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Business Restructuring and Training for Job Conversion in the Japanese Shipbuilding Industry*

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The two oil shocks paralyzed Japanese rapid economic growth. The Japanese shipbuilding industry confronted many hardships. As a first step, the management reduced the percentage of items ordered from outside suppliers and reduced overtime work. Many surplus employees were temporarily transferred to subsidiary and associated companies. As a second step, the company decided to implement the following three strategic policies. These were

(1) the diversification of operation,
(2) introduction of microelectronics technology, and
(3) shutting down of the old non efficient facilities and concentration of production.

The key was technical skill's development. Therefore the company attempted to convince and motivate employees and prepared well-designed education and training program.

The employees' participation with management through information sharing based on a system of union-management consultation was effective for transfer and training. This intensive course helped skilled workers into middle level high technology engineers. These experiences of innovation and restructuring can provide good hints for problem solving in different industrial sectors.

1. Introduction

The restoration of the Japanese economy after the second world war was initiated by the Central Government's priority production system policy. In the first stage of that system, the textile industry's rapid expansion was set in motion. After this recovery period, Japan initiated rapid economic growth in the 1960s through huge investment.

The cold war permitted Japan to easily participate in international political and economic systems (UN, IMF and GATT). Japan was able to import capital and technology from many advanced countries, especially the US. The Central

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Government's Ministry of International Trade and Industry (MITI) guided new investment effectively in the setting up of heavy industry.

A stable amount of low priced crude oil and other industrial resources was supplied mainly by developing countries. Japanese companies exported industrial goods aided by the free trade system. Industrial goods made in Japan were able to gain access to the affluent American market. Japanese diligence in business activities had achieved a big results.

In the 1950s, Japan-US trade conflict occurred with regard to textile products. Conflicts over steel products, home electronic products, automobiles and IC-products have followed. The Japanese Central Government's industrial policy has had a large influence on the industrial structure and companies' activities. MITI's industrial guidance set up conditions and rules in the domestic economy. After setting up the rules, private companies competed fiercely in each industry. The Ministry of Finance developed fiscal and monetary policies to encourage investment in the private sector.

In accordance with economic fluctuations, Japanese companies carefully carried out employment adjustments.

The oil shock in 1973 stopped the Japanese rapid economic growth. The second oil shock in 1978 demanded more fundamental changes in the Japanese social system. There was some doubt as to whether mass-production and mass-consumption systems were really meaningful to humankind. Another drastic event occurred in 1973. The industrialized world switched to a floating exchange rate system. The fixed rate system of 1$=360 yen was eliminated. The value of the Yen rapidly appreciated. This caused business circumstances to change radically. Demand and supply conditions in the economy shifted to different dimensions.

The Japanese economy was forced to change its industrial structure on a large scale.

2. Outline of Japanese Shipbuilding Industry

The symbol of Japanese economic restoration and rapid growth is the seaside industrial zone. This zone consisted of large-scale integrated steel works, oil refinery, chemical factory, power plant and shipbuilding yard.

Arab countries steadily supplied most of the crude oil for industrial material and energy. Mammoth tankers played an important role in marine transportation. The iron & steel industry had a crude steel production volume of 100 million tons/per year. Large exclusive ships, such as oil tankers, carried imported iron ore, coal and other raw materials. Imported wheat and corn also depended upon marine transportation. At the same time, these ships carried industrial goods (steel products, NC-machines, automobiles, electronic products) for

export from Japan.

Therefore ships were the key means to carry large volume, heavy products across the ocean in a safe, stable and low cost manner. The Japanese shipbuilding industry achieved rapid growth responding to the increasing demand for the shipping. The oil shock hampered this rapid economic growth. Modern mass-transportation, mass-production, mass-sales and mass-consumption systems were run aground temporarily.

In the same way, just like in other industries, the oil shock attacked the shipbuilding industry.

Overproduction capacity became a major issue in the world. Oil consumption declined due to the high price. Facing severe recesssion, Japanese industry had to restructure its business. Corresponding to reduced market size, shipbuilding companies had to make sharp adjustments for this downward spiral situation by eliminating overproduction capacity. This severe recession was the result of many causes. The first was that there was big over capacity of vessel which was not easily solved.

The second was that the qualitative change of sea transportation reduced the volume of transportation.

The third cause was that there was worldwide overproduction capacity.

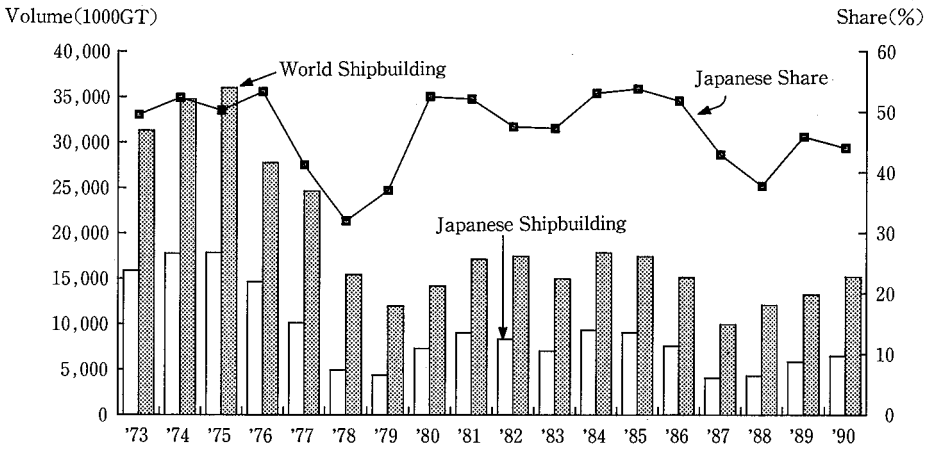
The fourth was that the NICS, in particular Korea, had caught up with the Japanese level of technology.

