Competitive Advantage of the Japanese Industry: The Case of Iron and Steel

November 7
Japanese Business and Economy a
Nozomu Kawabata

Topics of this Lecture

- Current market position of the Japanese iron and steel companies in comparison with emerging rivals in East Asian countries
  - East Asia includes Japan, Korea, China, Taiwan Mongolia and ASEAN countries
  - Big integrated steel companies are observed in Japan, South Korea, China and Taiwan
- The importance of production system evolution for the future development of iron and steel industry

Structure of this Lecture

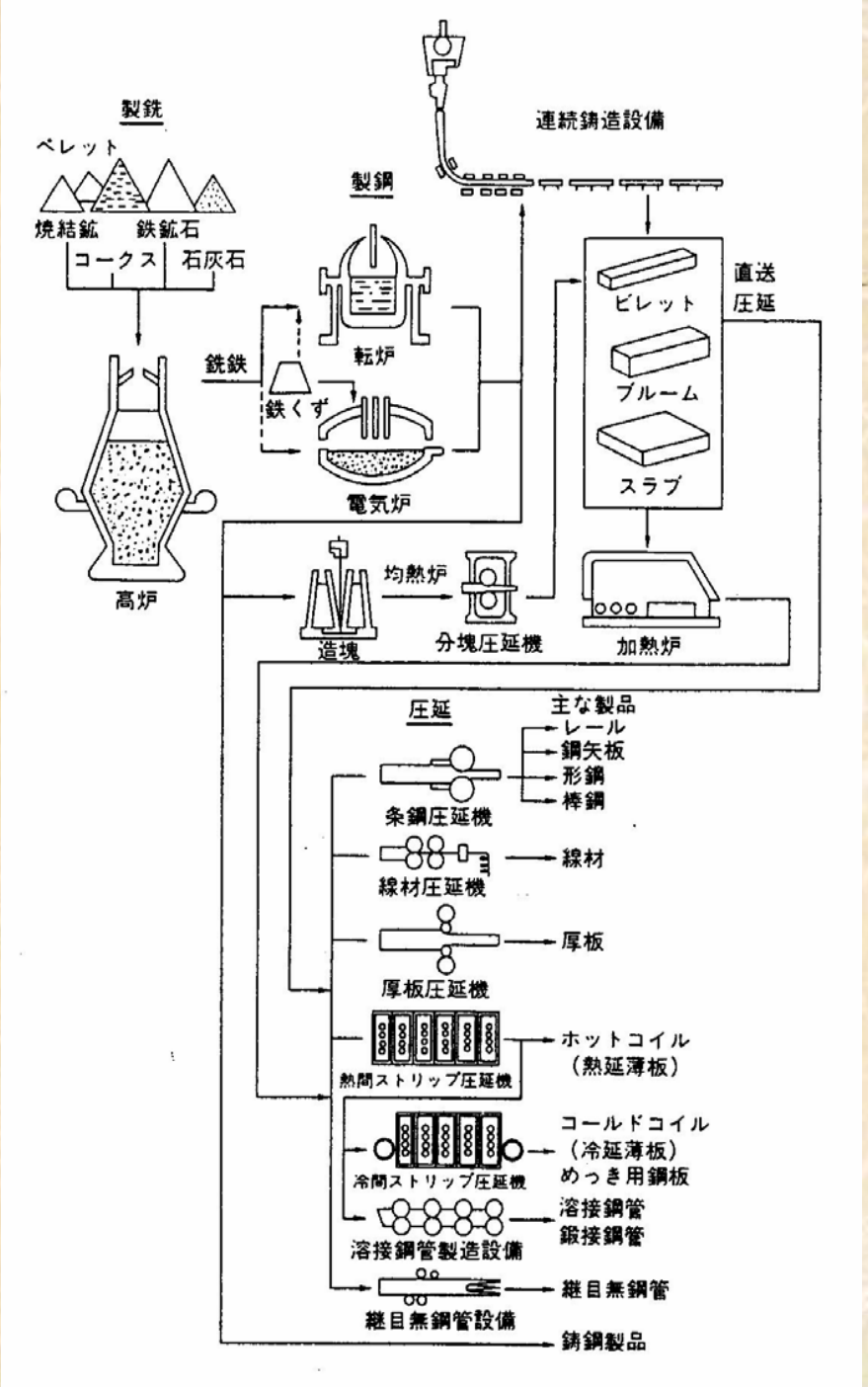
- Production system evolution and corporate growth
- Comparative analysis of production systems of the integrated steel companies in East Asia
- Comparative analysis of investment behavior of the integrated steel companies in East Asia
- Conclusion

1 Production System Evolution and Corporate Growth

What is Production System ?

- Definition of “production system”
  - Patterns of combination of production factors in line with production process under the guidance of production purpose
  - Wide definition that includes production technology and production management

Integrated Production System of Iron and Steel



Source: Kozai Club[1991]。

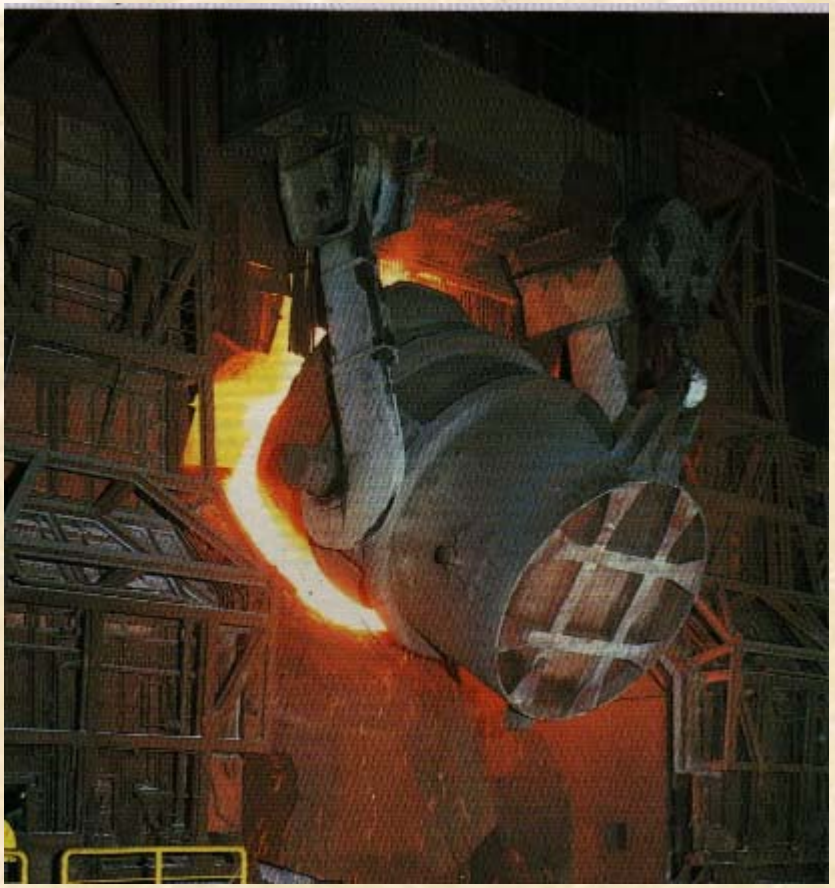
Integrated Production is a Major System in East Asia

