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Title	Innovation and Jishu Kanri Activities in the Japanese Steel Industry
Author(s)	YONEYAMA, Kikuji
Citation	ECONOMIC JOURNAL OF HOKKAIDO UNIVERSITY, 24, 25-58
Issue Date	1995
Doc URL	https://hdl.handle.net/2115/30527
Type	departmental bulletin paper
File Information	24_P25-58.pdf



Innovation and Jishu Kanri Activities in the Japanese Steel Industry*

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The old feudal Japanese rationalism helped to create a new ethos for work in modern industrial society. It was strongly impacted by Euro-American countries in the 19th century. Japan imported all of its soft and hard technology from advanced countries. Japanese put the western technology into practice and localized the modern factory and management system. They mastered and operated the transferred technology through manual labor. Length of service based on long term apprenticeship, became the measure of status for employees in the company. The Nenko-status system was set up based on transferred technology, in-firm training school, long term apprenticeship in the workshop and academic career. The internal labor market was formed on the basis of job rotation and promotion from within the workshop.

The suggestion system and information sharing through the employees' newsletter in the pre War II period helped to prepare for the rapid recovery and innovation in the production field in the period after the war. The rush to import production technology and the construction of new plants, provided employees with a chance to display their innovative skills. TWI, MTP, industrial engineering methods and quality control methods helped to unlock employees' creativity. These scientific approaches combined with traditional craftsmanship. The intensive and extensive education and training programs helped to develop the abilities of all employees. Engineers transferred quality control methods, other problem solving methods and original know-how to general workers. Information sharing and technology diffusion inside the company were the origins of research and development activities.

At first Jishu Kanri activities were regarded as an effective method to promote employees participation. Nowadays Jishu Kanri activities act as a creative team work process which has become a propeling innovative

* The author is particularly thankful to Professor Emeritus Robert H. GUEST, Amos Tuck School of Business Administration, for his valuable discussions and comments during his stint as Visiting Professor at Hokkaido University in 1984. And the author is also thankful to Mr. MIYATA, Vice-president, personnel division staff, engineers and foremen at the Muroran Works for the original data, interviews and their valuable comments which contributed to this research project.

force in the Japanese steel industry.

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1. Introduction

The foundation of the modern Japanese steel industry was based upon technology transfer from Euro-American advanced countries. Furthermore the Japanization process of transferred technology was eagerly pushed forward by Japanese managers, engineers and workers. They tried to adapt the imported technology to the local materials and climate conditions. The teamwork of innovative, hardworking engineers and workers led to this breakthrough.

The industry had to overcome three big crises to survive. In 1875 the Meiji central government set up a new steel works at Kamaishi. The plants imported from the UK were not suitably designed for the local conditions.¹ Kamaishi works was shut down because of the failure of technology transfer. In 1901, the central government started to setting up a new integrated steel mill at Yawata. At Yawata works German engineers and foremen proved to be ineffective at intercultural technology transfer.²

1. Kamaishi Works. (1955). "70 Year History of Kamaishi Works." (in Japanese) pp.27-35.

2. Yawata Works. (1980). "80 Year History of Yawata Works." (in Japanese) pp.20-26.

Japanese engineers independently developed new technology to adapt to the local materials. That was the beforehand treatment of iron ore and coke for pig iron making by blast furnace.

The second crisis was the destruction caused by intensive bombing during World War II. In 1945, almost all Japanese steel works stopped operating because of the destruction and the shortage of materials and energy. The industry was seriously damaged by the war. However some of the plants and equipment survived. Engineers and skilled workers standing in the ruins, did not give up their hope to reconstruct these devastated facilities. The Allied Occupation Forces in Japan had control over all industries.

After receiving GHQ's permission to reconstruct, they put all their efforts into reconstructing and catching up with the most advanced technology. Hard technology for iron and steel making was imported from around the world. At the same time soft technology for control and management was imported mainly from the U. S..

Quality control methods combined with Japanese groupism led to the development of quality control circle activities (these activities were called Jishukanri activities in the steel industry).

Transferred ideas and methods were polished up by Japanese employees leading to process innovation in the production field.³ Employees embraced the traditional Japanese craftsman work ethic of continuous gradual improvement (Kaizen). Western scientific approach was put into practice through Japanese craftsmanship. Teamwork among engineers and skilled workers succeeded in developing many patents and practical new devices.

These successes helped to overcome the third crisis, the pollution problem and the oil shock in 1973. What had happened in Japan between the two oil shocks was the development of the most effective energy saving technology at that time. By using newly developed anti-pollution, energy saving technology and a computer control system, the Japanese steel industry become the world leader.

In the 1990's, the Japanese steel industry is faced with the maturity of the domestic market as well as keen competition from mini-mills and newly industrialized countries. The Japanese iron and steel industry is now standing at a cross roads. It is forced to change its business strategy from international vertical division of production to a horizontal strategy (direct investment, technology transfer and local production instead of exporting finished steel products). To

3. Abernathy's concept "incremental innovation" is based on daily small improvements of production process.

William ABERNATHY. (1978) "Productivity Dilemma." Johns Hopkins University Press.

avoid the hollowing of domestic industry, the industry must put more resources into R & D activities to maintain international competitiveness. It is extremely important to operate key steel works using the most advanced technology.

The key to achieving this strategy, is the transfer and diffusion of hard technology, soft technology, creative know-how, skill and pioneer spirit among engineers inside the company. The development of all employees' creative power is absolutely essential for unique R & D in this new global age.

2. Technology Transfer and Development of the Japanese Steel Industry

2.1. Technology Transfer and Establishment of the Japanese Steel Industry

The modern Japanese iron and steel industry was based upon technology transfer from advanced countries. In 1874, Kamaishi works was constructed by the Ministry of Industry (Meiji central government). The plants were imported from the UK, British engineers and skilled workers were invited to assist with the iron making technology transfer. In spite of the foreign engineers' guidance, this works failed in the operation of two blast furnaces with 25 tons production volume. The cause of the failure was due to the fact that the officers believed unquestioningly in the foreign engineers' guidance and neglected to make use of the Japanese engineer's experience and proposals. Oshima Takato had already succeeded in the construction and operation of a western style pig iron making technology (blast furnace) in the Kamaishi area.

Also foreign engineers could not scientifically grasp the quality and quantity of the local materials (iron ore and charcoal) appropriate for the imported plants. They did not fully understand that the production technology was dependent on the special local conditions of materials and climate.⁴ Kamaishi works was shut down due to governmental financial difficulties.

These plants were sold to an entrepreneur, Tanaka Chobe. Tanaka went back to the production technology by which Oshima Takato succeeded in pig iron making in 1857. After that Japanese engineer Noro Kageyoshi and his apprentice Komura Koroku attempted to operate the 25 tons blast furnace. They overcame many difficulties and succeeded in operating it with coke the first case in Japan.⁵

On the basis of this success at Kamaishi works, the Japanese government

4. MORI Kahei/ITAHASHI Minamoto.(1975). "The Establishment of the Modern Iron Industry-prehistory of Kamaishi Works." (in Japanese) pp.69-127. Kamaishi Works.

5. Kamaishi Works. (1955). "70 Year History of Kamaishi Works." pp.60-61. Kamaishi Works.

decided to set up new big integrated steel works (Yawata works) assisted by a German steel company. Steel making plants were imported. Fifteen engineers and foremen came to assist in technology transfer at the workshop from 1897 to 1904.

However, German engineers and techniques proved to be ineffective in Japan. Japanese engineer Noro Kageyoshi designed, constructed and operated the second blast furnace. In 1905, he could make good quality pig iron greater than the official production capacity (120 tons).⁶

By 1930, Yawata works had already risen to the same level as European steel works. In 1934, Yawata works had two blast furnaces with an official production capacity of 1000 tons per day. In 1940, the cold strip mill imported from the U.S. began operation. In 1941, the hot strip mill started to make a profit. These mills were the first continuous rolling mills in Japan.

In 1942, Hirohata works started operating a wide steel plate rolling mill. This mill made by the American company UE & F Co., had a continuous rolling system with top level engineering and production capacity. In May 1944, 3500 tons of wide steel plate were produced at the maximum capacity.⁷

The Japanese steel industry could independently establish pig iron making technology at a comparatively early stage. Steel making technology using open furnaces could now operate independently. In comparing these two areas of technology, Japanese rolling technology was clearly behind that of American and European levels. The Japanese steel industry could catch up with advanced countries through the introduction of American made rolling mill and technology at Yawata and Hirohata Works, and then move into the forefront of new technology during World War II.⁸

Japanese engineers' technological abilities were well cultivated due to the drastic development which occurred after the war.

2.2. Catch-up and Autonomous R & D after the War

The Japanese iron and steel industry was destroyed by the intensive bombing

6. ditto pp. 419, 536.

WAKASUGI Kumataro. (1943). "The life of Blast Furnace Foreman TANAKA Kumakichi." (in Japanese) pp. 50-69. Kokumin Kogyogakuin Shuppan.

TANAKA Kumakichi pointed out that German engineers did not engage the guidance for technology transfer and were very arrogant to Japanese engineers and workers. They had a sense of racial superiority to Orientals.

Even without German language ability Tanaka could find out the mistakes in operation techniques.

7. Hirohata Works. (1990). "50 Year History of Hirohata Works." (in Japanese) p. 195 Hirohata Works.

8. Nippon Steel. (1950). "The History of Nippon Steel." (in Japanese) p. 159. Nippon Steel.

during World War II. The production facilities, materials and energy supply system were heavily attacked. After the war, the Japanese central government adopted a priority production system policy.⁹ The effective allocation of all domestic resources at the national level helped to gradually restore the Japanese economy. In 1950, the Korean war broke out. The war in Japan's neighboring country gave rise to special procurements. This boom kicked off the full-scale economic recovery. The Ministry of Finance developed fiscal and monetary policies to encourage investment in the manufacturing sector.