The fifth was the influence of the high Yen rate. The world shipbuilding volume climbed to a peak of 35.6 million tons in 1975. After that time the volume dropped down to a low of 9.7 millions ton in 1987. Japanese production volume was 17.7 million tons in 1975 and it dropped down to 4.1 million tons in 1987. The Japanese market share was 31.5% in 1978. It has constantly held more than 40% market share and the position of the biggest supplier in the world. (Fig. 1)

MITI investigated the operation ratio of the shipbuilding industry at the time of the world recession. In accordance with its conclusion, MITI decided to throw out its accelerating growth policy to cope with the new conditions of the world economy. The Minister of MITI made the fourth recommendation for the adjustment of operations in the shipbuilding industry in 1983.

In 1984, the shipping and shipbuilding rationalization council sent a report to MITI in May. According to the report's proposal, MITI chose the traditional way of a loose regulation system with production volume guidelines for the main 33 companies. These main 33 companies had the production ability to build over 10 million total tons. This new policy provided an outline for voluntary production restriction and estimated operating rate. The companies would strive for voluntary production restrictions according to MITI's forecasting market demand

Fig. 1 Shipbuilding Volume & Japanese Market Share



(Source)The Shipbuilding Association of Japan (1990), "Outline of Statistics of Shipbuilding."

of 4.1 million CG tons in 1986 and 4 million CG tons in 1986.

The companies would perform at 70% average operating rate in the following two years. The production volume given by this guideline remained at the level of 4.06 million CG tons and 68% operating rate in 1984.[1]

The capacity of the shipbuilding yard was reduced by half from 1979 to 1987. The capacity index in 1987 was only 47 in comparison with that of 1979 (index 100). During this period, the shipbuilding companies promoted link ups inside the industry. At the beginning of this period there were 21 groups and 44 companies. After the link up, only 8 groups and 26 companies remained.

The number of employees was reduced from about 256,200 (1975) to 83,300 (1988).[2]

Business had to change its price mechanism of goods and services to match the increased price of crude oil. To cope with the situation, all industries pursued energy and material saving technology in their production and distribution process. Effort was made to reduce oil consumption. R & D activity targeted energy saving technology. The steel industry succeeded in the development of energy saving technology. Paradoxically, the oil crisis made Japanese manufacturing industries more effective with regard to energy consumption.

3. Business Restructuring of Hitachi Zosen Corp.

The Japanese shipbuilding industry grew steadily in line with the economic growth following the second world war. Hitachi Zosen Co. had performed well until the oil shock in 1973. After the oil shock, the company put many business rationalization plans into practice. These practices were effective in improving business performance to some extent. Eventually a crisis developed in 1984.

Sale proceeds dropped sharply from 501.1 billion Yen in 1983 to 4,033 billion Yen in 1984. This was a decrease of 978 billion Yen (−19.5%) of sale proceeds. Although further decreases in sales were comparatively small, the current account balance of payments for 1987 closed with a deficit of more than 600 billion Yen. This marked the companies' worst performance record and left the company in a severe situation.

The sale proceeds and percentage of each division from 1982 to 1989 are shown in Fig. 2.

In 1983, the marine division's (shipbuilding) percentage of sale proceeds dropped to 46.2% from 54.4% in the previous year. On the other hand, the machine/land division's percentage rose to 53.8% from 45.6%.

From the year of foundation in 1881, shipbuilding had been the major business of Hitachi Zosen.

The number of employees and average age of male employees during the 30 years from 1960 to 1990 is shown in Fig. 3. During the period of rapid economic growth, the company employed new recruits on a large scale. In the peak year of 1975, this number climbed to over 24,000 persons. Although it decreased to the 17,000 person level in the first half of the 1980s. It is very clear that a drastic reduction started in 1986. The shipbuilding division has a labor intensive production process with highly systematized apparatus. Highly skilled workers are trained through long term on the job training in that workshop. They assemble big parts by electric welding and other methods. The average age of male employees was about 35 years old in the 1970s during the period of expansion. After that the average age went up constantly to over 40 years old in 1990. In the ten years up until 1986, the shipbuilding division made up 60% of the

Fig. 2 Sale Proceeds & Percentage by Bussiness

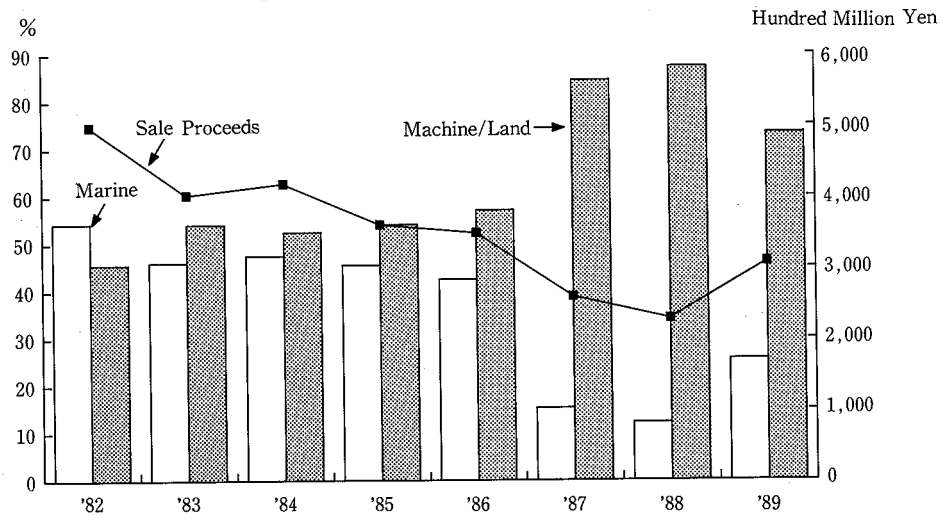
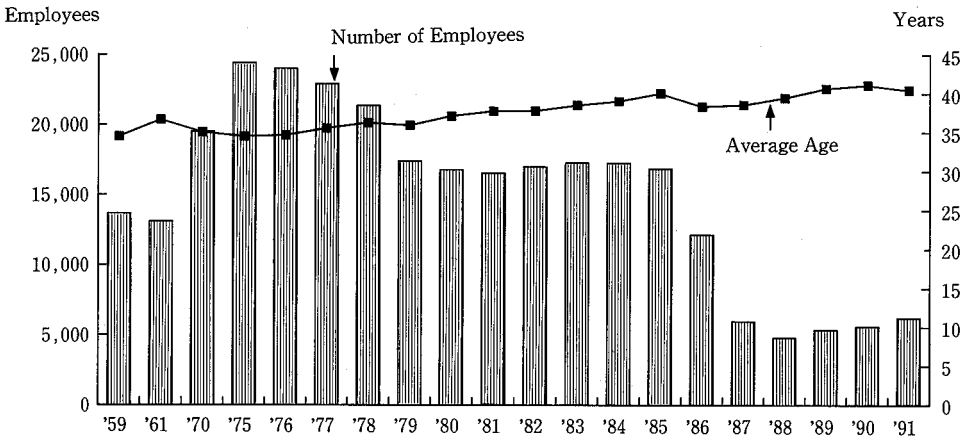