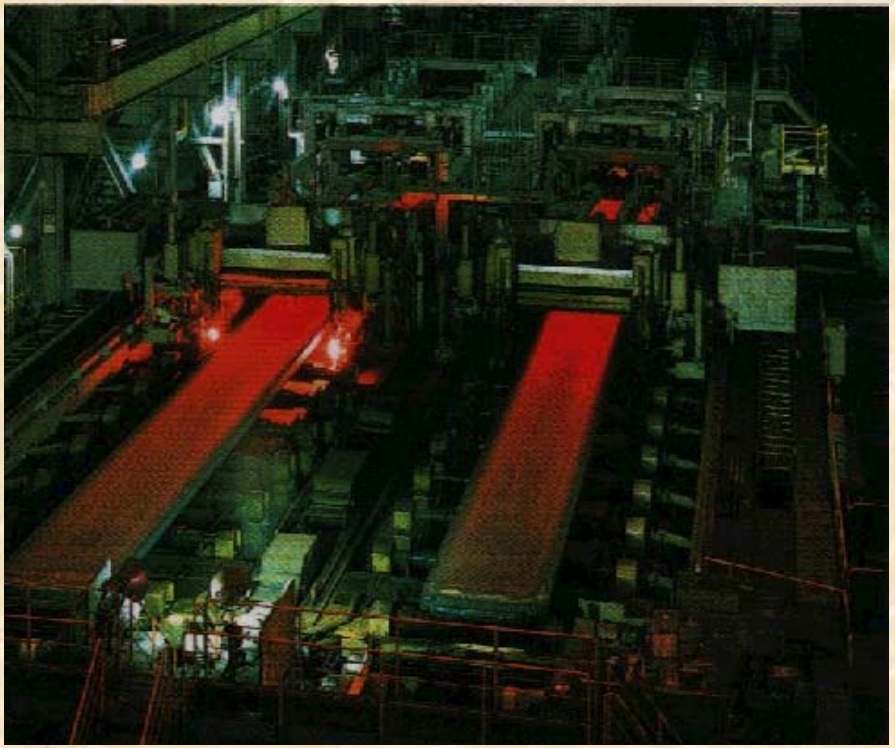
- BOF ratio as a proxy of integrated production is 66.6% in the world and 81.6% in East Asia
- EAF companies are not major players in international competition in East Asia region

Blast Furnace (Iron-making Process)

Four slides from this one shows the factory pictures of Nippon Steel Kimitsu Works.
Nippon Steel Corp. Kimitsu Works[2000].

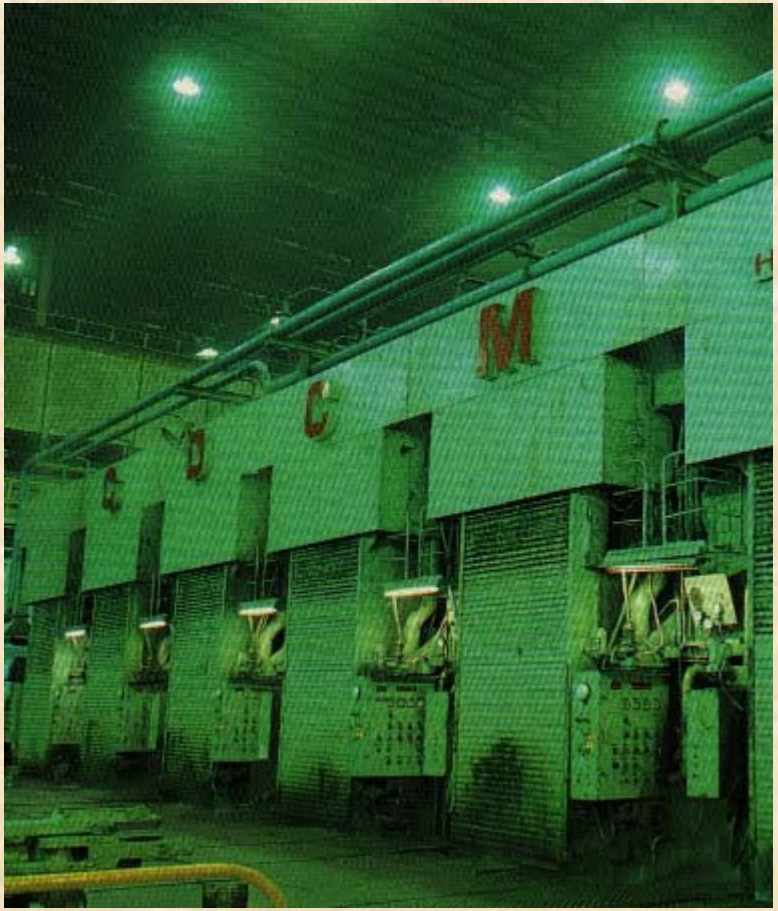
Basic Oxygen Furnace and Continuous Casting Machine (Steel-making Process)





Hot Strip Mill (Rolling Process)

Cold Strip Mill and Continuous Hot-dip Galvanizing Line (Rolling and Surface-treating Process)



Evolution Model of Integrated Iron and Steel Production (1)

- 1st generation (Latter half of 19th century): Restricted Mass Production
  - Factory location : near mine or coalfield
    - *Problem: Exhaustion of resources*
  - Main Products: long products and ingot for forging
    - *Before the emergence of consumer durable*
  - Blast furnace→Bessemer /Open hearth furnace →Ingot casting and slabbing mill →Various kinds of rolling mil
    - *Open hearth furnace needed fuel. Energy efficiency was not good*
    - *Ingot casting and slabbing needed cooling and reheating. Energy efficiency was not good*
    - *Sheet rolling mill was not automated. Mass production was impossible*
- Gradual evolution of Technology and System in Europe, USA, Soviet Union and Japan occurred from 1920s to 1970s.

Evolution Model of Integrated Iron and Steel Production (2)

- 2nd Generation (1970s): Mass production
  - Location: Seaside
  - Main Products: Flat products
  - Blast furnace → Basic oxygen furnace → Continuous casting machine → Hot strip mill as a major machine and other kinds of rolling mill
- Generation 2.5 (1980s): Flexible Mass production
  - Based on hardware of 2nd generation
  - Continuous product development of high grade steel
    - *Galvanized sheet*
    - *High-tensile steel*
    - *Fireproof steel*
  - Multi product, small batch production with the help of computer control
  - Reinforced integrity of process architecture (Fujimoto[2004])

Evolution Model of Integrated Iron and Steel Production (3)

- Requirement for the 3rd generation: Post mass production (Sakamoto[1996])
  - Humanity
    - *Extermination of exhausting, dirty or dangerous work*
  - Flexibility
    - *Multi product, small batch production without waste*
  - Sustainability
    - *Emission reduction of greenhouse effect gases*
      - Steel industry cannot survive without emission reduction of CO2
    - *Solutions for air and water pollution problems*
    - *Use of low grade materials*

Analysis of Production System and Investment

- Indicator of production system achievement
  - Technological progress of integrated iron and steel production
  - Research and development activity
  - Supply to automobile industry of which quality requirement is very strict
- Points of investment analysis
  - Current production system as a result of past investment
  - Effect of corporate form to investment activity
  - Concrete investment behavior in international competition

2 Comparison of Production Systems at Large Integrated Steel Companies in East Asia

2-1 Stats of the Integrated Steel Companies in East Asia

Integrated steel companies with 3 million or more crude steel production in east Asia, 2007）

Countries and companies	Crude steel production (mill. Tons)	Production share in East Asia
Sub total of the Japanese Integrated	95.7	13.7%
Nippon Steel	35.7	5.1%
JFE Steel	34.0	4.9%
Sumitomo Metal Industries	13.8	2.0%
Kobe Steel	8.1	1.2%
Nisshin Steel	4.1	0.6%
POSCO in South Korea	31.1	4.4%
Sub total of Chinese integrated	321.0	45.8%
Bao Steel Group	28.6	4.1%
Other 35 companies	292.5	41.7%
China Steel in Taiwan	10.9	1.6%
Total of East Asian integrated (43 companies)	458.7	65.4%
Total of East Asia	701.0	100.0%
Total of the world	1344.1	—

- 62.9% of crude steel in the world is produced in East Asia in 2007
- Production share of the 43 large integrated companies is 65.4%
  - Effective competition is possible
  - National concentration ratio is high in South Korea and Taiwan, low in China

Note: East Asia includes Japan, South Korea, North Korea, China, Taiwan, Singapore, Indonesia, Malaysia, Thailand, Philippines, Vietnam, Mongolia and Myanmar.
Source: IISI[2008a][2008b], JISF materials.

National Market Size as a Requirement of Existence of Large Producers

Unit: 1000 tons	Apparent consumption of crude steel	Apparent consumption of galvanized sheet	Apparent consumption of cold rolled sheets and strip	Production number of automobiles
China	**384,620**	**14,685**	**28,145**	**7,188,708**
Japan	**83,300**	**9,384**	**6,882**	**11,484,233**
South Korea	**51,600**	**4,209**	**4,342**	**3,840,102**
Taiwan	**23,790**	586	1,111	303,229
Thailand	14,488	1,232	2,277	1,296,060
Malaysia	7,320	756	1,372	523,580
Indonesia	6,631	434	545	296,008
Vietnam	5,627	N.A.	730	31,600
Philippines	3,969	151	489	45,311
Singapore	2,472	−26	128	N.A.