The iron and steel industry carried out the first rationalization plan (1951-1955). In accordance with this plan, rolling mills were repaired and new mills were set up. The total investment budget was 166.9 billion Yen.

The second rationalization plan (1956-1960) was aimed at the innovation of the iron making process and the steel making process. The total budget was 747.6 billion Yen.

Large scale blast furnaces were set up. The basic oxygen furnace (LD-converter), a more productive steel making technology, was introduced to replace open hearth furnace.¹⁰

The industry achieved larger production capacity through production line balance based on innovative technology. Rapid economic growth encouraged the huge amount of investment into the heavy chemical industry. In accordance with the government's double income policy, Japanese steel companies wanted to adapt to the enormous estimated demand.

The third rationalization plan (1961-1965), with a total budget of 1365.3 bil-

9. September, 1946 at Muroran Works the operation of the blast furnaces suspended due to the shift of production to Yawata Works.

Muroran Works. (1958). "50 Year History of Muroran Works." pp.222-225.

10. Japan Iron & Steel Industry caught the best chance to introduce new technology, the Basic Oxygen Furnace (LD-converter).

Leonard H. LYM. (1982). "How Japan Innovates-A comparison with U. S. in the case of Oxygen Steel Making." Boulder Westview Press.

The old open hearth furnace system was not an effective production technology for the growing demand of steel in Japan. Continuous casting technology was introduced in rapid succession. C. C. technology short cut the process of ingot making and blooming mill for slab. This technology made an epoch-making improvement of productivity, quality, saving human power and cut the cost of energy consumption.

ROWLY indicated that 6 million tons/year is the minimum production volume in economical scale.

C. K. ROWLEY. (1971). "Steel and Public Policy." pp.56-57. Mac-Graw Hill London.

COCKERILL indicated that 6-8 million tons/year is the international competitive production scale of integrated steel works in advanced countries.

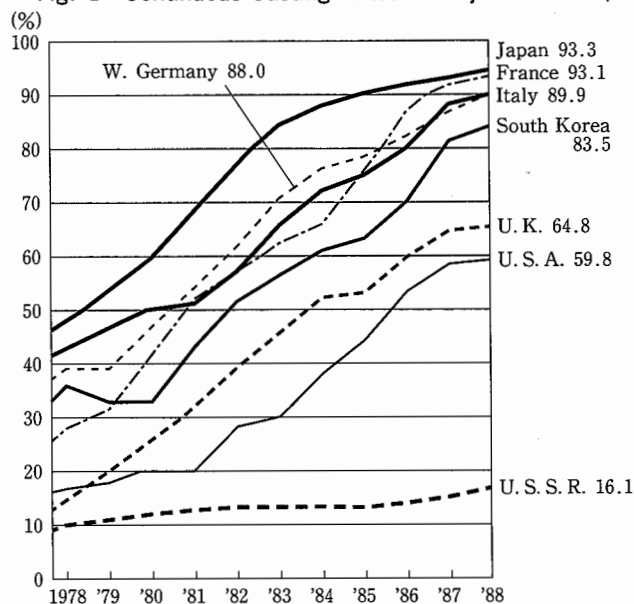
A. COCKERILL. (1974). "The Steel Industry-International Comparison of Industrial Structure and Performance." p.84. Cambridge University Press.

lion Yen, had the following characteristics :

- (1) Super large scale blast furnace, newly-established BOF (LD-converter), large scale mill, speeded up production, continuous connection between forward process and backward process, and a scaling up of all other facilities with advanced operation technology.
- (2) Newly located large scale integrated steel works were constructed and linked with industrial complexes in the seaside area.
- (3) Voluntary coordination for steel making plants and production facilities among companies.¹¹

After the third plan, the continuous casting technology was introduced to all steel making processes to improve the energy efficiency and productivity (shown in Fig. 1). In particular, the increase in the number of continuous casting plants and the improvement of yield percentage are symbols of innovation and business rationalization in the steel industry.¹² The computer technology turned a new and

Fig. 1 Continuous Casting Rates of Major Countries, 1978-1988



Note Continuous Casting Rate = $\frac{\text{Continuous Castings}}{\text{Crude Steel (IISI Calculation Formula)}}$

[Source] JISF (The Steel Industry of Japan 1989)

11. Hirohata Works. (1970). "30 Year History of Hirohata Works." (in Japanese) p. 159. Hirohata Works.
12. The Japan Iron and Steel Federation. (1988). "10 Year History of the Steel Industry (1978-1981)." (in Japanese) pp. 143-144.

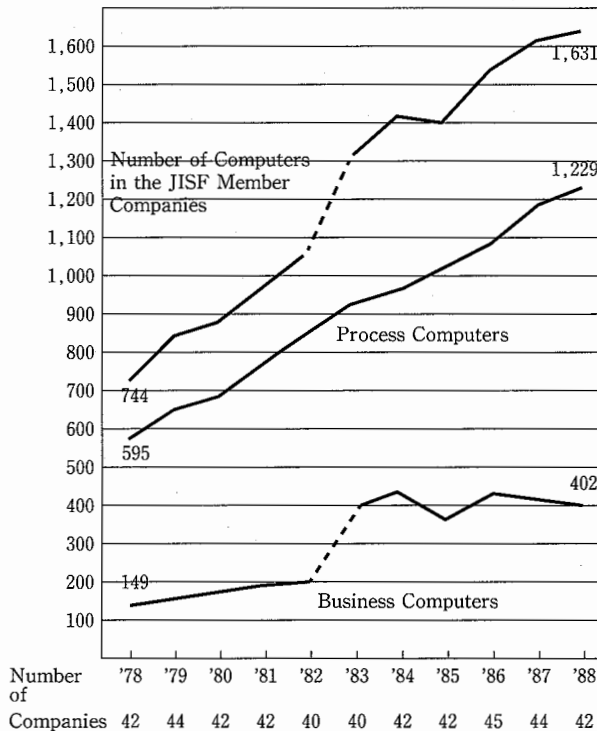
The percentage of rolled products by continuous casting are rapidly increased. 4.1% (in 1969), 11.5% (in 1971), 21.2% (in 1973), 31.7% (in 1975), 41.65 (in 1977).

Units of continuous casting plant were also rapidly increased, 26 units (in 1969), 40 units (in 1970), 60 units (in 1971).

powerful steel works into a huge mega-machine.¹³ The number of computer installed at steel works is shown in Fig. 2.

These industrial efforts over 25 years have made the Japanese iron and steel

Fig. 2 Number of Computers in Steel Industry, 1978-1988 (as of January)



Note: In 1979 and 1983 Surveys, the category of business computers was changed as follows:

1979: Computers whose category—whether they were business or process computers—was unknown were added to the "business computer" category.

1983: Business computers were divided into the following three groups:

Host: Computers used as main computers at computer centers.

Stand-alone: Systems operated independently from host computers and purchased at a unit price of ¥5 million or over.

Other computers: General-purpose units connected to host computers by circuit.

(Source) JI SF (The Steel Industry of Japan 1989).

13. 369 units of business computers and process computers (in 1971), 550 units (in 1975), 853 units (in 1979) were installed at the steel companies.

Tekko Kai 1979, May.

The Japan Iron and Steel Federation (JIFS). "The Steel Industry of Japan 1993." p. 17.

As of January 1, 1993, JISF member companies had total 508 units of business computers in operation, including those installed at their subsidiaries. This was up from the previous year figure of 464 units.

There were 1494 process computers in operation, an increase of about 5% from the previous year.

industry the top ranked in the world by both quantitative and qualitative measures. In spite of the oil crisis in 1973, the Japanese iron and steel industry produced 119.32 million tons of crude steel the largest amount in history.

The development of production technology in the Japanese steel industry had re-started after the war. It had succeeded in acquiring a mastery of basic technology. The original R & D added to the foundation of the improvements, applications and scale-ups of the transferred technology from advanced countries.

1945-1959 strip mill technology, LD converter technology and basic process technology were imported.

1960-1974 the improvements, scale-up of transferred technology and original technology were developed.

From 1975 onward the industry established itself as having the top ranked technology in the world.¹⁴

The trends of export and import of technology (technology transfer) in the steel industry are shown in Fig. 3.¹⁵ Before the 1960's, there was no export of iron and steel technology from Japan. At last in the 1970's, the exporting started. The ratio of export/import of technology exceeded one in 1973 just after oil crisis. In the 1980's, the ratio became more than 5 times.

This trend means that after the oil crisis the Japanese steel industry has become an exporter of technology.

Examining by areas, we can see that from 1975 onward exports are directed to South East Asian's countries. And exports to advanced countries (U. S. and



(Source) White Paper of Science & Technology (1970~1992)

14. The Japan Iron and Steel Federation. (1981). "10 Year History of Iron and Steel Industry. (1968-1977)." (in Japanese) pp. 285-286.
15. The Science and Technology Agency. (Japanese Government). "White Paper of Science and Technology." 1970-1992 editions. (in Japanese).

European countries) has started.¹⁶

In accordance with International Patent Classification (IPC), patent applications for C21 (Iron metallurgy), C22 (Metallurgy ferrous or non ferrous alloy) and C23 (Covering metallic materials) are shown in Fig. 4.