Fig. 3 Number of Employees & Average age of Male Employees



employees and machines. From the view point of sales, other steel fabrications and machines for environment maintenance made up about 60% of sales. In 1984 the marine division (ship) made up 47.8% of sales. On the hand, the 10,300 employees from the shipbuilding division made up 61% of total employees. Labor productivity was low in spite of the high level of tangible fixed assets per regular employee. The restructuring of this division was inevitable in a recession caused by a strong Yen in conjunction with the second oil shock. Top management decided to introduce a more radical approach besides the traditional constant cost minimizing approach. The past managerial policies were as follows.

In 1973: Countermeasures to Save Energy and Materials

In 1975: Rationalization Plan of Management and Non-Manufacturing Divisions

From 1976 to 1979: Stopping the Recruitment of New Recruits and Promoting a Plan Emphasising Posting Staff in Machine Related Operation in the Land Division.

In 1978: Rationalization of Apparatus and Staff in Shipbuilding Division.

During the term from 1976 to 1979, the total number of dispatched employees from Hitachi Zosen to 29 associated companies was 29,818. Key employees with life-time employment contracts were shifted into associated companies. Emloyees moved temporarily to other companies with employment security. (Fig. 4) Faced with this treatment, few employees decided to leave permanently from the company. The breakdown of the types of companies is shown in Fig. 5.

13,317 persons (44.7%) were shifted to Hitachi Ltd., which was one of the biggest home electronic appliance makers in a growing industry. Another 6,397 persons (21.5%) were shifted to Daihatsu Kogyo. It is an automobile company

Fig. 4 Number of Employees Transferred Outside Company

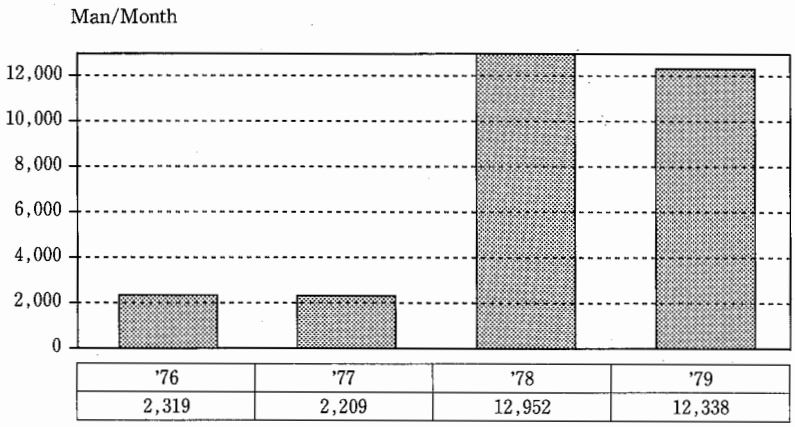
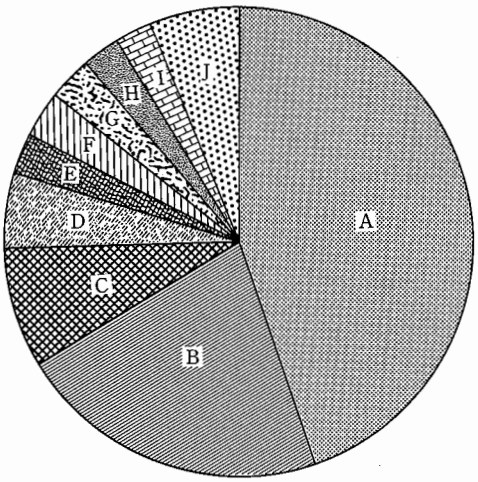


Fig. 5 Dispatched Employees '76-'79



A—Hitachi Ltd.	13,317	(44.7%)
B—Daihatsu Motor	6,397	(21.5%)
C—Hitachi Koki	2,478	(8.3%)
D—Shin Meiwa Ind.	1,540	(5.2%)
E—Hitachi Chemical	821	(2.8%)
F—Toyo Rubber Ind.	954	(3.2%)
G—Toyo Unpanki	908	(3.0%)
H—Shin Kobe Elect.	768	(2.6%)
I—Namura Shipbuild	750	(2.5%)
J—Other 20 companies	1,885	(6.3%)
	29,818	

with the main assembly plant in western Japan. These management measures were first aid treatments in the first half of the 1980s.

The company put a large scale business switchover into practice in the latter half of the 1980s. The switchover included cutting down and withdrawal from non-profit making divisions. To open the way for new break-throughs, the company decided to enter into new businesses to promote industrial reconversion.

During these years, corporate profits had decreased substantially due to the recession. Therefore large scale re-conversion became an urgent solution to this problem.

Korea had become a force in the world shipbuilding industry due to high labor productivity. Japanese competitiveness in the international market had decreased, particularly in comparison with the NICs. There was only a small possibility that Japanese companies could regain their market. The planning

department developed a large scale reassignment of employees based on the medium-range plan of 1984. This plan contained the reassignment of 1,500 persons in total.

It planned the transfer of 1,000 persons between different divisions within the same plant and the transfer of 500 persons between different plants. Reassignment of this scale was the first in the company's history.