- Large scale domestic market is necessary for the existence of large integrates steel companies
- Demand of high grade steel stimulates the evolution of integrated production system

2-2 Japanese Integrated Companies as a Front-runner of Evolution

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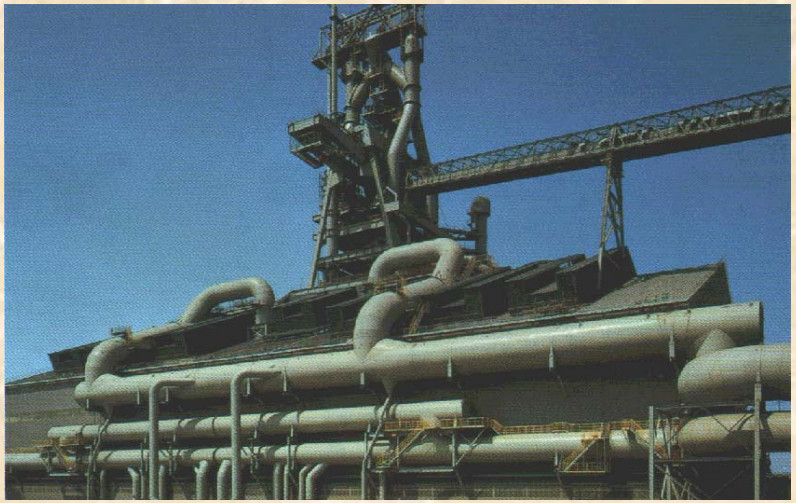


No.4 BF at Nippon Steel Kimitsu Works

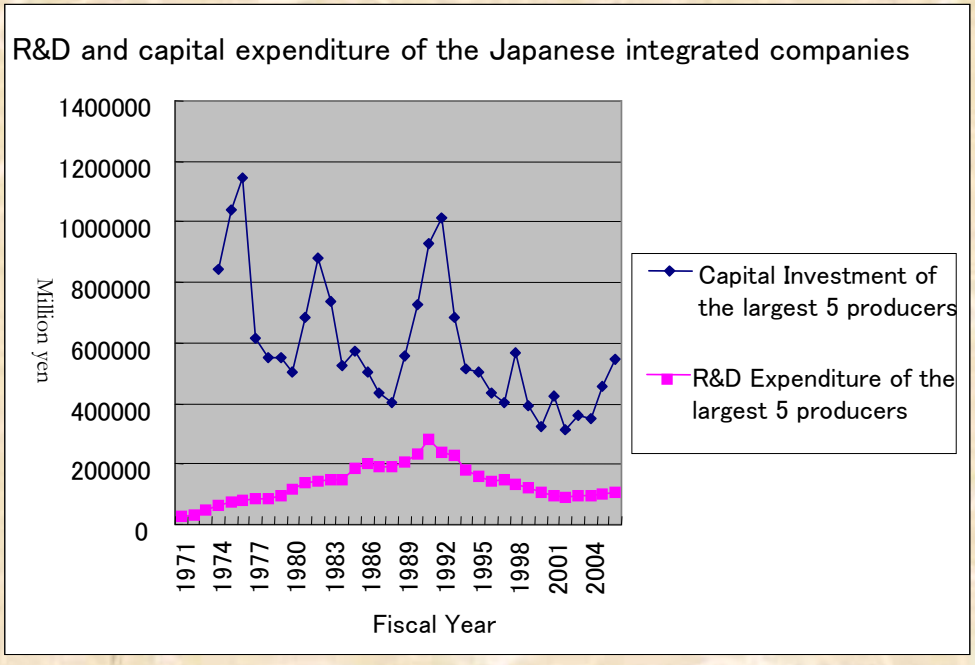
Source: Nippon Steel Kimitsu Works[2000]

Generation 2.5 of the Japanese Integrated Companies

- Flexible mass production was developed in 1980s
  - Joint product development with user industries (Nakaoka and Usuda[2002])
  - Production system development for multi product and small batch(Kawabata[1995][1998])
- Main suppliers for the Japanese automobile industries
  - High-tensile cold rolled sheet, bearing steel and some kinds of surface treated sheet made in Japan are indispensable to the Japanese automobile industry（NEDO-JRCM[1999]）
  - All suppliers of high-tensile steel are the Japanese steel companies (IRC[2004])
- R&D expenditure is high among East Asian companies

Stagnation of Investment in 1990s

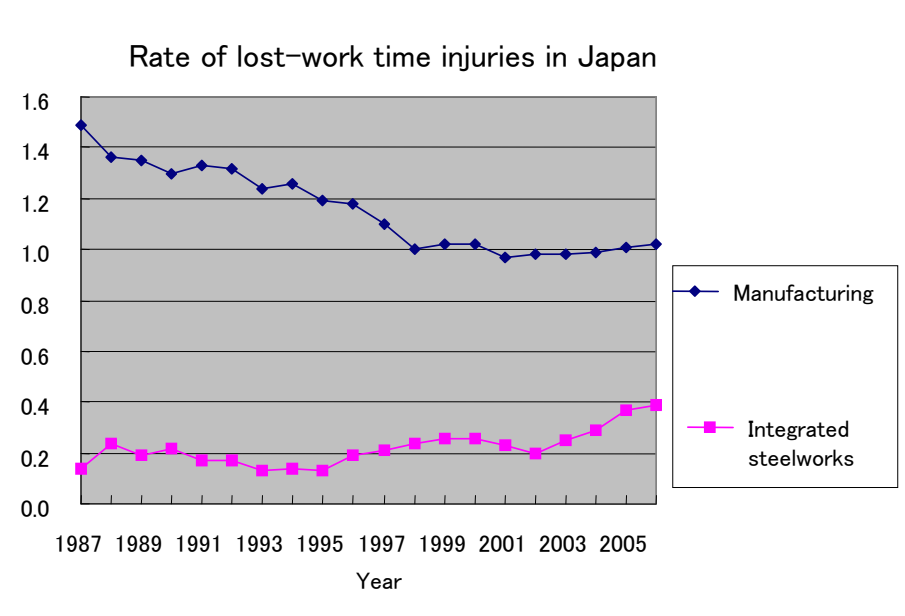
- Aftereffect of the burst of the bubble economy(Kawabata[2006])
  - Aging facilities
  - Stagnation of process innovation. Inclination to minor improvement without changes of main facilities

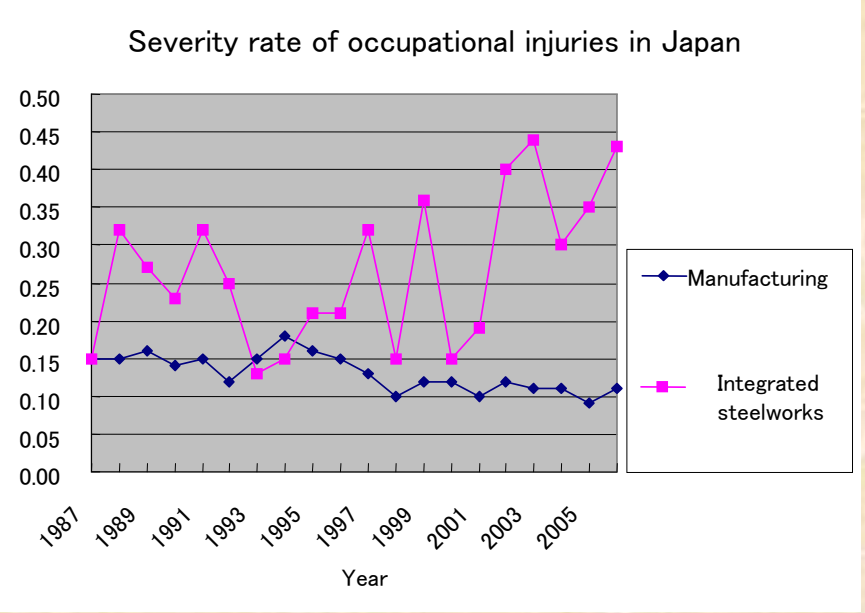


Source: Ministry of General Affairs[various years], JISF[various issues]

Job Retrenchment and Safety Problems

- Cost-cutting by job retrenchment in 1990s
- In 2000s production expansion imposed a heavy burden on workers' shoulder