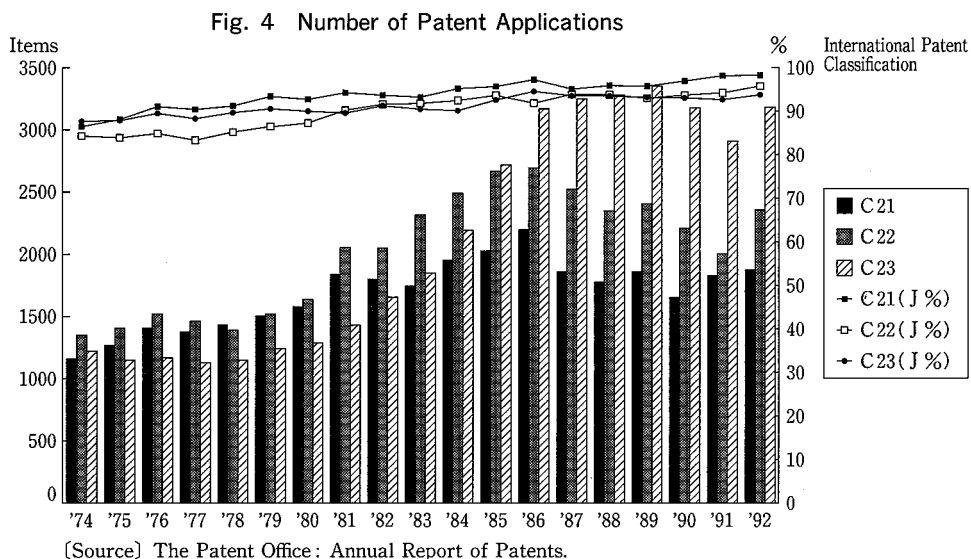
In 1976, the patents applications (C21) by Japanese became greater than 90%. From 1982, Japanese researchers have accomplished more than 90% of three items (C21, C22, C23).¹⁷

Nowadays, the Japanese steel industry has a independent R & D capabilities leading even advanced countries in the level of technology transfer and transplant.

They have an overwhelming lead in R & D in iron metallurgy related fields. Engineers in steel companies had played an important role in R & D activities. But typically in the steel industry, the large plants (blast furnace, LD-converter, strip mill etc.) are operated using by a highly integrated teamwork between engineers and skilled workers in the production field. Engineer's new R & D ideas and concepts are checked during the last stage by the production level workers'.

For stable and effective operations, workers' abilities in adaptation and proficiency to the plant are the keystones.

In 1958, the steel industry introduced the Japanese foreman system after the American foreman system.¹⁸



16. "10 Year History of Steel Industry (1968-1977)." p. 286.

17. The Patent Office (Japanese Government). "Annual Report of Patents." 1975-1994 editions. (in Japanese).

18. YONEYAMA Kikuji. (1978). "Technological Innovation and Shop Management." (in Japanese) pp. 228-235. Bokutaku Sha.

And in firm education and training, systems were eagerly arranged for each type of function (job) and level of management. Well trained and highly motivated workers have contributed greatly to the improvement in the quality of products and plant operation technology.

In 1950, the ideas and statistical methods for control were presented by Dr. W. E. Deming.¹⁹ Quality Circle activities were kicked off and promoted by the Union of Japanese Scientists and Engineers (Nihon Kagaku Gijutu Renmei) in many type of industries.

In the 1960's, the steel industry introduced small group activities in workshops. These activities were generally named "Quality Circle Activities". But these types of activities have a variety of different names (Quality Circle Activities, Zero Defect Movement, Jishu-Kanri Activities etc.) depending on the company. The Japan Iron & Steel Federation adopted the name "Jishu-Kanri (JK) Activities" to generalize the uniqueness of small group activities in this industry. JK activities are defined as "continuous group activities in which individual workers voluntarily organize small groups, select leaders from among themselves, hold discussions on an equal footing, and with their leaders as the nuclei, take up problems at the workshop, set goals for the solution of the problems, and make efforts to achieve the goals with participation by everyone".²⁰

Workers' voluntary problem solving activities cover a wide range such as product quality enhancement, efficiency improvement, cost reduction, promoting safety at the workshop, and others. In 1983, ensuring work safety was the top of activity (27.4%). About 90% of the activities in 1993 related to four areas: efficiency improvement (30.8%), cost reduction (24.6%), ensuring work safety (19.6%) and product quality enhancement (14.6%).

In comparing the results of 1983 to more recent trends, the themes are changing from ordinary daily issues to those directly linked with management effectiveness itself: productivity, delivery time, cost reduction and reducing basic unit cost. JK activities have been tackling more specific subjects.²¹

The number of Jishu-Kanri Activities and participants are shown in Fig. 5 and Fig. 6.²² These two areas reached highs in 1975. After that they gradually decreased because of the decrease in the total of number employees in the steel

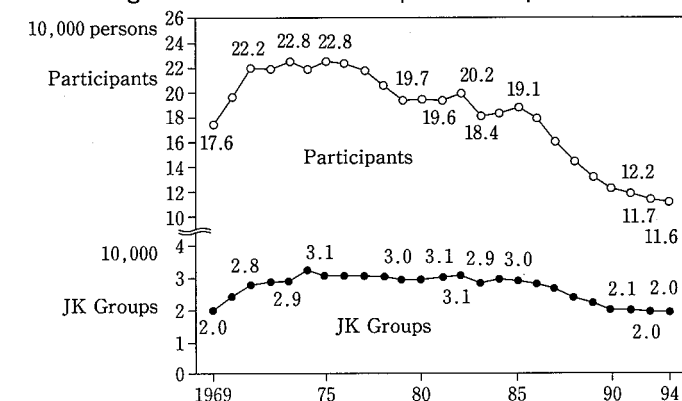
19. Deming W. EDWARDS. (1951). "The Elementary Principles of the Statistical Control of Quality-a Series of Lectures." Tokyo. Union of Japanese Scientists and Engineers (Nihon Kagaku Gijutsu Renmei).

20. The Japan Iron and Steel Federation. (1989). "Jishu Kanri Activities in the Japanese Steel Industry." (Pamphlet) Tokyo.

21. "Tekko Kai." 1994, June. pp. 9-10.

22. "Change of Jishu Kanri Activities in the Steel Industry." (in Japanese) *Tekko Kai*. 1994, June.

Fig. 5 Number of JK Groups & Participants



(Source) The Japan Iron & Steel Federation.

Fig. 6 Results of JK Activities

	1983	1993
Companies	45	37
Works & Offices	181	166
Circles & Groups (A)	29,159	19,821
Participants (B)	183,648	115,813
B/A (persons)	6.3	5.8
Completed Themes (C)	190,448	75,267
C/A (Items)	6.5	3.8

Note: Completed Number is the results of 1992.

(Source) *Tekko Kai*. June, 1994. p. 10.

industry.²³

The two oil crises in the 1970's were serious events in the modern history of industrial development. Energy consumption industries were faced with sharp increases in cost. They were dependent on a cheap and abundant oil supply. The rapid changes in oil supply halted the favorable economic growth after World War II.

Growing demand for steel disappeared due to the lack of big projects like the reform plan of Japan conducted by the Tanaka Cabinet. The volume of demand

23. The number of workers in the iron, steel making and rolling industry are drastically decreasing due to mechanization, computerization and rationalization of business.

The numbers are 317,000 persons (1975), 267,000 persons (1980), 255,000 persons (1985), 191,000 persons (1990), and 189,000 persons (1993).

"Summary of the Statistics of Steel Industry." (*Tekko Tokei Yoran*) '80, '85, '90, '92 and '94 edition.

for steel had reached its upper limits. The industry went into a period of maturity.

In the 1990's, the industry is faced with business restructuring and changing business strategy from quantitative growth to qualitative increases.²⁴

Nowadays the Japanese steel industry is burdened by the high Yen rate (1\$=90Yen) in international markets and by new technological systems for steel making in the domestic economy.

The large Korean steel company, POSCO has also appeared as a powerful new challenger in the international market. The company started to export low price steel products to Japan as well as other advanced countries.²⁵

Tokyo Steel Co., (Japan) has used electric furnace steel making technology to cut production costs. Top management's strategic decision was to use scraps as raw materials and economize on investment for facilities. But the regulated high price of electricity limited the cost reduction. Therefore the company has invented a new energy saving electric furnace.²⁶

Japanese big steel companies with Nippon Steel at the head of the list are forced to cut back their production capacity to adjust to the shrinking demand. The companies must cut production costs drastically to meet the changing demands of the market.

The business rationalization plan will also change the so-called Japanese management system, especially the life-time employment system for regular employees. Wage costs for big steel companies are higher than that of POSCO and Tokyo Steel. Therefore the companies must reduce the number of white color employees to regain competitive power.²⁷

3. Innovation and Jishu Kanri Activities at Muroran Works

3.1. Outline of Muroran Works

Muroran Works was established and No.1 blast furnace went into operation in 1909. In July 1945, after four air raids and five bombardments by ship, the

24. The Japan Iron and Steel Federation. (1988). "10 Year History of Iron and Steel Industry (1978-1987)." pp. 534-536.

25. "Economist" (Weekly, Japanese. January 24, 1995).