4. Strategy for Business Restructuring

Top management decided to introduce three main policies developed by the planning division. They were as follows,

(1) Establishment of Associated Company

(2) Reassignment from Local Factory to Osaka Area and the Head Office.

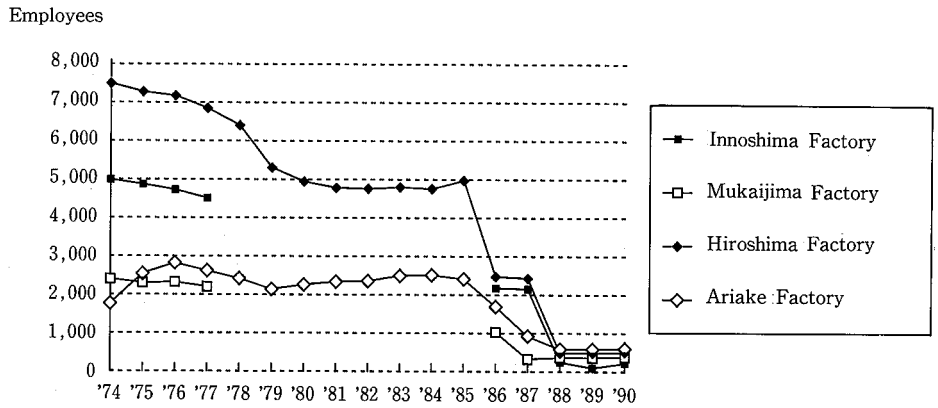
(3) Retraining of Skilled Workers.

They would start their lives afresh as engineers with new high-tech engineering. As part of this strategy, the company reduced its workforce by 4,631 regular employees from 1984 to 1985. (Fig. 3)

Moreover 6,346 persons lost their status as regular employees of Hitachi Zosen from 1985 to 1986. The Innoshima factory which has a brilliant history and tradition since its foundation in 1912, shut down the new shipbuilding division. It specialized as a repair and maintenance shop. The Ariake factory set up in 1973 as a new and powerful factory would build new ships intensively. The number of employees' classified by factory is shown in Fig. 6.

The number for the Hiroshima factory indicates the total of the Innoshima factory and the Mukaijima factory. The Innoshima factory employed 4,551 persons in 1977, but it employed only 139 persons in 1988. The percentage of employees reduced to 3.1%. During the same period the Mukaijima factory reduced its number of employees from 2,246 persons to 339 persons (15.1%).

Fig. 6 Number of Employees by Each Factory of Hitachi Zosen



(Source) "One Hundred Year History of Hitachi Zosen," pp. 752-753.

Business rationalization for the reconstruction of the production system occurred rapidly in the Innoshima factory, 1,420 employees were reduced in 1986 and 1,670 employees were reduced in 1987.

910 employees were shifted from Hitachi Zosen into associated companies. And other 930 persons found new jobs at different companies. Finally, 530 persons moved away from their home town. 620 persons were laid off temporarily. Jobless persons were almost all middle and senior employees. Traditionally in the Innoshima area, the shipbuilding industry was the only employment opportunity, thus it was difficult for the people to find new jobs in the same local area.[3]

In 1987, the number of employees rapidly decreased to 4,639 persons, 27.6% of the persons in 1984. The number increased slightly to 5,462 persons at the end of 1990. The shipbuilding division's total number was 2,152 persons and the percentage accounted for only 39%. The shipbuilding division faced with a structural recession slimmed down to cope with the new market situations. The number of secondments totaled 500 persons in 1990. Associated companies (including overseas companies) employed about 10,000 persons. Hitachi Zosen set up 60 associated companies and developed new businesses to accept workers from the shipbuilding division between 1986 and 1987 under a scrap and build policy.

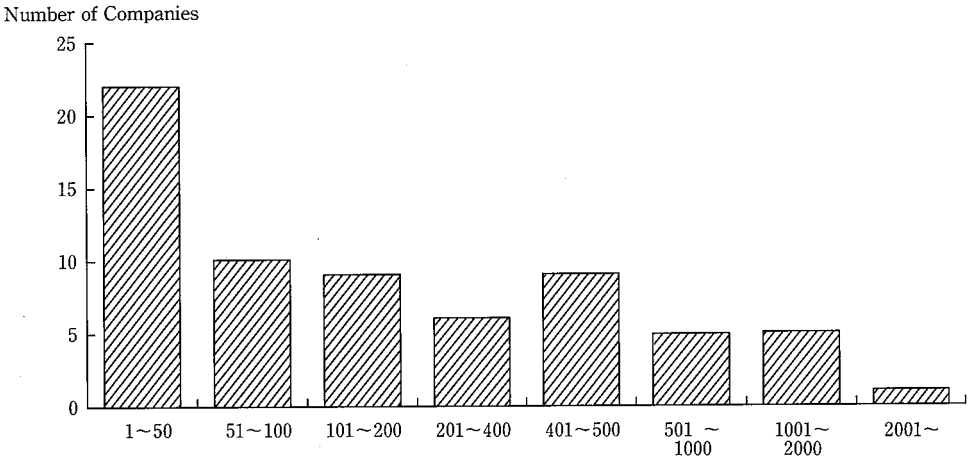
All of the new ideas for new businesses were put into practice by management at Innoshima factory. They were for example: brewing of mandarin orange brandy, culturing of flatfish and abalones. However making inroads into new fields of business were not always easy. Because they were completely different from the usual shipbuilding engineering. The company had to withdraw from the brewing of mandarin orange brandy. Shipbuilding engineering is related to marine related technology but is not directly related to marine biology. They had to struggle with great difficulty and disadvantage in unknown fields far from their expertise. A shipbuilding company which was representative of heavy industry tried entry into soft and organic goods.

It became the only topic of talk at the time. As a business itself it was not successful. There were severe difficulties for a company to diversify business and operate independently in new business areas.