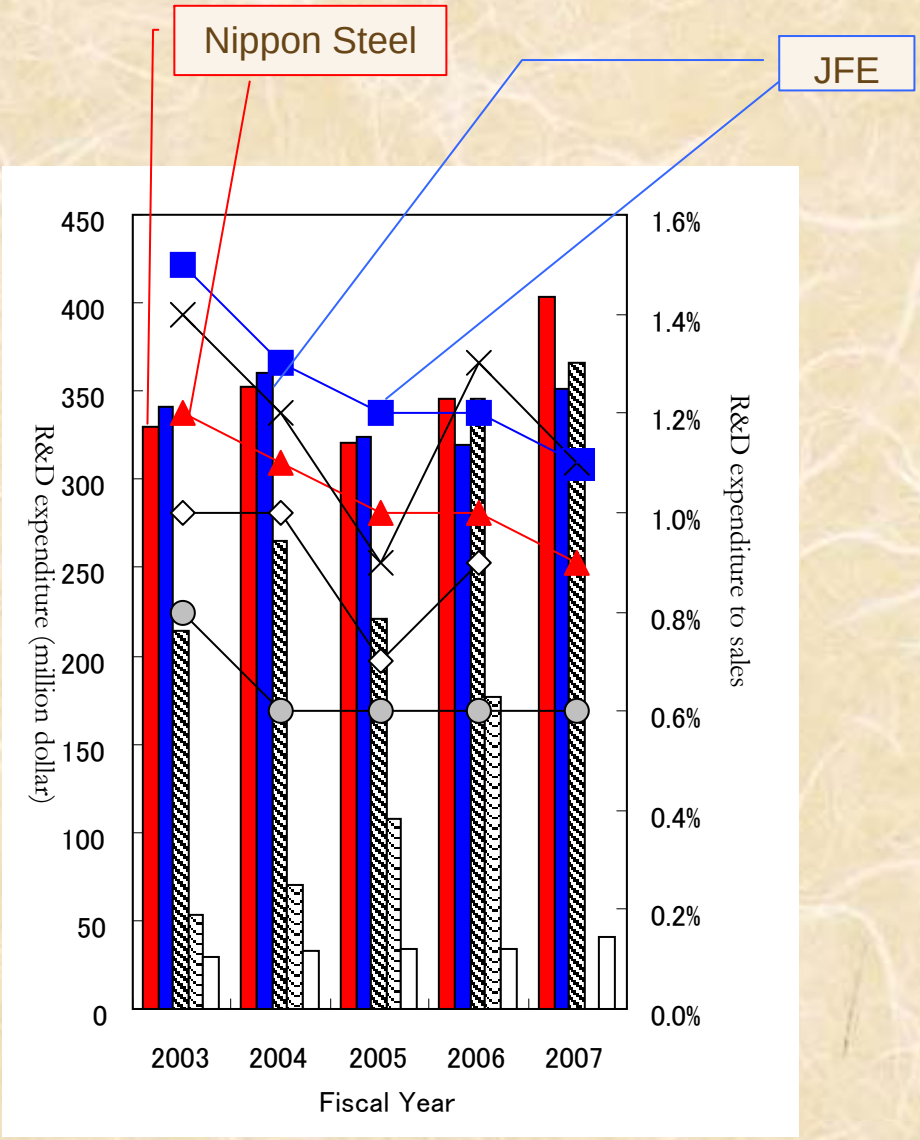


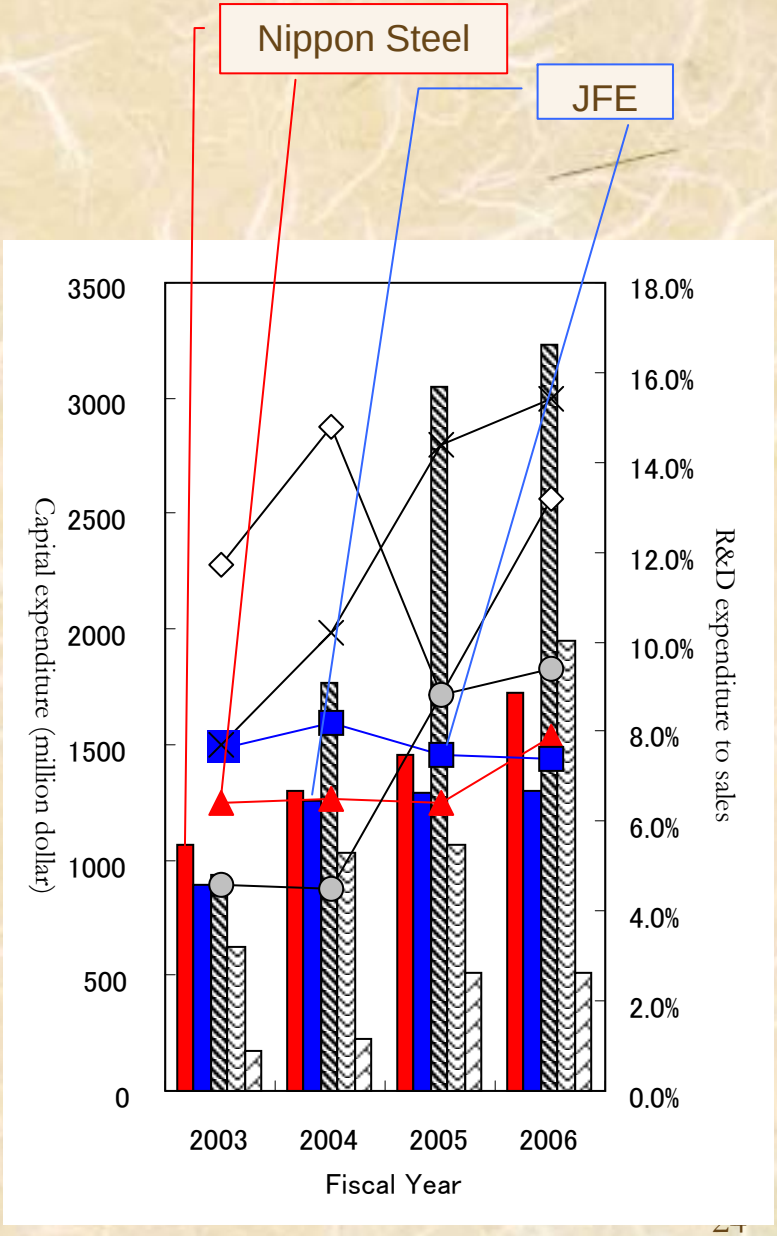
Source: Compiled from Daily Steel Times[1997][2005][2007].

Challenge to Renovation

- Upsurge of capital expenditure since 2003 due to the upturn of performance
  - Capital expenditure of largest 4 companies(JISF[2007 ed])
    - *F.Y. 2002:3.1 billion yen→F.Y. 2006:5.4 billion yen*
  - Investment to relieve bottlenecks on the integrated process
    - *Key processes to make high grade steel (BOF, pickling, cold rolling, galvanizing)*
- Expansion of production scale
  - Target of Nippon Steel Group: 40 million tons
  - Target of JFE Steel (Consolidated): 34 million tons
  - Foreign direct investment and technology licensing
    - *Nippon Steel --- Ujiminas (Brazil)*
    - *Sumitomo Metal --- Vallourec (France)*

Japanese Integrated Companies in International Comparison of R&D and Capital expenditure





Source: Company materials for R&D expenditure. WSD[2008] for capital expenditure.