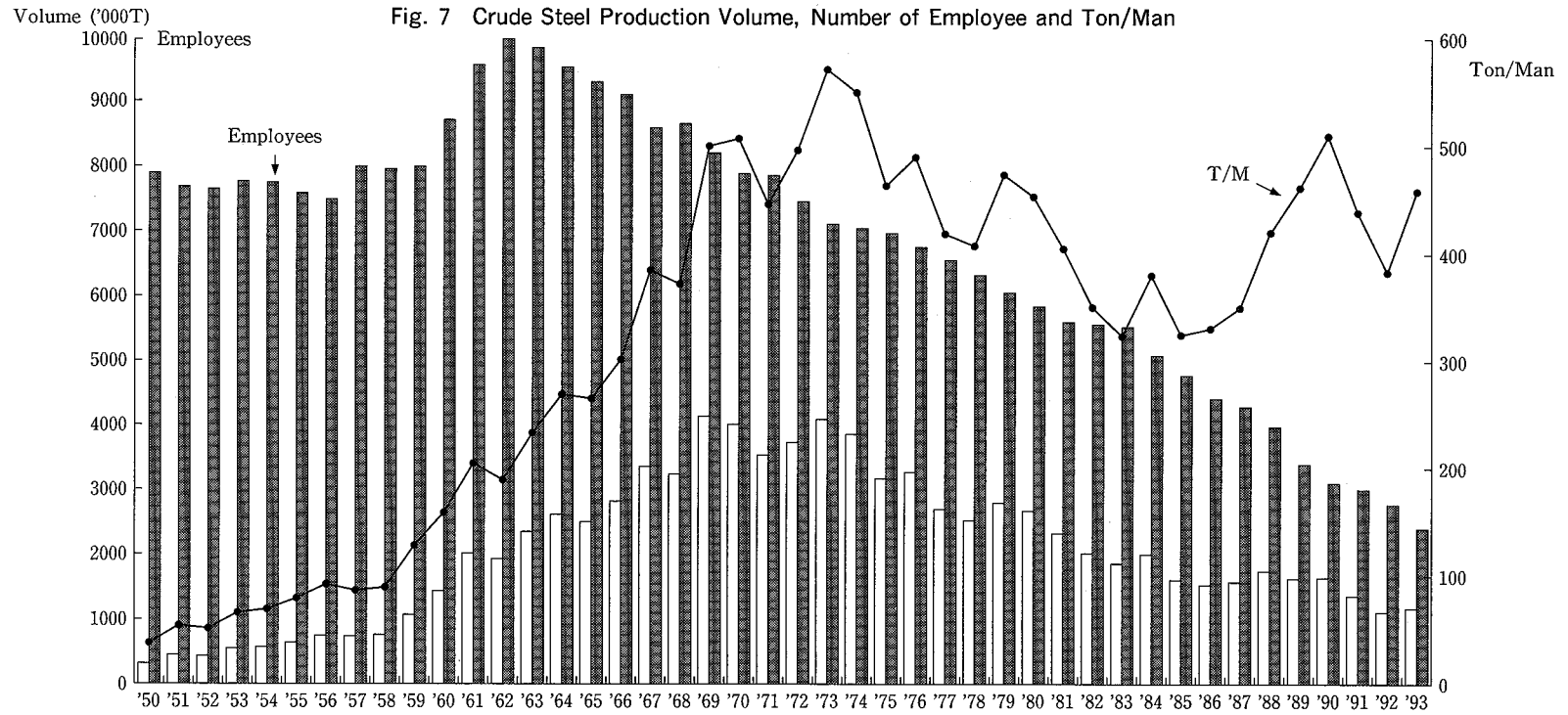
Article, Company-Struggle without Humanity and Justice, Korean POSCO vs Japanese Steel Companies.

26. *NIKKEI BUSINESS* (January 9, 1995). "Tokyo Steel." (in Japanese).

The company introduced a new type of energy saving electric furnace. The productivity doubled due to this innovation.

27. "Reexamining the big 5 steel companies' business rationalization plan." (in Japanese).

Tekko Kai. 1994, June.



works was faced with the crisis of destruction. In spite of difficulties such as the temporary shutdown of its blast furnace soon after the end of World War II, it has recovered in unison with Japan's economic recovery. It grew steadily until the first oil crisis in 1973. The crude steel production volume per year climbed to a peak of 407.1 million tons in 1969 and 400.5 million tons in 1973.²⁸

However with the oil crisis in 1973, the Japanese economy suddenly took a downturn, forcing the steel industry to drastically reduce production. To cope with the difficulties of high price of energy and resources and the shrinking of demand, the works made an effort to develop as much new technology as possible. So far the works has succeeded in developing a number of original techniques which have contributed to its own business modernization. These include technology for the manufacture of sintering ore with minimum energy consumption, blast furnace and LD converter operating techniques that produce a minimum of slag, refining techniques for high grade steel, advanced continuous casting technology and techniques for guaranteeing high product quality. Today it has become a new and powerful steelmill of medium size, specializing in the production of high-quality special steel (bars and wire rods).²⁹

The crude steel production volume, number of employees and productivity (crude steel production volume per employee) from 1950 to 1993 is shown in Fig. 7.

As to this result, in 1962 the number of employees had climbed to a high of 9936 persons. Over the next 30 years, the number has decreased. During the recession of the 1980's there was a sharp decrease. In 1993, the number was 2280 less than 1/4 that of the 1962 peak. On the other hand, productivity has sharply improved.

The steel industry is the most typical process industry that can benefit from economies of scale. Therefore the 400 million tons of crude steel produced in 1973 put the productivity at its highest level in the history of this works.

The number of employees slimmed down due to downsizing of the production volume to 100 million ton per one year. Passing through the difficult process of business restructuring, the productivity has recovered sharply in the 1990's.

Nowadays the works has been revitalized by diversification of management and introduction of new steel making technology.³⁰

28. Nippon Steel. (1985). "Honoo to tomoni-10 Year History of Nippon Steel." (in Japanese) p. 648.

29. Nippon Steel. (1985). "Muroran Works." (Pamphlet).

30. *Shirakaba*. No. 1189. (1994). New melting technology for steel making was introduced as a joint venture business with Mitsubishi Steel in 1994. Only one active blast furnace is still surviving.

3.2. In Firm Technical School

The origin of the education and training system was a special school for young workmen at the works (Shiritu Wanishi Seitetsusho Seinen Gakko) in July 1938. The new training school for key workmen was based upon national education standards. But confusion after the defeat, disabled all the traditional training programs for employees within the firm.

In December 1945, a new training school for employees (Jugyoin Kyoushuusho) was established. In February 1947, training for newly employed young men started.

In February 1950, the company set up a private school, Wanishi technical school, to educate and train young employees. The qualification for entrance was recent graduation from a junior high school. The school organized two grades with two classes. For each grade, there was a limit of 60 students. The curriculum at this school was similar to regular 3 year technical high schools. To develop multi-skilled workmen for the steel industry, education placed emphasis on a fundamental knowledge of mathematics, chemistry, physics and the required subject of skill the for steel making work.³¹

The company guaranteed jobs and give a scholarship to the students. In 1955, 3550 applicants from 54 schools tried to obtain one of the 50 positions. Many talented and ambitious young men wanted to get a job at this works. The entrance examination included writing, oral, physical, and skills, makings and function of exercises. Only young man who had the highest score could pass the examination.³²

In April 1961, this school was changed into a technical high school (Fuji

31. Muroran Works. (1959). "50 Year History of Muroran Works." p. 737. (in Japanese) Muroran Works.

Shirakaba. No. 330. (April 1, 1957).

The first grade, 1st term was organized of basic courses (67%) and of basic practicals (33%). 2nd term was organized of basic courses (64%) and of basic practicals (36%).

The second grade, 1st term was organized industrial courses (58%) and applied practicals (42%), 2nd term organized industrial courses (33%) and practicals in production field (67%). Industrial course contained the following curriculum: electricity, mechanics, metallurgy, drawing, chemical manufacturing, gauge and meter, quality control, energy control. Practical contained civil engineering, forging, finishing, electricity, machine tool, casting and car driving.

This school system was very unique in Japanese industrial society. Other in firm training schools aimed to bring up specialized skilled workers.

The education and training of basic knowledge and skills of steel making is an advantage for students to adapt themselves to different types.

32. *Shirakaba*. (In-company newsletter of Muroran Works) No. 282. (February 15, 1950).

Seitetsu Muroran Koto Kogyo Gakko). A three grade system was introduced for more effective education and training.³³

The objectives of education and training in 1969 were the following :

- (1) strengthening company consciousness
- (2) elevating for the spirit of fortitude
- (3) instill disciplined attitude.³⁴

In 1970, this school joined with a prefectual high school. The pupils could receive high school credits. After completing the 4 year course at this high school, they would receive a high school degree.³⁵

By using this school system the company could recruit the best talent in the local area. These talented young men lead the innovation of production process and promotion of small group activities in the workshop.

In 1975, this technical school closed down after a 25 year history. One seventh of the employees at this works are workmen who graduated from this school. This school contributed a great deal to the development of bringing up workmen with basic knowledge, technical skill, spirit of harmony, friendship and teamwork.³⁶

3. Employment of Male High School Graduates

The company also wanted to more actively promote innovation. In 1959, management decided to employ male high school graduates to do ordinary skilled work. Young men graduated from high school at the age of 18. The Labor Standard Law prohibits mid-night work for persons younger than 18 years old. The steel mill wanted to hire talented young men who could step in and be effective immediately during the new automated plant's construction and start up. The company could put those older than 18 on shift work. With the new personnel management policy, the company could save energy, time and cost regarding

33. *Shirakaba*. No. 846. (April 5, 1975).

In November 1967, 304 young pupils sit for the entrance examination. The applicants for recruited number of pupils was 7.6 times.

A scholarship of 3 thousand Yen was given to 1st grade students and 2nd grades students. 5 thousand Yen was given to 3rd grade students.

This education system (curriculum, scholarship and promise of getting job at Muroran Works) appealed to talented young students.

34. *Shirakaba*. No. 704. (May 5, 1969).

35. *Shirakaba*. No. 735. (August 20, 1970). The high school's name is Sapporo Yuho High School and it offered a 4 year correspondence course.

36. *Shirakaba*. No. 846. (April 5, 1975).

From 1938 to 1975 in total about 2600 young men graduated from this training school. One seventh of the employees are workmen who graduated from this school.

young employees' education and training.