In October 1990, 60 newly built companies were reorganized into 34 companies. For example, Nichizo Innoshima Co., (Head Office in Hiroshima, capital 490 million Yen) reorganized and unified three companies. Its business affairs concentrated on the following; (1) ship body bloc, (2) heavy steel big and medium size frame structure manufacturing and construction, (3) ship repairs, (4) manufacturing, (5) installation of various types of industrial plant, and (6) construction of special type of floating body. This company was making a profit.

Aimex Co. (Head Office in Hiroshima, capital 490 million Yen) operates the following businesses. They included the design and manufacturing of boiler and

Fig. 7 Main Associated Companies & Their Capital



pressure containers, diesel engine, industrial machines, ship, marine construction for marine use and cranes for ship and manufacturing, installation and after service of machines for air-conditioning. This company has also begun to make a profit.

The distribution of capital of domestic associated companies including these 34 companies is shown in Fig. 7. The capital of 22 companies was less than 50 million Yen. The capital of 10 companies was greater than 50 and less than 100 million Yen. Small companies which stand on the front line of business diversification, played an active motivating role.

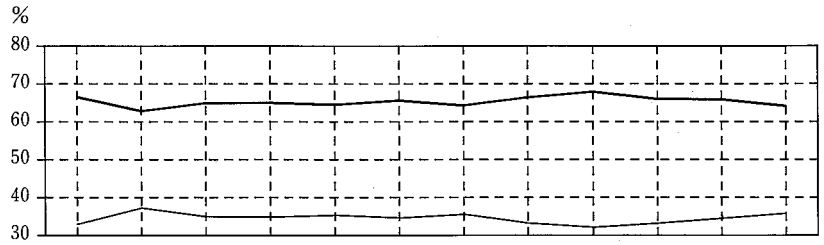
The total sales in the 1989 fiscal year of Hitach Zosen was composed of steel/fabrication 30%, machine/engine 22.6%, industrial plant 17.3% and ship/marine 25.9%. Although the company's name "Hitachi Zosen" was the same, the business has completely changed from the marine-related area to manufacturing and service of machines and goods for use on land. Utilizing the engineering for elevators installed on ships, manufacturing and sales of vertical car parking apparatus was continuing to grow.

5. Education and Training for Job Conversion

The employee's classification by job type at Hitachi Zosen is typical. Traditional Japanese manufacturing company oriented mainly production field itself. The percentage of manual skilled employees had consistently accounted for more than 60% of the workforce from 1970 to 1981. In comparison, the percentage of engineers and clerks accounted for about 35%. (Fig. 8)

The company developed intensive high technology education and training for converting manual skilled workers into engineer. Owing to these intensive

Fig. 8 Percentage of White & Blue Collar Employees



	'70	'71	'72	'73	'74	'75	'76	'77	'78	'79	'80	'81
—White Collar	33	37.3	35.2	35.2	35.5	34.8	35.6	33.7	32.6	33.4	34.6	35.7
—Bule Collar	67	62.7	64.8	64.8	64.5	65.2	64.4	66.3	67.4	65.6	65.4	64.3

(Source) "One Hundred Year History of Hitachi Zosen."

courses, many skilled workers made a new start in their professional life as high-tech engineers. In 1989, the percentage was reversed. Engineers increased to 60% and skilled workers were reduced to 39% of the total employees.

This business activity was called as a restructuring in structural depression type of industry. Overproduction capacity combined with a decrease of demand created a very severe problem for management, employees and the enterprise based union.

In the post second world war Japanese shipbuilding industry has been guided by the Central Government (MITI) policy for rapid growth to gain new potential world markets. Top management actively decided to invest large amounts of capital for modernization of facilities and introducing of new technology supported by public financial investment. For operating new facilities, the company employed many talented high school graduates.

These motivated young people had done very efficient work in the production field. The growing demands in the world market, innovative new facilities and young human capital enabled the Japanese shipbuilding industry to grow rapidly. This industry had to change its direction drastically because of the oil shock.

A jump in prices of crude oil and natural resources, the strong Yen rate and the rise of NICs, weakened the competitive power of the Japanese shipbuilding industry. The business domain of this industry was confronted with severe world market circumstances. Hitachi Zosen started a new strategy for restructuring and revitalization.

5. 1. Hardship in Professional Life and Employee's Motivation

Hitachi Zosen was the only well-known big company in the local Innoshima and Maizuru area in Japan. The company was able to offer employees better working conditions in comparison with other small and medium size companies.

Therefore young talented people eagerly wanted to get a job in this com-

pany. They wanted lifetime employment as highly skilled workers by contributing to this company. The company prepared well-designed training programs for them. Ordinarily they had enjoyed their professional lives at the same factory.

They felt a strong attachment to the shipbuilding industry and were proud of their crafts and engineering. In spite of their high morale, drastic change of business circumstances undermined their positions. The feelings of most employee were that they entered into this company to build the best ships in the world and not to be engaged in other jobs. The employees wanted to continue doing shipbuilding related work.

The program of transfer from a shipbuilding job to other jobs hurt their feelings. They were at a critical point in their lives.

The first condition was that management prepared enough explanation for employees and good motivations appealing to their emotions. The second was the persuasive and concrete training program. The third was new job compensation. These were essential conditions for employees to react positively and overcome this critical situation.

5. 2. Mutual Trust and Cooperation in Industrial Relations

Berlin citizens destroyed the wall, the symbol of the cold war in 1990. People's eagerness for democracy accomplished this historical event in the 20th century. People in East Germany wanted a free economy system instead of a centralized controlled economy dictated by the Communist Party. These historical experiences proved that the ideological social revolution was a gross error. Ironically, this was not the case in Japan just after the Second World War.

For most of the ten years from 1945, the Japanese Communist Party had a strong influences upon the labor movement due to severe inflation, shortage of food and all kinds of necessities of life. The GHQ of the occupation allied army and the Japanese Central government made every effort to reduce the Communist's political influences over the labor movement.