3-3 POSCO: Search for Technological Independence and High Grade Product Mix

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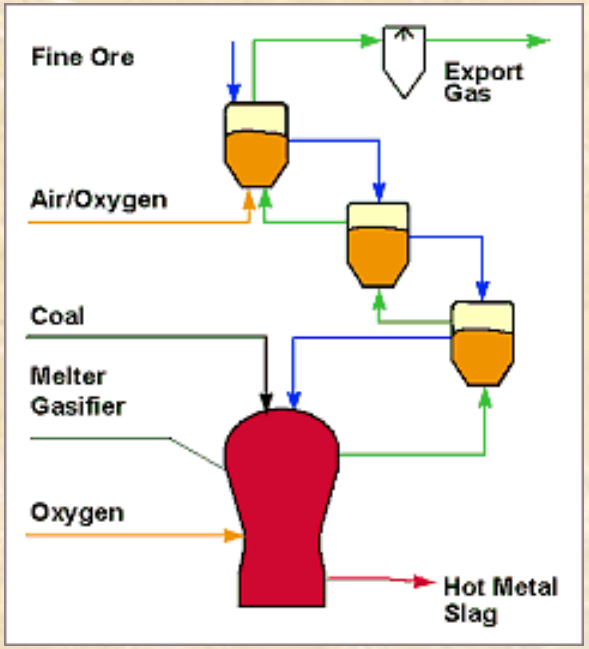
Total of the world	1344.1	—

FINEX: New type smelting furnace at POSCO Pohang works

Source: KROHNE website

Active Investment in R&D and Capital Equipment

- Target: 50 million ton of crude steel production per annum
  - Construction of steelworks in India and Vietnam
- R&D efforts came to fruition in the form of new smelting technology, FINEX
  - Low quality materials are applicable for FINEX
  - SOx, NOx and dust are reduced in comparison with conventional process by blast furnace



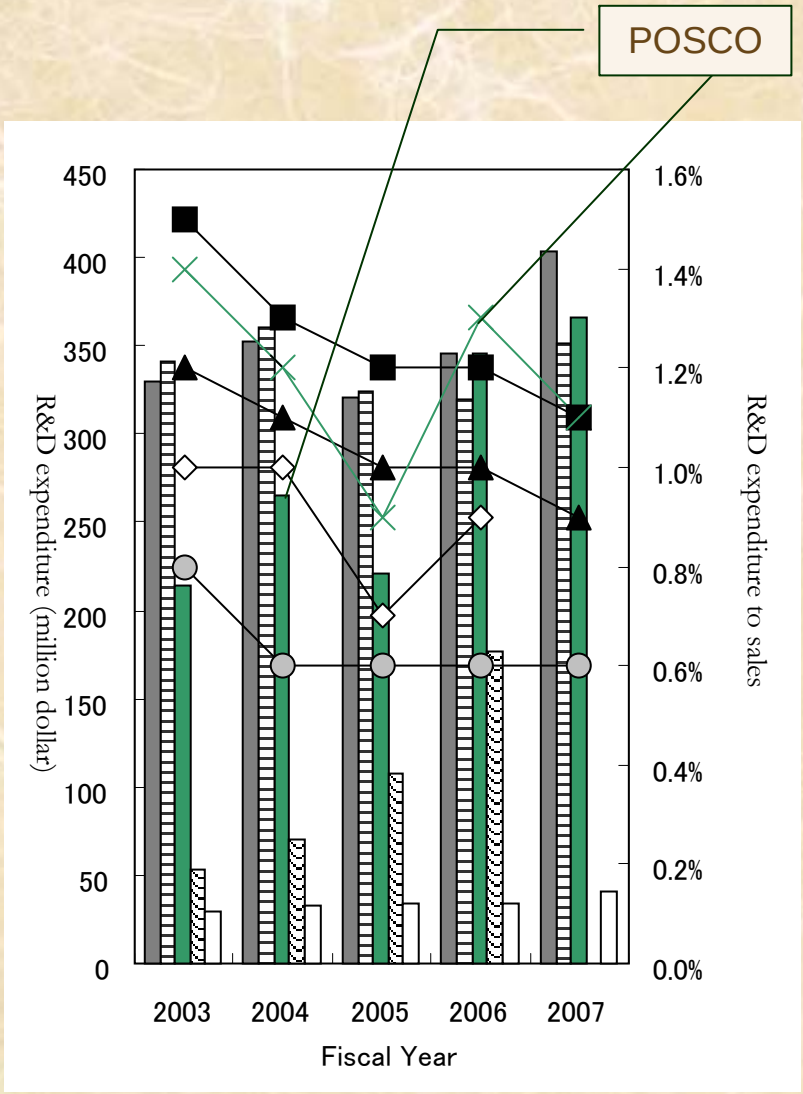
Basic concept of FINEX

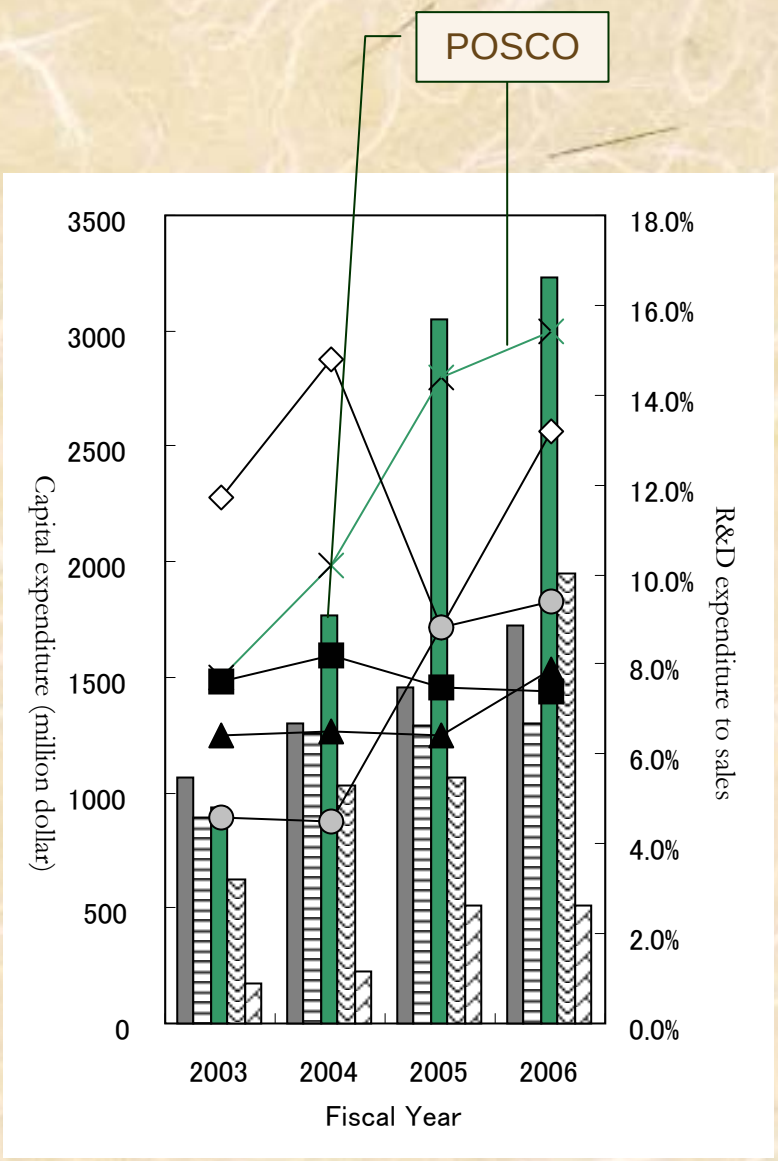
Source: voestalpine website

Production System of Generation 2.5 Lead by High Grade Steel Strategy Similar to the Japanese Rivals

- Production share of 8 strategic products will be lifted from 48% in 2005 to 80% in 2008（POSCO[2005]）
  - POSCO started to supply Galvannealed sheet for body panel to Japanese automobile assemblers in 2005
- Business process innovation with ICT(Otsuka[2004])
  - With the help of company information system (POSPIA), business process standardization
  - Lead time of hot-coil was shortened from 30 days to 14 days
- Just In Time delivery to automobile assemblers based by Six Sigma quality control movement (Otsuka[2004])
  - Information sharing with automobile assemblers: production planning, steel rate for each model, inventory volume at distributors
  - Long-term cooperation with customers

POSCO in International Comparison of R&D and Capital expenditure





Source: Company materials for R&D expenditure. WSD[2008] for capital expenditure.

3-4 Bao Steel :Expanding Production of Auto Steel Sheets

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BF of Bao Steel Co.