In the later half of the 1950's after overcoming hunger and poverty in the ruins of war, Japanese families could send their children to high school. Demand side needs and supply side needs established a new equilibrium point in the labor market.³⁷

Yawata Steel, among other companies had already begun employing male high school graduates. These young men could easily adapt to the automated steel making facilities. They contributed to production activities with their basic knowledge of science and flexibility.³⁸

In March 1959, 41 male high school graduates were employed as general workers for the first time at Muroran works.

Young men having high school level knowledge were expected to actively contribute to the modern automated mill.

There were 506 applicants, more than 12 times the number to be recruited.³⁹ Young men attended 5 day intensive courses at the training center. The staff of the works, conducted lectures mainly on safety in the workshop and life as an employee of the company. After this class, they were directly assigned to a workshop.⁴⁰ Some of them were given jobs as assistants to engineers who were university graduates.⁴¹

4. Invention and Improvement (Kaizen)

In February 1942, the official commendation rules for invention and improvement were established.⁴² But this system remained as a spiritual slogan for the increase in production. The movement put stress on morale and work attitude. Most engineers could make some improvements to existing facilities. For gen-

37. Ministry of Education. (1992). "Education Policy of Japan 1991." (in Japanese) pp. 588-589.

In 1959, the ratio of pupils who go on to high school climbed to 94.1%.

38. Yawata Works. (1980). "80 Year History of Yawata Works." (in Japanese) pp. 275-277.

39. *Shirakaba*. No. 378. (March 5, 1959).

40. *Shirakaba*. No. 380. (March 25, 1959).

The manager of personnel encouraged the newly employed men with the message that they are the first men who have graduated from high school.

They were assigned to the following workshops; Quality control section (process control), Energy control section (instrument), Industrial engineering section (efficiency check), Maintenance section, and the most automated continuous sheet mill, the wire rod mill.

41. These types of engineers integrate the engineering theory and practices. They occupy the intermediate position between engineer and skilled worker (technician). Job rotation system in not so wide area made them walking dictionary at the mill. They will play an important role for invention of new operation technology and improvement of mills.

42. "50 Year History of Muroran Works." pp. 520-521.

eral workers however, there was no democratic participation.⁴³ In war time, this system did not produce good results because of the lack of a free atmosphere and usable resources.

But employees wanted to restart production with repaired facilities in the confusion of defeat. This eagerness brought out new inventions. From 1947 to 1957 the results of inventions led to 513 commended cases. New American style education and training systems, TWI and MTP were introduced at the beginning of 1950's. These training systems, were based on the principle that the improvement of work methods were actively diffused by managers inside the firm. In June 1953, the rules were established to improve employees' morale and promote improvement. The company laid the foundation for a formal suggestion system with these rules. In February 1954, a reward system for improvement was established.⁴⁴

Foremen and many skilled workmen strived to improve their immediate job (Kaizen). The accumulation of these improvements (Kaizen) crystallized into inventions and patents of production technology.⁴⁵

These rewards heightened employees' energy and interest. From 1953 to 1968, a total of 111,660 suggestions were presented and 73,152 cases were adopted as shown in Fig. 8. Average adoption rate was 65.5%.⁴⁶ 30% of the adopted suggestions were to improve employees' morale. 70% of them were put into practice. Themes on safety in the workshop also made up a large part of the total suggestions.

For example in the pig iron making factory, 200 suggestions per month were presented by employees related to the newly installed facilities. New machines usually brought about the possibilities for improvements. Management appreciated the huge number of suggestions which were more than expected. However,

43. *Shirakaba*. No. 66. (July 1, 1944).

The company committee commended 40 cases in total. Engineers played monopolistic roles.

44. "50 Year History of Muroran Works." pp. 520-521.

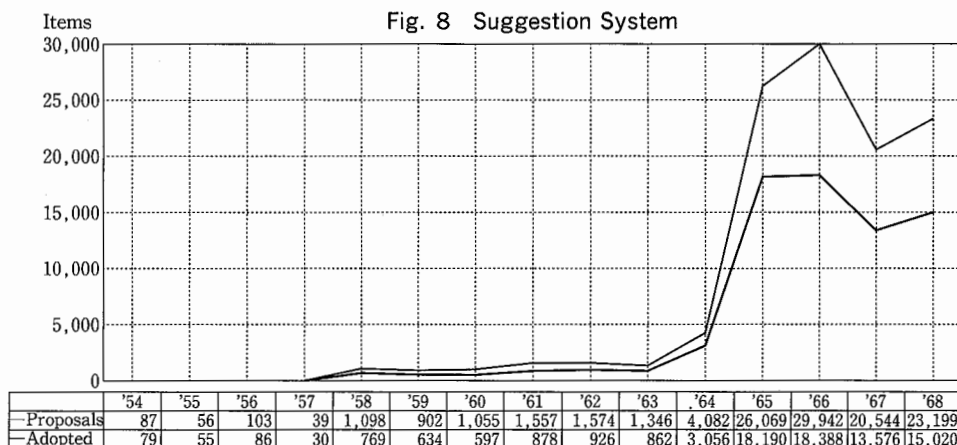
45. After finishing primary school Mr. TANAKA Kenichiro entered the state-operated Yawata Works in 1916. He was given two years education and training at the in-firm training school (*Shyokko Yuseijo*).

He was transferred to Muroran Works in January, 1946. He worked in the rolling mill. Over 11 years he invented 2 patents of rolling mill technology and was commended 16 times by the company. Japanese workmen with craftsmanship like this foreman practiced improvements (*Kaizen*) of their immediate job. These improvements (*Kaizen*) enabled them to develop new devices and inventions.

This approach is learning through practice itself. It is not based on an analytical way of thinking but on pattern recognition.

Shirakaba. No. 328. (March 1, 1957).

46. *Shirakaba*. No. 687. (April 5, 1968) and No. 699. (February 20, 1969).



due to the limitations of budget and other managerial resources, it was difficult to put all useful suggestions into practice.⁴⁷ This suggestion system helped to stimulate idea-making, which is the first step to problem solving. This type of problem solving is a necessary condition for job satisfaction. Thus Jishu Kanri activities which intellectually stimulate small groups were necessary to introduce into workshops.

3.5. In Firm Education and Training

(a) MTP for managers

In 1951, a forty hours MTP (Management Training Program) course was created for chief directors, section chiefs and chief clerks. In 7 years, 237 in total persons attended this seminar.⁴⁸

Managers' comments on the MTP seminar include the following.

"The contents of MTP are the same as what we have already experienced in professional life. But until now Japanese have had no ideas and methods on how to teach this wide array of knowledge and techniques. American scholars and practitioners have succeeded in the systematization of practices in the business world. That is the standardization of American style teaching methods. Owing to MTP, we have again realized the meaning of ordinary work. We can now get a wide angle viewpoint. MTP is not a matter to be handled hastily but a very effective method. We will make use of MTP on the job."⁴⁹

47. *Shirakaba*. No. 678. (April 5, 1968).

48. "50 Year History of Muroran Works." p. 736.

49. *Shirakaba*. No. 204. (September 15, 1951).

MTP courses taught the managers new ideas with regard to the process of scientific management and industrial democracy in the company. Managers realized that the steel company should run like a private enterprise free from governmental bureaucracy and regulations.

(b) TWI for foremen

In 1950, a ten hour TWI (Training within Industry) course was created for foremen at the workshop level. In the 7 years since 1950, 4000 persons in total including clerks, engineers, foremen and assistant foremen attended this course.⁵⁰ In the early stages, Japanese management culture was quite different from the American version. Many trainees felt that this American style training program was not applicable to the Japanese workshops. As a result of trial and error, many benefits were discovered.

- (1) The work atmosphere became more open
- (2) Trainees became more aware of their own responsibility as a foreman through teaching young employees how to do their jobs
- (3) Trainees became more aware of safety in the workshop
- (4) Greater emphasis on attentiveness and spirit of inquiry
- (5) Craftsmen's skills were accessible to fellow workers through the training schedules and job analysis charts
- (6) Proper posting could be done
- (7) Each person's skills, practices and personality became clear by planning the training schedule
- (8) An advantage to the trainer was that, they trust that trainees would undoubtedly practice the course contents
- (9) An advantage to participants was that, it was easy to understand the content of the instructions.
- (10) Participants could achieve self-confidence in their own jobs
- (11) The trainer's passion created a serious study environment⁵¹

TWI as a symbol of the new way of thinking and training had a strong impact on the old Japanese style apprenticeship system. Traditionally apprentices were instructed to only follow the bosses' way without any explanation of the meaning or method of the job. It became clear from official documents that, in accordance with TWI, foremen were responsible for training their subordinates

50. "50 Years History of Muroran Works." p. 736.

Shirakaba. No. 213. (February 15, 1952).

In 1952, in the first stage TWI was planned for 1741 employees. (273 clerks, 422 engineers, 1046 foremen, assistant foremen and general workers).

51. *Shirakaba*. No. 207. (November 11, 1956).

and improving the methods and tools of work.