Union leaders decided to change the direction of movement. They attached greater importance to the improvement of their working conditions inside firms than to social revolution. The Japan Productivity Center (JPC), founded in 1955, was organized by three different social groups; the employers, union members, and public organizations. The productivity principles were as follows; the first was cooperation in the phase of improvement of productivity. The second was the negotiation for distribution of profit between management and union. The third was the fair distribution of profit among management, employees and consumers.[4]

This productivity principle oriented Japanese attitudes towards economic activities. The free and flexible way of thinking based on facts and data became

the infrastructure at the site of the workshop. It was the basis for Japanese rapid economic growth in the post second world war period. Fortunately, international political, and economical systems (UN and GATT-IMF) provided a chance for Japan to accomplish this rapid economic growth.

Too acclimated to favorable international situations, Japanese developed an illusion that the rapid economic growth would continue for a long time. Ordinary Japanese forgot that economic fluctuation and recession were unavoidable. The oil shock and severe recession were a bolt from the blue to Japanese believing in the myth of growth. Management calmly rejected employees' demands for job security and wage increases.

All employees had to reconsider their own professional lives since they were employed by the company. Management must adapt itself to changes in its surroundings. It is comparatively easy to dispose of old fashioned machines and apparatuses as depreciation or deficit. American style business treats man power the same as other kinds of management resources. The employment adjustment, or lay-off is put in operation in connection with economic fluctuation. On the contrary, it is not so easy to adjust employment in the Japanese style of industrial relations.

Japanese management has traditionally awakened the employees' sense of belonging to the company as a work community. Employees accepted management policy and wanted to get life time employment based on a tacit agreement. From the stand point of management, life time employment had been an essential condition to maintain employees' loyalty to the company and morale to job performance. Usually in the first stage, companies will reduce overtime work, subcontracting orders and cut wages during times of recession. In the second stage, companies will stop recruiting. To reward employees' loyalty to the company, management will provide a wide variety of transfers, transfer to new business and the associated companies. This personnel management policy aims mainly at the security of employment. After fully using these approaches, the company will start to discharge employees. The Innoshima area has been prosperous as a company town of Hitachi Zosen. Local people had obtained jobs at the company and a high living standard. Severe recession and tough competition deprived the well trained and highly skilled men of the opportunity of building new ships. Clever men could think logically about this situation but could not understand this completely from an emotional point of view.

This severe recession was an urgent problem for the company. At the same time, it was a crisis for each employee in his professional life. The workers' union is an enterprise based union in Japan. The decrease in members damages the base of the workers' union. The energy for a breakthrough in this hardship will come from a mutual reliance of the three; management and

employees, management and union, union and employees. The most important element is the active motivation of each employee for developing their own lives.

It is easy to denounce management for the deficit, although it is not so meaningful an action for problem solving. The employees and the union are also parties concerned. They are responsible for their own activities and lives.

Traditionally management had shared important information with employees through a management and union consultation system. Management gave information on business circumstances, business strategy, policy and business performance to each employee. The union and employees were able to participate in problem solving upon the basis of this concrete business information.

Information sharing between management and union is a key condition for constructive ideas and discussion.

5. 3. Education and Training Program

It was mainly the shipbuilding division that was effected by the structural recession. The company presented a solution to the employees of Innoshima Works. This proposal contained three different types of items. These were

(1) Transfer to Other Works (factory)

(2) Active Entrepreneurship and Development of New Business

(3) Resignation and Taking up Different Employment in Innoshima Area.

The shipbuilding industry is one type of manufacturing industry. Its main production process consists of a general assembly of big parts and machines. Traditionally this industry has manufactured big apparatuses and machines installed in ships by itself. This engineering for manufacturing of machines and apparatus was applicable to those activities used on land. The shipbuilding company was able to restart as a machinery maker. Besides building new ships, the manufacturing of machinery will become a potential new business field of the company.

The company must adapt its existence to new circumstances. It had to reallocate its business resources and rebuild its management system to catch a business chance in new circumstances. The main target was the change from marine (ship) to land. They were steel structure, construction machinery, steel-making machinery, diesel engine, chemical plant, environmental protection facilities, casks for spent fuel and nuclear power equipment. The second was the change from hardware to software. The third was the change from upstream to downstream for business diversification to directly meet the end-user's needs.

Whether in the case of the main company or subsidiary companies, new business would be organized by new jobs. These new jobs needed sophisticated hard and soft engineering skills.

Therefore, a new retraining course had to be developed for shipbuilding

craft men. These ambitious men had made efforts to acquire high skill through a long term on the job training after leaving high school.

These high potential men would be able to find a suitable job at the new workshop. Needless to say, the continuity of employment and wage securities were essential conditions for the training term.

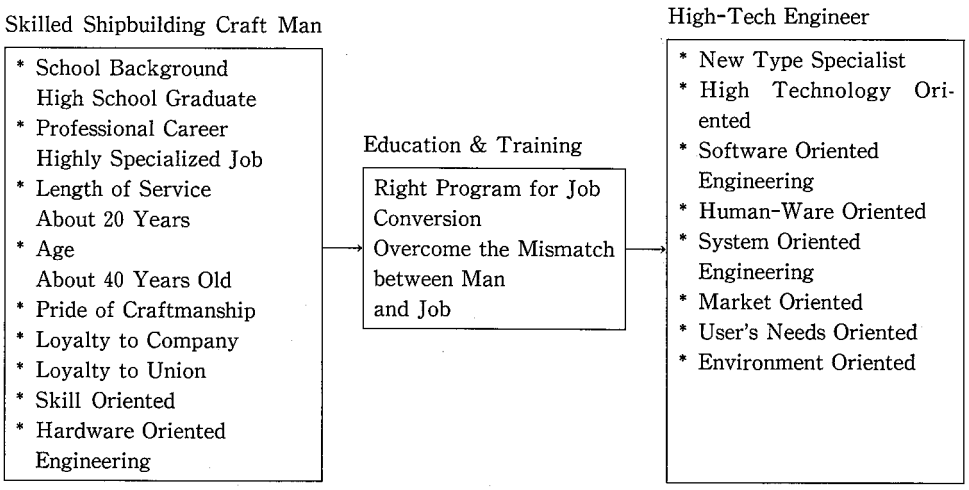
Japanese companies, especially manufacturing companies, had employed university graduates and technical college graduates as white collar workers, engineers, and high school graduates as blue collar workers. Engineers were engaged in R & D, design, control and management of machine & equipment. On the other hand, blue collar workers were engaged in operation and maintenance of production process.