Source: Website of Japan Iron and Steel Recycling Institute, Kyushu Branch

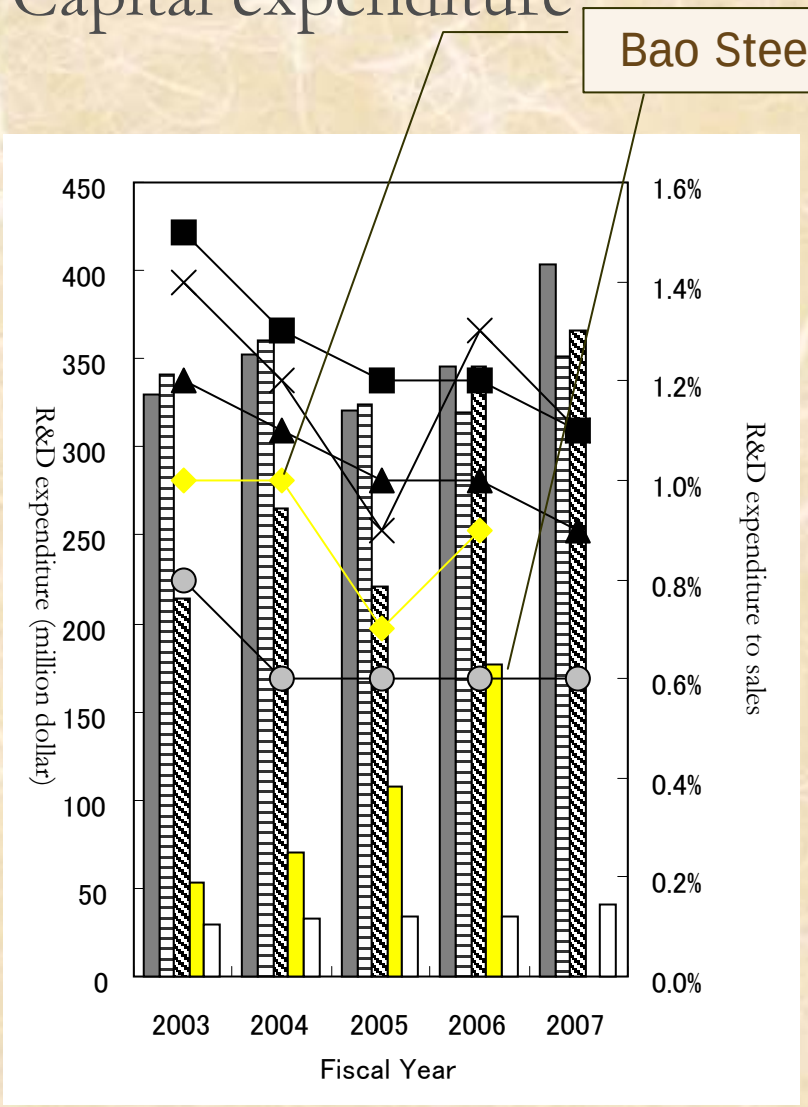
Rapid Growth of Bao Steel

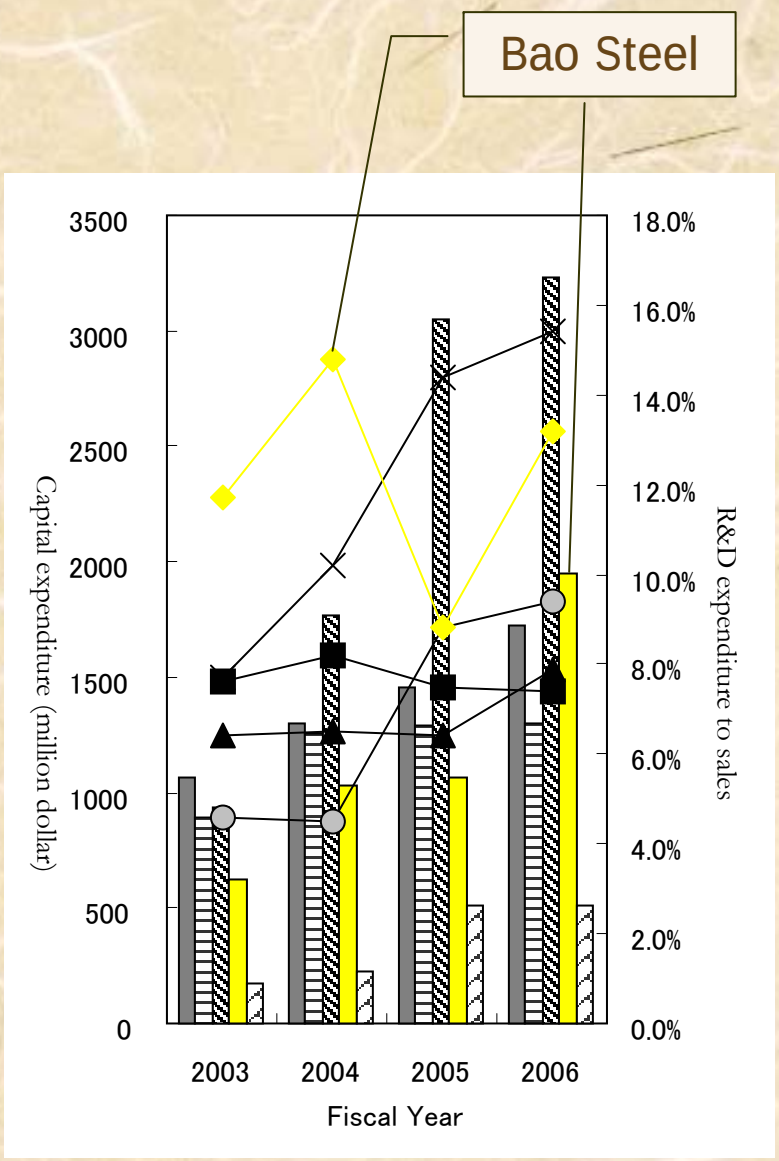
- Bao Steel constructed the 2nd generation production system until 1990s (Nakaya[2007])
  - 1st stage (completed in 1985): Technology transfer from Nippon Steel to its upstream processes, from former West German companies to its piping process
  - 2nd stage (completed in 1991): Established an integrated production system for flat products
  - 3rd stage (completed in 2000): Installed some facilities for high grade steel sheet like electrical sheet and galvanized sheet.
- Target: 80 million tons of crude steel production per annum
  - Construction of two integrated steelworks in China
  - Construction of new integrated steelworks in Brazil by joint venture with Vale, the world largest iron ore supplier

Bao's Rising Position in Auto and Appliance Steel Market

- Bao supplies auto steel for body panel not only to Chinese auto assemblers, but to foreign-affiliated assemblers
  - Shanghai GM, Shanghai VW and other assemblers adopted Bao's steel sheet
  - Bao's Market share of cold rolled sheet for automobiles was 47% in 2004 (Bao Steel[2007])
- Limitation: Bao had some troubles for supplying to Japan-affiliated assemblers
  - Formation of new joint venture with Nippon Steel and Arcelor Mittal: BNA Co.
    - *A joint venture for cold rolling and galvanizing. Target is 50% of market share in auto-steel sheet market in China*
    - *Bao Steel is majority supplier of hot coil to BNA*
- Production system of Bao Steel arrived in generation 2.5. However, R&D capability is not high
  - Bao Steel can make the most use of introduced technology. But capability of system evolution has not been internalized yet

Bao Steel in International Comparison of R&D and Capital expenditure





Source: Company materials for R&D expenditure. WSD[2008] for capital expenditure.

3-5 Large Scale Integrate Companies Except for Bao: Searching for the New Stage

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BF of new steelworks of Maanshan Steel

Source: Author took the photo in March 2007

Evolution to the 2nd Generation and Next Challenge

- Chinese large steel companies improved their production system from the 1st generation to the 2nd generation in 1990s under the reform to the market economy (Ye[2000])
  - Unbalanced capacity in major processes → Balanced system
  - Open Hearth Furnace→Basic Oxygen Furnace
  - Ingot Casting →Continuous casting
  - Upgrade of product mix from long products to flat products
  - Low cost investment. Second-hand mill from Europe and Japan
- Limitation: Technological barrier of entry to auto-steel and appliance-steel market
  - High grade steel production by joint ventures with foreign companies from Germany, South Korea and Japan
  - Construction plan of new integrated steelworks
- For evolution to the next step, technology transfer from foreign companies or Bao Steel is necessary

Development Strategy of Maanshan Steel

- The first state-owned company of initial public offer at security market
- Upgrading of product mix
  - Until 1980s: Bar, wire rod, axle, shape, thick and medium plate. Only axle was high grade product
  - After 1990s: Sheet products (hot coil, cold rolled sheet, galvanized sheet and prepainted galvanized sheet)
  - Ma Steel entered into sheet market with low investment because it introduced Compact Strip Production system for mini-mill. It has technological limitation. CSP cannot produce steel sheet for outer panel of automobile
- Construction of new integrated steelworks
  - New works is specialized to sheet production
  - Full scale strip production system was installed
- One issue
  - State of the art facilities were introduced from : advanced countries
  - How will Ma Steel realize the knowledge and technical know-how to make high grade steel?

