through the introduction of automatic open-hearth furnace control, positive furnace-pressure operations, and tighter combustion control.

The conventional furnace combustion method which depended on by-product gas or mixed gas was replaced by new methods in which heavy oil only or a mixture of heavy oil and coke-oven gas or blast-furnace gas was used. This was a reflection of the worldwide shift in energy consumption from coal to petroleum that was taking place after the war. This change in energy usage also led to significant improvements in steelmaking productivity.

The first Steel Industry Rationalization Program was inaugurated in 1951. This program emphasized the modernization of outdated equipment. Rationalization efforts under this program centered on the modernization of existing rolling mills, and the construction of new hot- and cold-strip mills.

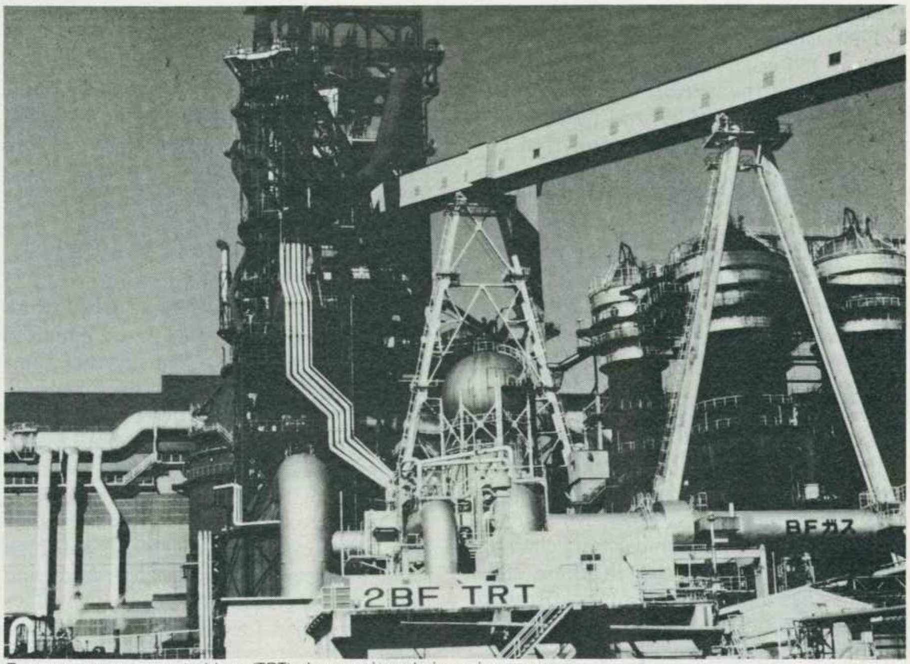
Along with the introduction of foreign equipment and technology, Japan's steel industry also made many efforts to improve quality control and productivity. Dr. W.E. Deming's "scientific control method" played a big role in the introduction of quality control to the Japanese steel industry. Various other control techniques also contributed much to the diffusion and improvement of quality control techniques in the steel industry.

The establishment of the Japan Productivity Center in 1955 is usually regarded as marking the start of productivity improvement efforts by Japanese industry. It was about that time that the steel industry sent its first productivity study mission to the United States. The mission studied general management practices in the U.S. steel industry, including corporate organization, management policy, labor-management relations, and so on.

Based on the report submitted by this mission, the Japanese steel industry decided to introduce the concept of industrial engineering (IE) and strengthen its marketing research activities. To introduce IE in Japan, the Japan Productivity Center and the Japan Iron & Steel Federation in 1957 invited Mr. E.L. Hughes to come to Japan to instruct the steel industry in IE.

As stated above, the Japanese steel industry imported various technologies, equipment and management skills from the United States and other countries through the 1950s. By the late 1950s, Japan's economy had become strong enough to stand on its own. This marked the end of the immediate postwar era.

It was also at this time that the first basic-oxygen furnace (the LD converter) was introduced into the Japanese steel industry, marking the beginning of a new era in steelmaking technology.



Top-pressure recovery turbines (TRT) play a major role in saving energy.