TWI contains three components JI (Job Instruction), JR (Job Relations), JM (Job Methods). The function of JI was to prepare "the work standard" and "work instruction sheet" in the workshop. JM contributed to the promotion the suggestion system (Kaizen Teian). JR helped to cultivate team work in the workshop.⁵²

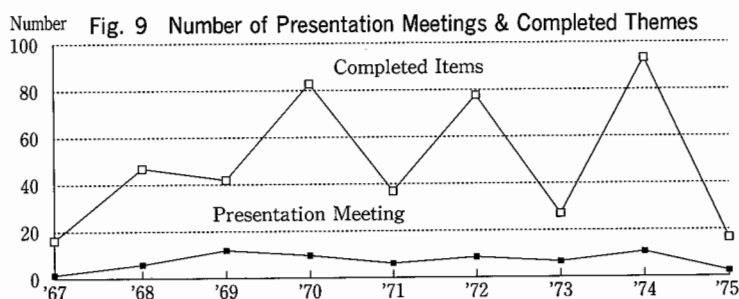
In modern Japanese industrial history, both TWI and MTP played major roles in changing the old apprenticeship style. Education and training programs were developed for all employees. Different curriculum were designed by level of management and function (Shokuno Kaiso Betsu Kyoiku Kunren).⁵³

3.6. Beginning of Jishu Kanri Activities at Muroran Works

In November 1966, foremen were sent as observers to participate in the No. 25 Quality Circle national general assembly at Hamamatsu in Shizuoka prefecture.⁵⁴

The foremen were shocked by the reports of Q. C. Circle activities in Matsushita Electric Industrial Co., and Bridgestone Tire Co.,. In particular, female workers at Matsushita reported that the number of production workers were reduced from 5 persons to 3 persons by the improvement of methods and techniques in the production process. At the same time, the labor load was reduced. Young women's ideas and problem solving practices drastically improved the productivity. They had already acquired the managerial skills and an engineer's way of thinking.

After returning to the works, the foremen of the cold strip mill started to



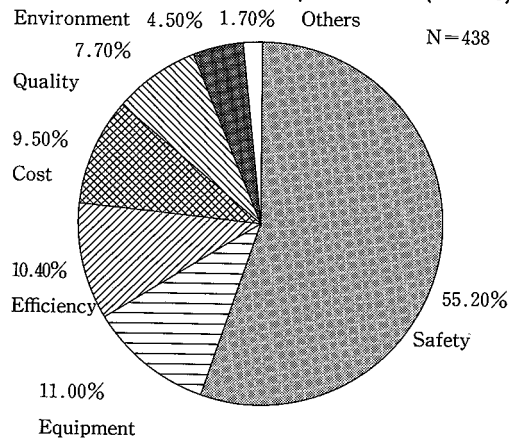
52. "Honoo to tomoni-History of Fuji Steel Co.," (in Japanese) pp. 733-734.

53. ditto, pp. 733-734.

54. Muroran Works Cold Strip Mill. (1982). "The Track of 10 Years." (booklet in Japanese) pp. 35-37. Muroran Works.

QC Circle Headquarters, JUSE.(1987). "25 Year History of QC Circle Activities." (in Japanese) p. 15. Japan Union of Scientists and Engineers.

Fig. 10 The Classification of Completed Themes ('67-'75)



study statistical quality control methods using newly purchased textbooks. Assistant foremen also participated in this study group. After 3 months' study, in February 1967, Takata circle was launched as the first quality control circle at the cold strip mill.⁵⁵

In August 1967, all 120 men in the cold strip mill were organized into 18 circles. At this time, informal study groups for quality control were within the mill. In January 1968, the committee for quality control circle was formally organized within the works. In June 1969, eight members participated in the company general assembly for cold strip mills. The number of presentation meetings and completed items from 1967 to 1975 are shown in Fig. 9. The classification of the completed themes (N=438) is shown in Fig. 10.

The quality circle (QC) groups in the cold strip mill cultivated a new form of management culture based upon scientific thinking.

In October 1970, quality control circle activities in the Japanese steel industry were uniformly called "Jishu-Kanri Activities".

55. "The Track of 10 Years." p. 35.

"Yu Hi-20 Year Memorial Booklet of JK Activities." (1986) p. 8. Muroran Works.

Record of interview with Mr. KUWABARA Shigeru. (July, 1994 at Muroran Works).

In the first stage the course for group leaders was prepared by Mr. KUWABARA. Mr. TAKATA was the leader of the circle. In August 1967, all employees in the cold strip mill participated in QC Circle activities.

As a result, the changing time of the rolling machine was reduced to one third of the traditional level.

Shirakaba. No. 688. (September 5, 1968).

3.7. Development of Jishu Kanri Activities

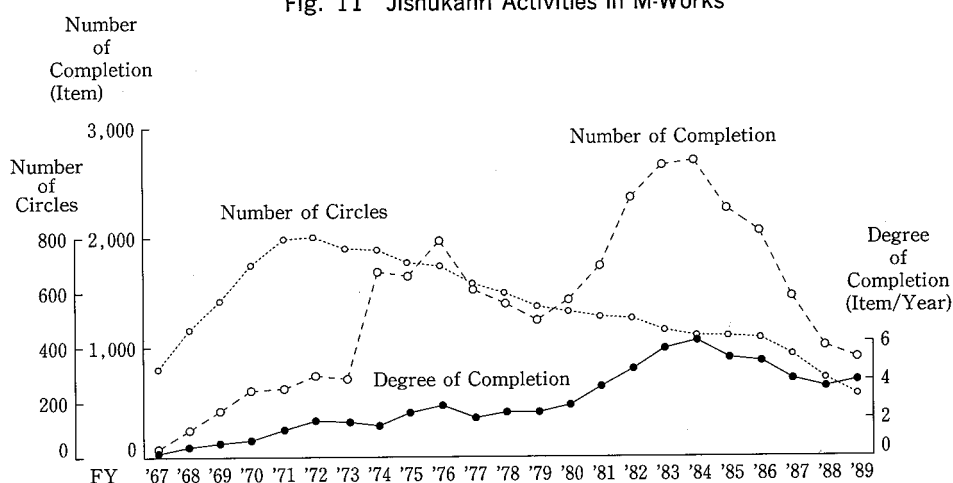
At first, these small group activities were called "QC Circle Activities." In October 1970, the name was changed to "Jishu Kanri Activities". Total picture of JK activities from 1967 to 1989 is shown in Fig. 11.

In 1967, the number of participants was 2940 and the number of circles 326. In 1972, the number of circles climbed to 821 organized by 5449 participants. JK activity was numerically at its peak. Due to the effects of technological innovation and business rationalization, the number of total employees is sharply decreasing. The number of participants and circles followed the same trend. The number of circles decreased to 430 in 1986 and 220 in 1989. The number was 122 in 1993. The number of participants decreased to 2873 in 1986.⁵⁶

The JK activities' history of more than 20 years has two main peaks. The first peak, number of completions occurred just after the first oil crisis in 1973. Aiming to save energy, every employee tried to find new solutions to the severe conditions of high priced energy. JK Activity circles made countless breakthroughs leading to many improvements and inventions of energy saving technology.

Employees' consciousness (May, 1975) of originality and improvement is shown in Fig. 12.⁵⁷ In Question (1), 91.2% of employees presented plans for improvement. Jishu Kanri Activities were firmly established at the works in the 1970's.

Fig. 11 Jishukanri Activities in M-Works



56. Muroran Works. (1987). "Yu Hi-20 Year Memorial Booklet of JK Activities." p. 5.

57. *Shirakaba*. No. 848. (May 5, 1975).

Fig. 12 Consciousness of Originality and Improvement (1975. May)
(Random Sample of 200 General Workers, Effective Answer 147)

Q1. Have you ever presented an idea or a plan for improvement ?		
Answer	(1) Many times	37.2%
	(2) Several times	54.0%
	(3) Few	8.8%

Q2. Now do you have any new ideas or plans for improvement ?		
Answer	(1) Many	13.9%
	(2) A few	73.0%
	(3) None	13.1%

Q3. Do you think there is any room for developing new ideas ?		
Answer	(1) a great deal of room	40.1%
	(2) some room	57 %
	(3) very little room	2.9%

Q4. Do you make improvements for the betterment of your job and to make the environment better ?		
Answer	(1) Always	48.2%
	(2) Sometimes	39.4%
	(3) Seldom	12.4%

Q5. Do you offer any ideas or opinion for solving problems in your job ?		
Answer	(1) Very often	12.4%
	(2) Fairly often	65.0%
	(3) Can't say yes or no	16.8%
	(4) Seldom	5.8%

[Source] *Shirakaba* No. 848. May 5, 1975.

Therefore many ideas for improvements are created at the scene of JK activities. In Question (2), 86.9% of employees had some kind of ideas. But what is important is how to put these ideas into practice.

As to Question (3), 97.1% of employees found room to develop new ideas in the production field. Generally speaking, mechanization and systematization seem to decrease the room for improvement. But from the subjective perspective of workmen, there were no misgivings about this.

As to Question (4) and Question (5), there was no one who did not offer ideas and make improvements for their own immediate jobs.

An original survey was conducted by the author in June 1979.⁵⁸ According to this survey, employees' attitudes toward JK Activities were positive. 24.1% of them evaluated it as a challenging job. 59.5% of them evaluated it as "somewhat of a burden but unavoidable". Only 15.2% of them felt it was a "mental burden" in a negative sense.

The second peak in 1983 and 1984 appeared just before the rapid Yen appreciation and the recession which followed. At this time, the number of completions reached an all time high. There were 2686 items in 1983 and 2726 items in 1984. With a huge stock of know-how and professional energy from the day of introduction of TWI, MTP, the modern foreman system, quality control and other all problem solving methods, all workmen tackled these difficulties.

After the G5 conference in the Fall of 1985, the Yen rate to the US Dollar sharply increased from 220 Yen to 120. The high Yen rate killed the Japanese international competitive power in the steel industry. To cope with the recession, the steel companies introduced and implemented rationalization measures on a larger scale than ever by discarding production equipment and trimming the work force.⁵⁹

Muroran works took two strategic approaches to maintain competitiveness. The first one was the improvement of productivity by lowering production cost. The second approach was to develop new technology.