CSP factory of Ma Steel. This photo was taken by the author in March 2007.

3 Comparative Analysis of Investment Behavior of the Integrated Steel Companies in East Asia

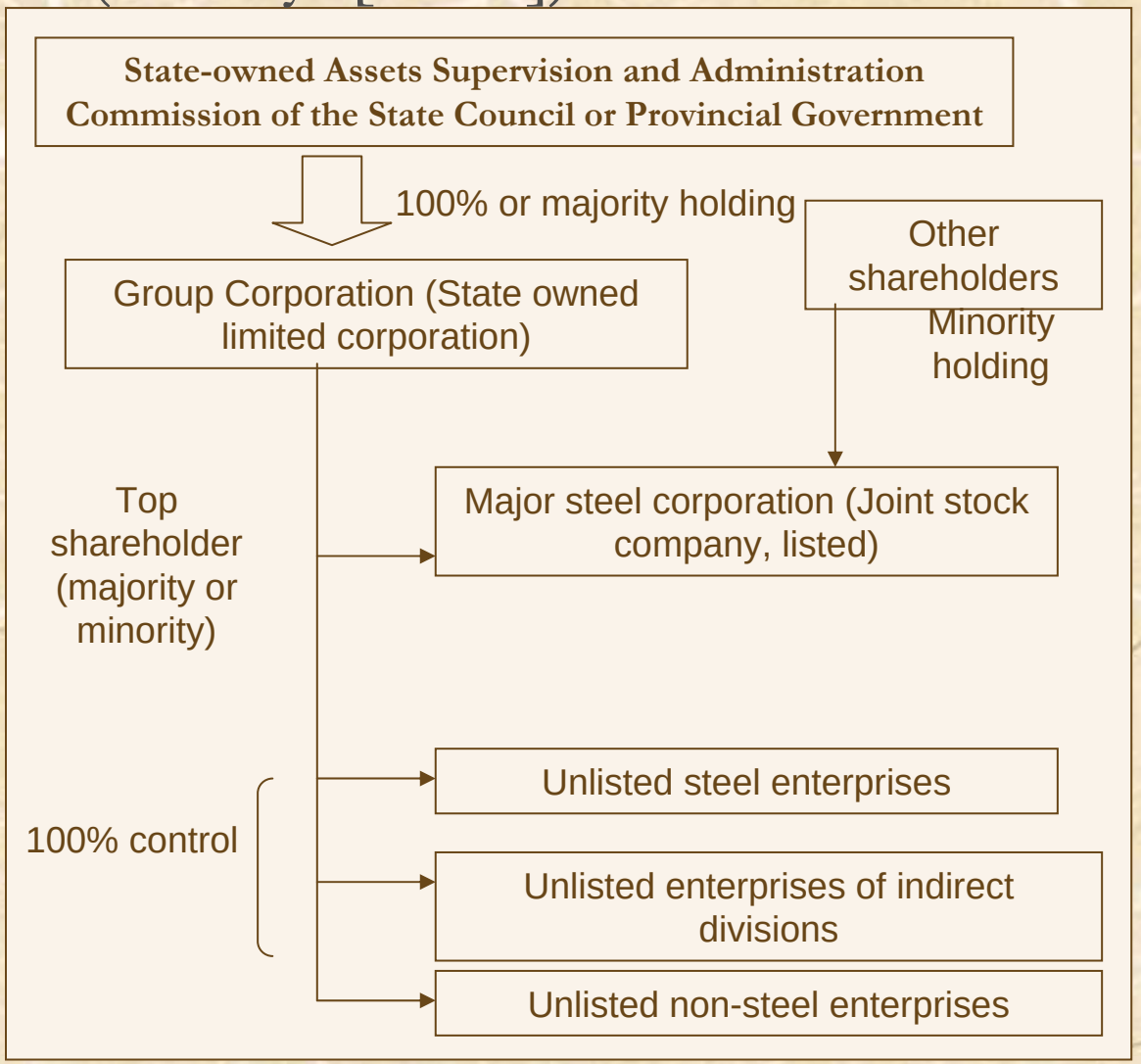
3-1 Effect of Privatization and Dilution of Governmental Control

Privatization and Reinforced Competition

- Japanese Companies: Private corporation managed by professional managers
- POSCO : Perfectly privatized in June 2006. Government holding was dissolved
- Chinese Companies: Most state owned enterprises have been converted to joint stock companies. Governmental direct holding was dissolved

→Corporate behavior and performance are determined by competition and profit-making investment rather than protective or promotion policy of governments

Indirect Governmental Control of the Chinese Steel Industry (Liew and Imai[2005]) (Nakaya[2001])



- Centralize the excellent assets to major steel corporation
- Stock of major steel corporation is listed
- State owned group company keeps top shareholding
- Stock price will keep high because investors can observe only the excellent major steel corporation
- Listed steel corporation can raise fund
- The fund is expended to capital equipment and reorganization of other companies under the same group

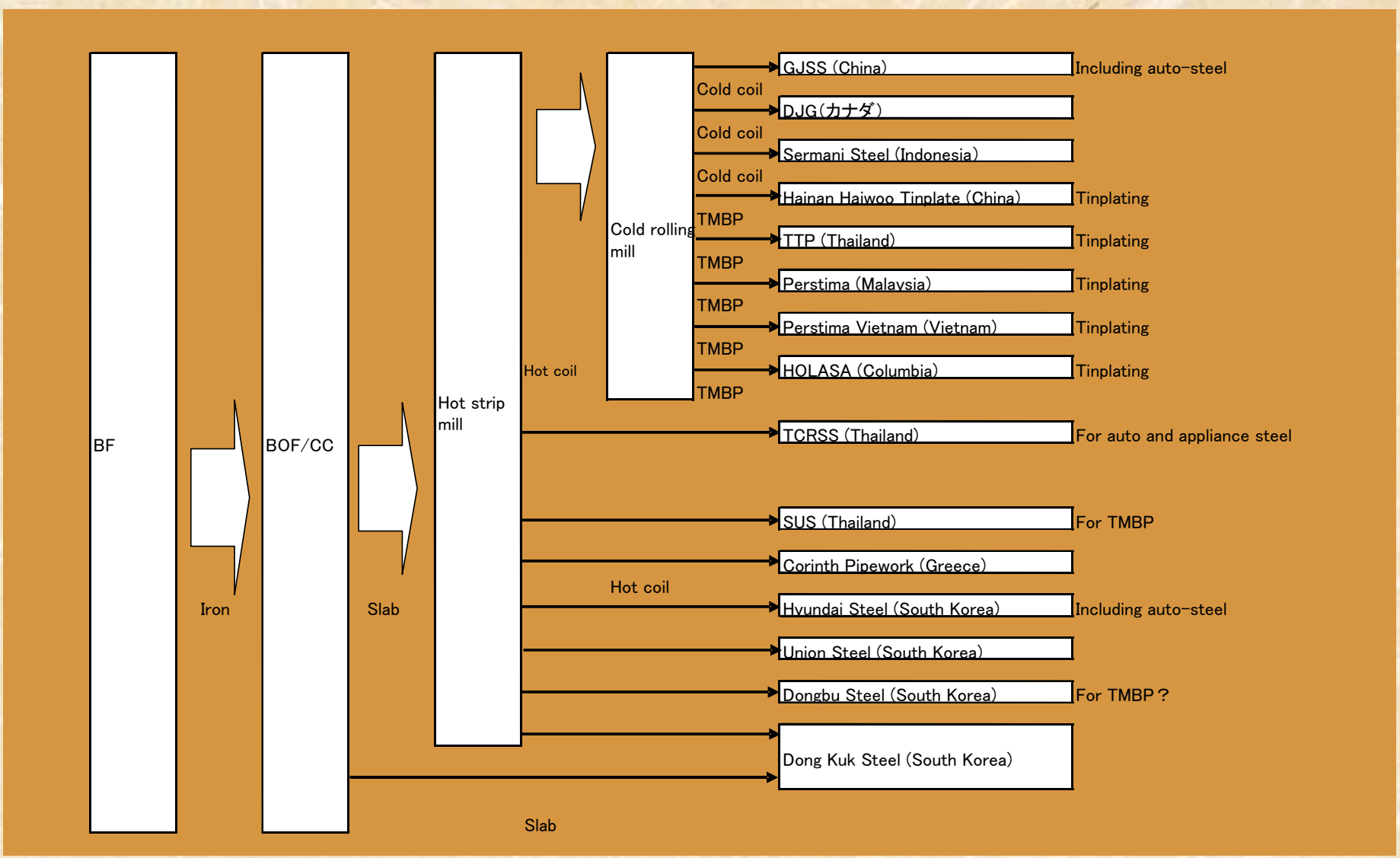
→This type of reform promotes fund raising and investment of major steel corporation