The steel industry then faced several problems due to the heavy dependence of its open-hearth furnaces on steel scrap which was not only costly but also often difficult to obtain. However, the introduction of basic-oxygen furnaces enabled the industry to overcome those problems. The new basic-oxygen furnaces also led to a significant improvement in Japan's steelmaking productivity. This is a typical example of how the Japanese steel industry succeeded in acquiring a technological edge over other steelmaking countries.

In the High Growth Period

Thanks to the nation's high economic growth in the 1960s, Japan's steel production increased rapidly. In 1964, Japan's raw steel production reached 40 million tons, making Japan the third largest steelmaking nation behind the United States and the U.S.S.R., and ahead of West Germany. Construction of huge, modern integrated steelworks on new coastal greenfield sites provided greater economies of scale and strengthened the international competitiveness of the Japanese steel industry. As a consequence, Japan became the world's largest steel exporter in 1969.

Looking at postwar recovery, the ensuing rapid development of Japan's steel industry can be ascribed in part to the economic and industrial policies adopted by the Japanese government during the postwar rehabilitation period in the 1950s. At the same time, it should be noted that the Japanese steel industry efficiently assimilated the technologies it learned from the United States and western European countries. And drawing upon its own ingenuity and skill, the industry greatly improved the technologies it imported. *Jishu-Kanri* (J-K) activities (workers' voluntary group activities) are a good example of an imported technique that was adapted very successfully in Japan.

The origin of J-K activities can be traced back to the QC and ZD activities brought to Japan from the United States in the 1960s. The self-motivation workers displayed in mastering the use of imported equipment and technology was vital to the establishment of a modern steel industry in Japan. While the concept of a work contract is an integral part of the societies of the West, Japanese society is based on a somewhat different approach. Japanese workers endeavor generally to work as effectively and creatively as possible. J-K activities backed up by this natural inclination of Japanese workers have greatly helped to improve the productivity and structure of Japan's steel industry since the 1973 oil crisis.

Computer control systems were introduced toward the end of the 1960s and have had a far-reaching effect on the Japanese steel industry. The fully on-line computer system of Nippon Steel Corporation's Kimitsu Works was the first such system introduced in the world. The major results of computer control have been (1) substantial labor savings, (2) higher product yield, and (3) closer inventory and delivery-time control through the realization of integrated process control from order acceptance to product shipment.

Since the 1973 Oil Crisis

The oil crisis of 1973 shook the very foundations of the existing economic order, and delivered several hard blows to the Japanese steel industry.

First, sharp rises in the prices of fuel and raw materials, especially coal and iron ore, imposed the heavy burden of higher production costs on the steel industry.

Second, the demand for steel fell off considerably, which forced a sharp cutback in production. The steel industry is a capital-intensive industry, so persistent low-capacity operations have had a marked depressing effect on corporate earnings.

Third, consumer requirements for steel products became more and more diverse. For instance, the automotive industry had a growing need for steel products with higher strength and workability while other industries, like can manufacturers, were demanding lower-price steel products which contain less expensive alloys.

To cope with these far-reaching changes in product demand, the Japanese steel industry has directed most of its efforts to improving productivity and reducing production costs while not increasing production. The two key parts of this strategy are (1) conservation of energy and raw materials, and (2) improvement of product yield by streamlining production processes and reducing labor input.

As for the first part of this strategy, energy and raw materials savings, Japan's steel industry reduced its unit energy consumption by 13.5% during the 1973-1981 period. The steel industry's efforts in this area have naturally centered on the iron- and steel-making processes that together account for more than 70% of the industry's overall energy consumption. Measures that have proved to be particularly effective include the use of mixed feed of formed coke, coke dry quenching (CDQ), power generation from top-pressure recovery turbines (TRT), and the recovery of basic-oxygen furnace waste gas. What should be emphasized here is the enthusiasm with which plant workers have adopted and added useful improvements to new equipment and processes.

A major energy-savings achievement outside steel-making operations was the development of energy-efficient, ocean-going ore carriers. To ease the burden imposed by rising bunker fuel oil prices, the Japanese steel industry, in conjunction with shipbuilders and shipping companies, designed and built new energy-efficient vessels. These large ore carriers feature an optimum navigation speed and hull profile, low-speed engines and large screw propellers, all of which combine to cut bunker oil consumption to two-thirds the conventional level. Two vessels of this type have been constructed as of September 1982.