The management presented a medium-range plan of business restructuring to the employees' union. The plan contained the shut down of the iron-making process (blast furnace) and steel making process (LD converter) in 1990. New melting technology was to be introduced. It will substitute for the upstream production process of the blast furnace and LD converter. Due to rationalization measures for productivity improvement 1082 employees lost their jobs as of 1987.⁶⁰

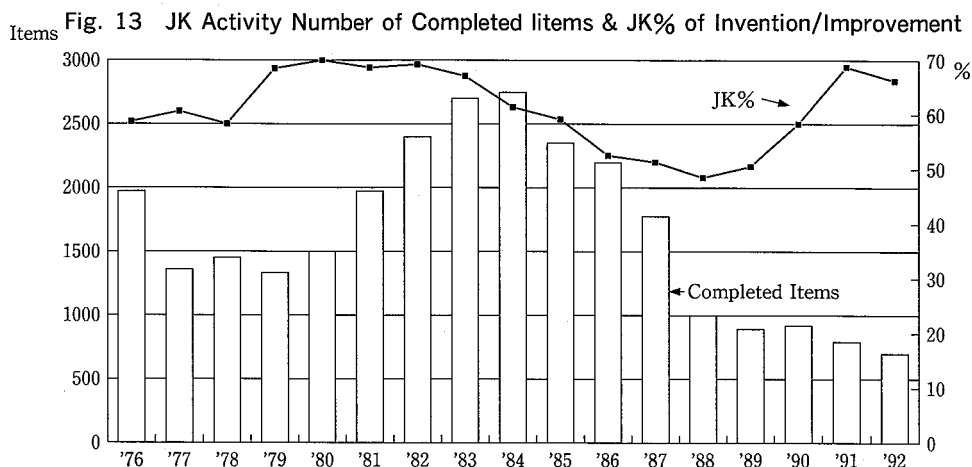
The basic characteristics of JK activities have changed in difficult business circumstances. At first, JK activities focused on the methods of employees' participation in management and improvement of morale. Nowadays, it has two other important functions. The first is the improvement of production process and technology. The second is the succession of skills and know-how from the

58. Random sample survey of 100 employees. The rate of effective answer was 79% ; Foremen (7 persons), Assistant foremen (20 persons), general workers (52 persons).

59. The Japan Iron and Steel Federation. (1989). "The Steel Industry of Japan and the World." p. 7.

60 YONEYAMA Kikuji, Chairman "Report of the Committee on Employment to Hokkaido Productivity Conference " (in Japanese) Sapporo, Hokkaido Productivity Center.

YONEYAMA Kikuji. (1989). "Economic Restructuring and Regional Development in Hokkaido." *Hokudai Economic Papers.* Vol. XVIII, 1988-1989.



old generation to the young generation. A team work problem solving approach was added to on-the-job-training methods.

Following the decrease in the number of employees, numbers of completed items by JK Activities are also decreasing. However, the percentage of JK Activities' results is increasing over than 60% in the invention and improvement items shown in Fig. 13. The quality of JK Activities has reached a 20 year high. Intellectually polished teamwork is indispensable for the improvement and development of plant operation technology.

General employees' team work for problem solving supported by managers and engineers are ranked as JK Activities. Usually engineers target the research and development of sophisticated technology. It is very important for engineers to think and apply in the field itself. In that sense, worker's intellectual results from JK Activities will continue to contribute to the research and development function of the company.

4. Discussion

4.1. Industrialization and Japanese Ethos

The feudal regime of *Shi-Nho-Ko-Sho* (Samurai-Farmer-Craftsman-Merchant) in the Edo period has its roots in the agricultural structure of the nation at that time. Farming class made up the majority of the total population. The economy was based on rice. The finances of the Edo feudal government (*Bakufu*) and local feudal clans (*Han*) were based on crops of rice. Therefore the government encouraged farmers to increase the yield of rice.

In the farm village, farmer put plenty of fertilizer into the land and developed systematic irrigation using continuous bank technology. Man power, horse

power and bull power were the only types of energy for cultivation. Farming using simple farming implements compelled the people to work hard. Families were given a narrow strip of land. Physical labor was needed for small scale rice cultivation and encouraged hard work, groupism (cooperation doing farm work) and a sense of improvement for a good harvest.⁶¹

In the farm villages, there were many private elementary schools, generally run by one teacher (*Terakoya*). Children could learn reading, writing, and arithmetic. This high rate of literacy helped to prepare for technology transfer from Euro-American countries in the later half of the 19th century.

Craftsmen class (*Shokunin*) made daily necessities using traditional tools. They were skilled at working with their hands and had a sense of pride to achieve perfectionism. The merchant class (*Shonin*) had sense of contrivance and economization.

The ruling class (*Samurai*) had the organization to fight to maintain own territory. The fighting organization was functionally designed by division and cooperation of work. In the Edo period there was no war for more than 200 years. The organization to fight was secularized into the bureaucracy of daily administration.

The dream of peace and self-sufficiently economy was attacked by American warships led by Admiral Perry in 1853.

Japan was forced to open its doors to foreign countries. At the end of the Edo period, in 1864, the Edo feudal government established Yokosuka shipyard assisted by the French government.⁶²

Many engineers, foremen and skilled workers were invited to aid the technology transfer. This was the first full scale technology transfer in modern Japanese history. Highly ranked (*Samurai*) of the Edo feudal government became top management and managers. Young able officers (*Samurai*) became the engineers and interpreters, having studied foreign languages at the Research Institute of Foreign Literature (*Bansho Torisirabesho*).

Technical schools were set up for the engineers in firm. This was the origin of Tokyo University. On the other hand, general workers needed to do manual labor were recruited from the lower classes (farmer, craftsman and merchant). Learning by doing and on the job training were the only types of training for general workers. Workers imitated the French skilled workers and foremen. The acquired knowledge and information were quickly shared among the Japanese workers. Technology transplant and diffusion inside the firm were

61. TAMAKI Akira. (1982). "Japanese Social System." (in Japanese) Nisan Gyoson Bunka Kyokai.

62. Yokosuka Navy Shipyard. (1915). "History of Yokosuka Navy Shipyard." (in Japanese) p. 7.

effectively put into practice. The succession system of technology using on the job training in firm was invented within the company.⁶³

The length of service became the index of an employee's skill level. The length of service based on the technology transfer is the foundation of the Nenko seniority system in a technological meaning.⁶⁴

On the job training and information sharing became essential elements of the Japanese management system.⁶⁵

The Edo feudal status system maintained a pyramid structure of administration in the business organization.

An education course was designed for selected young men (*Samurai*) teaching science, technology and foreign languages. Another course was designed for general people teaching reading, writing, arithmetic and skill formation needed for infirm on the job training.

This double-tracked type of national education system with strata was established in the field of technology transfer.

The Meiji central government set up the following two national targets for restoration,

- (1) to become a rich nation with a strong army,
- (2) promotion of industry.

The national education system was founded by central government to promote Westernization and technology transfer. The modern school system educated and classified all Japanese. Managers, engineers, clerks, were classified not by feudal status but their school career. Graduates from University could get jobs as managers and engineers (*Shokuin*). Primary school graduates could

63. YONEYAMA Kikuji (1990). "Development and Transfer of Appropriate Technology-Foundation of Malaysian Steel Industry." (in Japanese) p. 401. Bunshindo.

64. YONEYAMA Kikuji. (1978). "Innovation and Shop Management." (in Japanese) pp.97-99. Bokutakusha.

65. In Kamaishi Works "Koyu." (Magazine style newsletter of the company) was published in 1910, the first case in Japanese industrial history. Items of news covered not only company business activities but also sports, literature, hobbies and all other employee activities. The publisher was the employees' association (*Shindo Kai*). This association was the parent organization of the industrial patriot association for nation (*Sangyo Hokoku Kai*) during World War II and the enterprise based union after World War II.

Kamaishi Works established a primary school (*Kamaishi Kozan Shogakko*) for the employees' children in 1900.

Kamaishi Kozan Shogakko Sinnen Kai. (1981). "Ayumi-60 Year History of Kamaishi Kozan Shogakko" (in Japanese).

Technical School. (*Seinen Kunrenjo*) was founded in 1927.

Kamaishi Works. (1975). "46 Year History" (in Japanese).

Kamaishi Works. (1985). "100 Year History of Kamaishi Works." (in Japanese) p. 843.

At Yawata works Technical Training School (*Shokko Yoseijo*) opened in 1903.

get jobs as general workers (*Koin*). The merit system was introduced among employees with same school careers. Only a small number of people graduated from University and thus had a great advantages over most people. They benefited from different rules for promotion in the organization.

The *Nenko*-seniority system was organized as a modern status system based on school career and length of service. The merit system was used among employees of the same rank with similar school backgrounds (*Shokuin* or *Koin*). Loyalty to the company and one's superior was an absolutely necessary condition for employee to get and maintain membership in the workgroup.⁶⁶

The Japanese Imperial military system had a strong influence on the Japanese mentality, and behavioral patterns. Obedience and group behavior were strengthened by military service. The pre second world war Japanese ethos for work was based on traditional Japanese style rationalism.

After the second world war, the Japanese central government carried out four big social reforms under the influence of GHQ. They were (1) Breaking up the *Zaibatsu* (reform of modern sector) (2) Agrarian reform (reform of traditional sector) (3) Recognition of labor unions (industrial democracy) (4) Reform of school system from complex system to single system.

"Catching up to the advanced countries" was set as the new national target.

Under these reforms, Japanese were given a chance to develop their own creativity at different stages of life and in different social situations. At this time, Honda and Sony were established by entrepreneurs.

To overcome the gap and delay of technology between Japan and advanced countries, all of the necessary technologies were imported. Technology transfer and diffusion were actively carried out within the industry and inside each company.