Computer technology and robotics had been introduced into the production process of the Japanese manufacturing industry in the 1980s. The automobile industry, a growth industry, attached importance to the improvement of workers' skill and engineering abilities. These companies developed new OJT and Off-JT programs for employees to be suitable to the robotized production process.

The shipbuilding industry did not have enough time to develop new type of engineers. These new type mech-tronics engineers were born in the machine tool industry and automobile industry.[5]

A short term intensive education and training program was developed by the company. This program was prepared for skilled workers who would change jobs. Traditionally in firm OJT and OFF-JT programs had aimed at bringing up specialized highly skilled workers for shipbuilding. There was a wide gap between the traditional type of skilled worker and the new type of mech-toronics engineer. (Fig. 9) The ability required for job performance is expressed as follows;

Fig. 9



Ability of job performance = (basic scholastic ability) × (learning) × (motivation) × (degree of realization)

F2 = F1 × (learning) × (motivation) × (degree of realization)

F1 : present ability of skilled shipbuilding craftsman

F2 : necessary ability for new job

A fundamental question was whether appropriate learning and training could change traditional skilled craftsman into a new type of mech-tronics engineer. Because of this, characteristics of F1 and F2 had to be determined and analyzed precisely. What kinds of differences were there between F1 and F2 ?

Managers of the present and the transferred workshops came together and discussed this. According to this discussion, they classified the main points at issue. (Fig. 10) Hitachi Zosen set up a "Mech-tronics promotion committee" inside the firm in 1981.

The committee carried out intensive research and development on how to embody mech-toronics technology into ship and machine & apparatus for land use. At the same time, it investigated how to introduce mech-toronics technology into production apparatuses. In this research and investigation, staff training was clearly the critical path for the problem solving.

Japanese heavy industry such as the shipbuilding industry could not employ enough electric and electronics engineers in the rapid economic growth era after the second world war. The electrical equipment manufacturers mainly employed these types of engineers.

Every shipbuilding company endeavored to make their own business qualitatively high instead of expanding the production volume. Their main strategy aimed at high technology and strengthening the division of engineering. Therefore they wanted to employ and place the necessary engineers for the new business target.

The new trend in high technology and software caused a man power shortage of high technology engineers.

Hitachi Zosen had decided to focus on mech-tronics innovation as the core business policy, which all the employees knew well. Top management also had to study and learn mech-tronics engineering just the same as middle management and general workers. Engineers occupied many of the present top management positions. The men who entered this company before 1950 were specialists in shipbuilding engineering.

Owing to the traditional training and promotion system inside Hitachi Zosen, all the employees specialized in shipbuilding engineering and management. Unfortunately they did not have a chance to study and acquire new high technology in the 1970s.

Top management decided to place the mech-tronics revolution at the core

Fig. 10 Points at Issue for Job Displacement

Sender Side		Receiver Side		Points at Issue
Division	Type of Job	Division	Type of Job	
Ship -building	Basic Designing	Machine/ Land	Basic Design	After transfer to a new workshop, practice of planned OJT is sufficient or not?
Ship -building	Production Design	Machine/ Land	Basic Design	Man who is technical high school graduate and has an aptitude to elaborate work will be developed or not to middle class engineer by carefully planned basic education & training?
Ship -building	Outdoors Job Welding, Fitting etc.	Machine/ Land	Electric Measurement Instrument Control Engineer	Necessary school career is technical high school (electric engineering course). Sufficient education and training are indispensable. The man may display his ability as a programmer, a staff of electric system designer and a staff of CAD.
Ship -building	Outdoors Job Welding, Fitting, Finishing etc.	Factory	Mech-Tronics Equipment Control	Basic knowledge of electrical engineering, operation techniques of personal computer and robotics and brief knowledge of programming will be given. If company does it this way, will man conduc this job?
Ship -building	Outdoors Job Staff of Process Control	Machine/ Land	Production Design	Basic knowledge of mechanical engineering Knowledge & Skill for dratfting of machine Mastering these knowledge and skill, will man be able to do a job of middle level engineer?
Ship -building	Outdoors Job General	Machine/ Land	Supervisor for Outdoor Construction Work	Knowledge of construclion work engineering and practice in the field are necessary. If possible, it is better to get the license of a second class authorized architect & buildler and a second class manager of civil engineering works.

(Source) "Production Management," (JMA), 1985 April, pp. 57.

of innovation. According to this strategic policy, all general workers and middle managers had to study and acquire mech-toronics engineering. The training course for new engineering was prepared for not only the employees but also all the management. Upper management who were faced with industrial restructuring took the lead by putting themselves through the new training course. This initiative increased the morale of employees to overcome the severe situation. There was no excuse for failure of job conversion training. Immediately, the personnel staff developed the training program. The selection of candidates also started in February of 1985.

As the criteria for selection, the staff employed job career in the company, school background, condition of health, ability of English, basic mathematical

ability, and the results of an achievement test. The staff examined the candidates based on each of the criteria. They carefully selected employees who would demonstrate their ability in the new workshop.

The personnel department explained the basic reasons for change to the employees. Job conversion and new training were inevitable for two reasons. The first was that the company had to survive in the worldwide waves of innovation. The second was that at the same time each employee had to grow as an engineer possessing abilities to perform new high technology jobs. Only this newly trained engineer would be able to enjoy a productive professional life.

The personnel department took a soft style of leadership. Factory managers were expected to pay careful attention to the employees in and out of the factories. These measures would not aim at cutting back on redundant labor and redeploying surplus labor from present workshop to the others. The employees had psychological resistance and work groups also had resistance to job conversion in this drastically changing situation. Personnel staff and managers of the factory tried to cooperate to explain and to persuade each employee based on clear principles. The training of high-tech engineer was the key to business activities. The company set up a training institute in Onomichi City by renovating a company dormitory. Many computers, robots, machinery and audio-visual education instruments for training courses were prepared. The training institute named Mukaishima Techno Center opened on March 21st in 1985.