3-2 Foreign Investment Strategy of the Japanese Companies and POSCO

Japanese Integrated Companies are Gradually Expanding the Generation 2.5 Systems

- Cross-border process linkage(Kawabata[2005])
  - High grade steel markets like auto-steel are target
  - Inter-firm and international division of labor
    - *Base material is exported from the integrated companies in Japan. It is rolled or/ and galvanized in host countries by joint venture companies.*
    - *Technology and know how are transferred to the joint ventures to keep the technological level of each process*
    - *Fine tuning among processes to keep integrated control*

Inter-firm International Division of Labor : The Case of JFE Steel Corporation



Source: Author edited from various materials

Challenges and Solutions to Expand the Global Share of the Japanese Companies

- Supply volume of base material from Japan is a constraint condition
- Solution 1: Participation to construction of new integrated steelworks abroad
  - Nippon Steel: Investment to the construction plan by Usiminas in Brazil
  - Sumitomo Metal: Joint investment with Vallourec, French Pipe Producer, to construction of new integrated steelworks in Brazil
  - Problem: High risk investment because of capital volume and the task of technology transfer. Reliable partner is limited
- Solution 2: Procurement of high-grade base materials from partners in host countries
  - Nippon Steel: Procurement of hot coil from Bao Steel for expanded capacity of BNA in China
  - Nippon Steel: Procurement of hot coil from Arcelor Mittal USA for expanded capacity of I/N Tek and I/N Kote in USA
  - Problem: Reliable partner is limited. Technical assistance to upstream processes of partner is necessary

POSCO is Pursuing the Quantitative Expansion Abroad

- Not only high-grade but low-grade steel markets are target for POSCO's global strategy
- Utilizing low-grade materials by FINEX
- 28.8% of total investment was for overseas businesses in 2007
  - India: Construction of an integrated steelworks and development of iron ore mine. Total investment is 12 billion dollars. Projects have hard going due to conflict with local community
  - Vietnam 1:Construction of cold rolling and galvanizing factories. Total investment is about 1.1 billion dollars
  - Vietnam 2: Feasibility study of an integrated steelworks is in process

3-3 Chinese "Musical Chairs" Hosted by Government

"Development Policy for the Iron and Steel Industry" in China (2005)

- Target: Making larger companies and increasing concentration ratio of top 10 companies
  - 35% in 2005→50% in 2010→80% in 2020
  - Government promotes to make 2 biggest corporate groups with annual capacity of 30 million or more tons each, and some corporate groups with annual capacity of 10 million or more tons each
- Prohibition of majority holding by foreign capital in major iron and steel companies
- Prohibition of small facilities and obsolete technologies like mini blast furnace. Compulsive shut down is ordered
- Two aspects of "Development Policy"
  - Industry policy: Promoting economies of scale, operating efficiency
  - Environmental policy: Controlling pollution by small and obsolete factories

Nation Wide "Musical Chairs"

- Managers of large scale steel companies considered the "Development Policy" as a start of "Musical Chairs" to get seats of 2 largest or some second-largest group
- Investment plans, mergers and acquisitions, alliances were announced one after another
  - Bao Steel forced down under Xinjiang Bayi Steel, Guangzhou Steel and Shaoguan Steel
  - Anshang Steel Group and Benxi Steel Group merged into Anben Steel Group
  - Three major steel company groups in Hebei Province merged into Hebei Steel Group, top producer in China
- Establishment of production systems and integral control of multiple factories are key factors of competitiveness
  - Scale itself does not secure competitiveness
  - Transfer of knowledge and know-how from foreign companies or Bao Steel is necessary to make high grade steel

4 Conclusion

Investment to Production System is a Major Factor that Promotes the Growth of the Steel Companies in East Asia

- Achievement of major integrated steel companies
  - Japanese Companies are the lead racers of evolution of steel production system
  - POSCO has established the generation 2.5 system. It is catching up on the Japanese rivals
  - Bao Steel has the generation 2.5 system in production. But its R&D activity, in other word, evolution capability is weak
  - Chinese integrated companies except for Bao are trying to improve their production systems from the 2nd generation
- Investment that construct and upgrade production system is a driving power to reinforce competitiveness

Summary Table of the Comparative Analysis

	Japanese Integrated Steel Companies	POSCO	Bao Steel	Chinese Integrated Companies except for Bao Steel
Integrated Steel Production System	Generation 2.5	Generation 2.5	Generation 2.5	Generation 2
Capital Expenditure	Debottlenecking and expanding for high-grade steel	Maximum in East Asia. Focus on foreign investment	Outpaced the Japanese with amount and ratio	Active. Not available in detail
Target of crude steel production	Nippon Steel Group: 40 million tons plus something. JFE Group: 34 million tons	50 million tons or more	80 million tons or more	Company by company
Research and Development	High level in amount and ratio	High level in amount and ratio	Inactive in comparison with the Japanese and POSCO	Not Available
Status as supplier of Auto steel sheet	Major suppliers to the Japanese automobile assemblers. Monopolistic supplier of some important materials	Started supply of GA sheet for body panel to the Japanese automobile assemblers	Supplier to local and foreign-affiliated US/European affiliated automobile assemblers. Technology transfer is needed to supply to Japanese affiliated assemblers	Technology transfer through join venture is needed to supply auto steel sheet
Corporate Form	Joint stock corporation	Joint stock corporation. Perfectly privatized	Joint stock corporation under indirect control of government	Most of them are joint stock corporation under indirect control of government. A few corporation without governmental control
Foreign Direct Investment	Construction of generation 2.5 system abroad. Gradual expansion through joint venture	Rapid expansion with new technology through 100% control or joint venture	Rapid expansion including construction of integrated steelwork through joint venture	Concentration to construction and mergers and acquisitions within the country

Implication (1): Role of Mergers and Acquisitions

- M&A have gotten attention as a strategy of corporate growth.
  - Arcelor-Mittal, the world largest steel producer has grown by M&A.
  - What should we think about the function of M&A in East Asia ?
- Merits and demerits of M&A
  - Pro- M&A opinion: The larger the corporation, the stronger the competitiveness
    - *No evidence if it is over the minimum efficient scale, 3-5 million tons per annum. Monopolistic power may be harmful for economic efficiency*
  - Anti-M&A opinion: Mergers by foreign company is a threat for the country
    - *In economic sense, nationality itself does not make serious trouble in steel industry. In fact mergers is a threat for current top managers*
- The point is whether M&A promotes the improvement of production system or not. That is a divide between good M&A or bad M&A

Implication (2): Challenges for the Japanese Companies

- Challenge 1: Spearheading the 3rd generation of steel production system
  - Japanese integrated companies cannot settle for the current status as a top race of 2.5 generation. East Asian rival can catch up in near future
  - Productivity is necessary condition. Additionally, Great leap forward in Humanity, Flexibility and Sustainability is necessary.
- Challenge 2: Energy saving and emission reduction of CO
  - Numerical goal of emission reduction is inevitable
  - Intensive R&D for new technology including CO_2 collection and reposition, Hydrogen reduction
- Challenge 3: Business model construction based on production system
  - Profit performance of the Japanese integrated companies is not better than East Asian Rivals. High competitiveness does not necessarily lead high profit
  - Searching for the compatibility between high competitiveness, high profit, high social reputation

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Thanks for your attention !

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