The second key part of the industry's strategy for coping with changes in the steel market is the improvement of finished product yield. This strategy consists mainly of the wider use of continuous casters and other process-simplifying techniques such as hot charging (HCR), hot direct rolling (HDR) and the continuous annealing and processing line (CAPL). Japan's continuous casting ratio rose from 6% in 1970 to 72% in 1981. Crude steel to finished product yield in 1981 reached 90.5%. The figures for raw steel and finished-product production reflect this trend even more clearly. Raw steel production decreased 17.6 million tons or 14.8% between 1973, the year in which Japan's steel industry achieved its all-time high in production, and 1981. During that same period, the drop in finished steels production was only 9 million tons or 9.0%. This means product yield rose by about 6.0%.

The Japanese steel industry also worked hard during this time to meet the new needs of various steel-consuming industries. For example, new types of high strength sheet, surface-treated sheet and low-alloy, high-tensile steel sheet have been developed to satisfy the automobile industry's needs for fuel efficiency, greater durability and safety. To meet the demand of can manufacturers, a new light-gauge, deep-drawing quality tinplate for two-piece cans was developed. And research is continuing on the development of line pipe that can withstand the severe climatic conditions of arctic regions.

The development of these new products is the result of not only the steel industry's investment in R&D but also its close co-operation with machinery and other relevant equipment industries and the steel-consuming industries. And in these days of low economic growth, each individual worker must realize the difficult situation the industry is in and devote himself to helping the industry tide over these trying times. In fact, the cost reductions, productivity increase and quality improvements the Japanese steel industry has achieved since the 1973 oil crisis are in large measure the result of voluntary efforts made by steelworkers themselves through J-K activities. These worker-initiated J-K activities have infused new life into not only the workers who participate in such groups but into the whole corporation as well.

Future Tasks

The world steel industry will continue to face many difficulties throughout the 1980s. The Japanese steel industry will not be an exception. It may safely be said that technical innovation is the only route left for the steel industry to follow in order to find a way out of its current difficulties. Taking into consideration the recent depressed condition of the steel industry, it should promote technical innovation at a much faster rate than other industries.

Two basic issues the Japanese steel industry must come to grips with in the future are quality-oriented operations and the strengthening of international cooperation.

The first issue is how best to continue the pursuit of technical innovation. No industry can retain its competitive position without updating its equipment and facilities. Taking into account the recent depressed market for steel, the steel industry must promote technical innovation at a much faster rate than other industries. Accordingly, the Japanese steel industry must continue to search for technical innovations and utilize fully whatever innovations are found. In addition, the improvement of productivity will be an important task for the industry. Particularly essential for the Japanese steel industry is investment in R&D to meet the increasingly sophisticated and diverse demands of steel-consuming industries and to develop production processes that will offset the disadvantages of a steel industry operating in a country with meager steelmaking resources. Because steelmaking is an evolving technology, it still has great potential for further development.

The second issue concerns the promotion of technical cooperation with foreign countries. Steel companies of the United States and Western Europe are now making all-out revitalization efforts. The Japanese steel industry is ready to lend as much cooperation as it can to repay those countries for the guidance and cooperation the Japanese industry received from them immediately after the war. It is also necessary for the Japanese steel industry to contribute appropriately to the development of steel industries in developing countries.

In closing my remarks on technical innovation, I am reminded of the words of a famous Zen priest quoted by Mr. Eishiro Saito, past chairman of the International Iron and Steel Institute, at the institute's annual conference in Rome in 1977.

> "Stillness amidst stillness is not true stillness. Only when one perceives stillness in the midst of motion, can one glimpse the true nature of Heaven and Earth. Pleasure amidst pleasure is not true pleasure. Only when one perceives pleasure in the midst of pain, can one begin to understand the exquisite meaning of life."

Mr. Saito quoted these words at a time when the world steel industry was still suffering the after-effects of the 1973 oil crisis. As the words imply, stillness and pleasure cannot be truly appreciated except in the context of their exact opposites. I think the words of that old Zen master pose a kind of challenge to us today. Will the world steel industry be able to see past its present pain, hold on long enough and do what it must to enjoy the rewards of a future recovery? I believe it must and will. ●