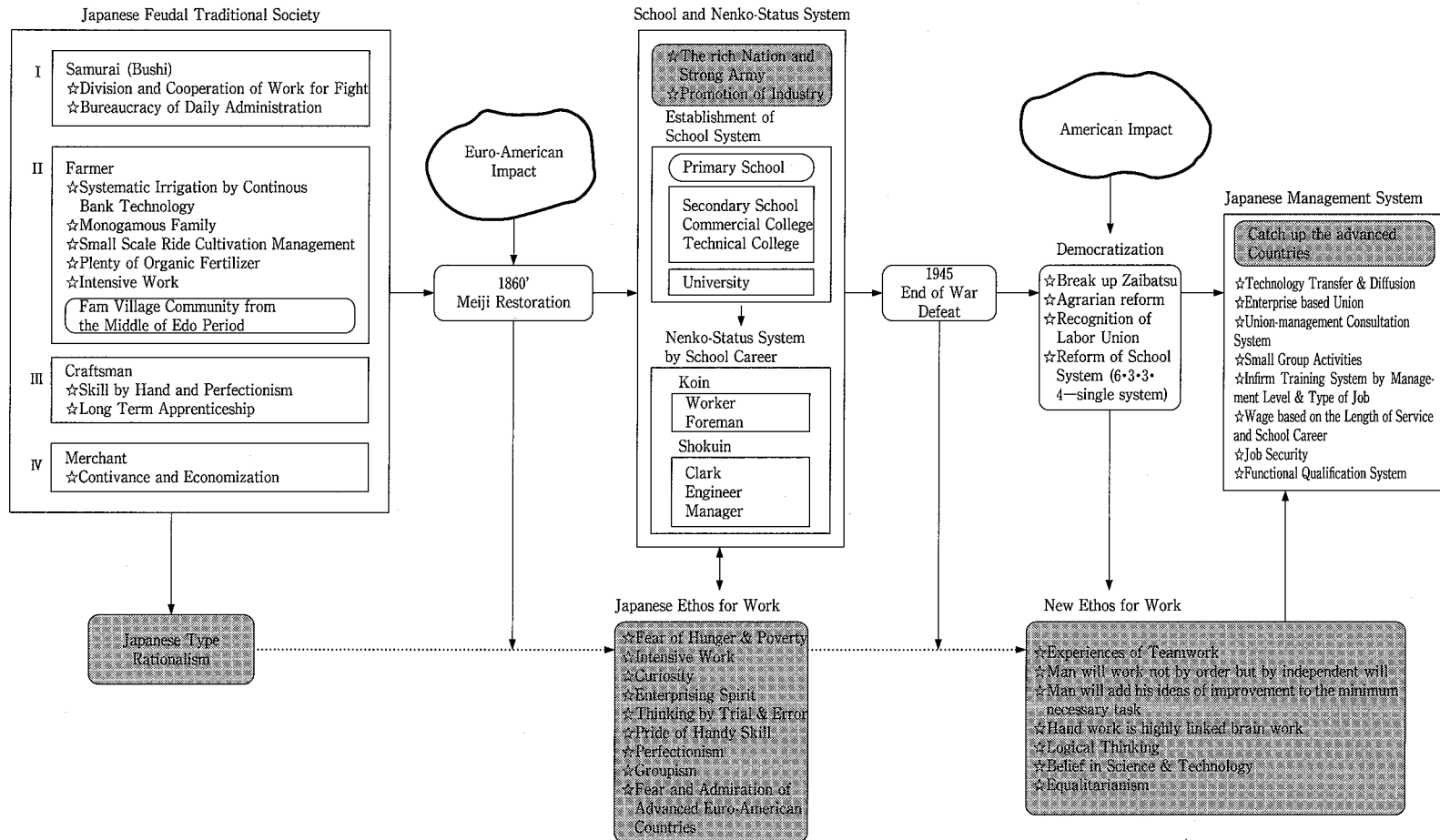
During the decades of rapid economic growth beginning in the 60's, the Japanese management system (enterprise based union, life time employment and *Nenko*-seniority system) worked effectively.

The enterprise based union developed into union-management consultation system within the company. The union and company found common goals to expand global business. Employees could thus enjoy job security, better wages, infirm training and promotion. With these good employment conditions, employees could concentrate on small group activities in the workshop without worrying about their own economic concerns.

The Japanese work ethic, a traditional strength was refined in these new social situations. Play and work experiences in childhood encouraged a sense of

66. FUJITA Wakao. (1961). "Theory of Japanese Labor Agreement." (in Japanese) pp.10-11. Tokyo University Press.

Fig. 14 Industrialization and the Japanese Ethos



work and improvement. This work ethic was based on a sense that (1) men will work not by order but by independent will (2) men will add their ideas for improvement to the minimum necessary task (3) team work is essential for all kind of work. Democratization of all social sectors allowed Japanese to more freely participate in newly opened social areas. The new constitution supported a sense of equalitarianism. The new education system in high school, especially natural science and English education stimulated the younger generation's logical way of thinking. As a result of these social dynamics, the mental and intellectual foundation for quality circle activities (Jishu Kanri Activities) was laid. In Jishu Kanri Activities, manual labor using one's hands is highly linked with scientific brain work. (shown in Fig. 14)

4. 2. The Global Environment Age and Jishu Kanri Activities

The Japanese steel industry as a basic industry has contributed much to the reconstruction of damaged national economy and helped to lead the rapid economic development. Following governmental industrial policy, the steel company's top management made the most of limited managerial resources in (capital, equipment, technology, natural resources, energy, and human power) difficult business circumstances.

Favorable trends in the growing world economy allowed the Japanese steel industry to grow quickly. From an analytical standpoint, the following factors helped to play a synergistic role:

- (1) As a well-known company in a leading industry, the steel company could recruit the best young men with high abilities among their generation.
- (2) In firm technical school (*Jugyoin Kyoshusho*) could recruit top students due to the pressure of job shortage.
- (3) An employees' newsletter (*Shanai Ho*) began publishing before the war. This newsletter clearly stated the management target and other necessary information to all employees. The minimal information gap between management and employees led to effective consensus required to introduce new technology and production facilities. Information sharing was the basis for innovation.
- (4) Education and training programs for employees were well developed and put into practice. The programs were designed according to management level and type of job. TWI and MTP methods were used as models for modern education and training methods. All in firm education and training programs were designed in this manner.
- (5) The newly introduced foreman system (*Sagyochō Seido*) modernized the organization of plant management. The foreman's span of control was en-

larged and the section manager's authority was delegated to the foreman. An intensive education and training program was developed to increase the foreman's knowledge, technological abilities and leadership.

- (6) The suggestion system (scheme) was started in the 1940's. This system stimulated Japanese rationalism and encouraged employees to make improvements (Kaizen).
- (7) The engineers from the production management department contributed to teach and train the workers at the plant. An intensive training course of industrial engineering (IE) was prepared for the workers. IE & QC as well as other problem solving methods accumulated in company were opened to all employees. These soft technologies were transferred from the administrative office to the production field. Thus managers and engineers did not monopolize the managerial and technological information and knowledge. There was no obstacle between the management & engineering side and the general workers' side about information sharing.
- (8) Innovation of production technology was promoted with good timing. Typically, the cold strip mill, bar mill, LD-converter, continuous casting and large scale blast furnace were introduced one right after another at the works. Planning, engineering, construction and start-up of new large scale integrated steel works (Nagoya, Kimitsu, Oita etc.) offered challenging tasks for all employees. These were the best chances to develop their own technological ability and creativity
- (9) Steel making facilities such as a blast furnace, LD-converter and continuous casting machine were operated by workers' group. Characteristics of the technical system in the steel plant were based on team work.
- (10) The employees' union agreed with the introduction of new production facilities. The company could offer job security to its employees owing to economic growth and expanding business.
Thus employees could concentrate on their own immediate job. They were free from political discussions led by ideological political parties outside the company.
The employees' union accepted Jishu Kanri (JK) activities from the perspective that it improved QWL (quality of work life) and participation in management.
- (11) The steel company prudently encouraged an atmosphere of autonomous small group activities by re-systematizing the above mentioned managerial practices. Able employees were given free space to develop their own ideas and creativity. The small group was independent from the formal management organization. Small groups could develop problem solving activities beyond the horizontal and vertical boundaries of the organization. The com-

pany set up a new supporting system to promote JK activities. The JK groups were also given the opportunity to present outside the company.

Technology transfer from advanced countries along with independent R & D and JK activities have led the Japanese steel industry to become a world leader in this industry in the 1980's.

4.3. Conclusion

In the 1990's, faced with the maturity of the domestic market and a high Yen rate, the business conditions have changed fundamentally. Key elements for production system in 21st century are as follows: (1) Maintaining the environment (2) saving resources (3) saving energy (4) saving capital (5) saving manpower (6) developing creativity in all participants. (7) contributing to both local and global societies.⁶⁷

The Japanese steel industry has to change its business strategy to redesign the existing large scale production system to adjust to these conditions and the new domestic and international market situations. It is obvious that small scale production systems (mini-mill) are necessary for the recycling of resources and energy to maintain the local environment. In the coming century, two different types of production systems will coexist. They are large scale integrated steel works using virgin ore and mini-mills using recycled resources (scrap).

Under this market situation and environmental conditions, the nature of JK activities has changed from the improvement of QWL and participation in management. It now focuses on R & D and on the job training through the succession of skills and know-how.⁶⁸

R & D function linked with JK activities is a new systematic approach to make a breakthrough. JK activities gather the ideas and know-how in the production field. The plentiful experiences in the field are the origins of new ideas. For 50 years after the war, Japanese steel engineers have had the most abundant technological experiences regarding steel making in the world.

Japanese steel engineers will develop new technologies not only for steel production, but also for maintaining the environment.

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