Fig. 11 List of Training Courses (1985)

Classification	Name of Course	Term of Training
Mech-Tronics Technology Area	Mech-Tronics Instruments Control	3 Months (1 Month*)
Designing Technology Area	Designing for general Machine	3 Months (1 Month*)
	Designing for Power & Rotary Machine	3 Months (1 Month*)
	Designing for Plant Instruments	3 Months (1 Month*)
	Designing for Civil eng. & Construction	3 Months (1 Month*)
	Designing for Electric Contol	3 Months (1 Month*)
	Basic Electric Technology	3 Months
Engineering Area	Supervisor : Control Instrument	3 Months
	Project Manager, Site Officer	(2 Months*)
	Plant Construction Supervisor	
	Supervisor : Steel Frame Engineering	1.5 Months
	Supervisor : Civil Engineering & Construction	1.5 Months
	Supervisor : Small size bridge	1.5 Months
Sales Area	Sales Engineer	2 Months (1 Month*)

(Note) *Term for men who have graduated from University or Technical College.

Many of the top management attended the opening ceremony to express a firm resolution about the reconstruction of the company.

Personnel staff carefully considered candidate's basic scholastic ability, jobs experiences, morale and age. Seventy-three trainees were selected from six factories from all over Japan. Their background was as follows; the average age distribution was from 19 to 46 years old. School background distribution was from junior high school & company training school to university. Trainees were

Fig. 12 Training Systemat at Techno Center

Target	
Bringing up the Personnel for the Strategic Business Field under Restructuring	Specialized Subject

Name of Course	Aim	Important Points of Subject
Design for Machine	Designer for the Machine Used on the Land	Basic Calculation for Design & Basic Drafting
Mech-Tro Instrument	Operation of Factory Automation	Numerical Control Data Making HIROBO Operation Maintenance
Supervisor: Mesurement Instrument Control	Operation of Machine Used on the Land Ajustment. Personnel for Service	Basic Technology for Measurement Instrument Basic Technology for Operation Adjustment
Basic Electricity Technology	Personnel for Electic Instrument	Basic Knowledge, Electricity Theory Instrument, Materials, Regulation, Practice
Supervisor. Plant Construction	Supervisory Personnel for Construction Feild	Skill for Promoting the Construction on the Spot Outline of Plant Construction Role of Supervisor

Common Subject

No.	Subject	Aim
1	Orientation	Conformation of Goal, Guidance for Group Life
2	Physical Training Lecture on Mental Health	Upbringing of Mental & Physical Health
3	General Education Zen	Cultivation of Plentiful Social Common Sense
4	Management of Office Work	Writing Business Document to Promote Operation Basic Knowledge
5	Training for Good Business Manner	Acquiring Necessary Manners for Business Man
6	Home Room	Improving Mutual Communication among Classmate Upbringing the Consciousness of Solidarity
7	Practice of Manufacturing	Upbringing Teamwork through Group Work
8	Study by Observation in the Factory	Getting Broad Outlook by Observation in the Filed

engaged in various jobs at the present factory. Among all these trainees, men who finished technical high school made up 83%. Their average age was 30 years old. Their average length of service was 11 years. Highly evaluated employees who finished high school were selected and headed the list of the training program. It was a big challenge for a high school graduate to take part in the training program. This challenge was a unique event in vocational training in Japanese modern history. They tried to change themselves into technical college graduate level engineers of high abilities. The staff had succeeded in developing a new training program matching the needs of the workshop in the future. Fig. 11 outlines the training program in 1985. At first, 5 courses were held. They improved the program afterwards. Fig. 12 outlines the training curriculum in 1985. Engineers with related engineering skills, professors of universities and technical high school teachers (including retired persons) played the important role of lecturers.

In 1982 Senri Mech-Toro Training Center was founded in Osaka where the headquarters was located. The total of 1,200 people were trained in this center from 1982 to 1986. This training course aimed to develop new engineers to build a high technology ship with technology saving energy and manpower. At the same time, it aimed at improving the engineer's abilities to make progress in

Fig. 13 Course Curriculum at Senri Mech-Toro Center

Name of Course	Name of Course	Name of Course	Name of Course	Name of Course
Micro Computer Control Technology	System Engineering	Computer Aided Design Technology	Mechnics/Mechnism Control Technology	Personal Computer Technology
*System Design *Basic Planning *Standard *Specialized Subject *Short Term Basic *Applied upper Grade *Computer Communication *Logic Circuit *Introduction to Micro Computer *Applied Micro Computer *Practice of Robot Operation *PL/M8 bit *Assembler (Introduction) *Assembler (Upper grade) *PL/M Introduction *PL/M Application *C Language(Introduction) *C Language (Application)	*Management System *Factory Automation *System Engineering *Measurement Instrument Control	*FORTRAN *CAD Introduction *CAD Basic *System Design	*Precision Machine *Sabo Mechanism	*Basics Beginning *Basics Upper Grade *FORTRAN

high technology innovation at all the factories. In the first stage, the center functioned as a development center for transferred engineers from Innoshima to Osaka. These courses at Senri Mech-Toro Training Center were originally developed from the Innoshima High Tech Center's course. They were composed of Micro computer control technology, system engineering, CAD (Computer Aided Design) technology, Mechanics/Mechanism control technology, and personal computer technology. (Fig. 13) Actual results of training at the center are shown in Fig. 14.

In the micro computer control course, 493 persons in total were trained; 222 in the system engineering course, 255 in the CAD technology course, 50 in the Mechanics Mechanism control technology course, respectively.

According to the results, it is very clear that huge amounts of managerial resources were used to develop engineers well informed about computer technology and robots. Fig. 15 shows the actual number of trainees by year. From

Fig. 14 Number of Trainees by Course at Senri Mech-Toro Center

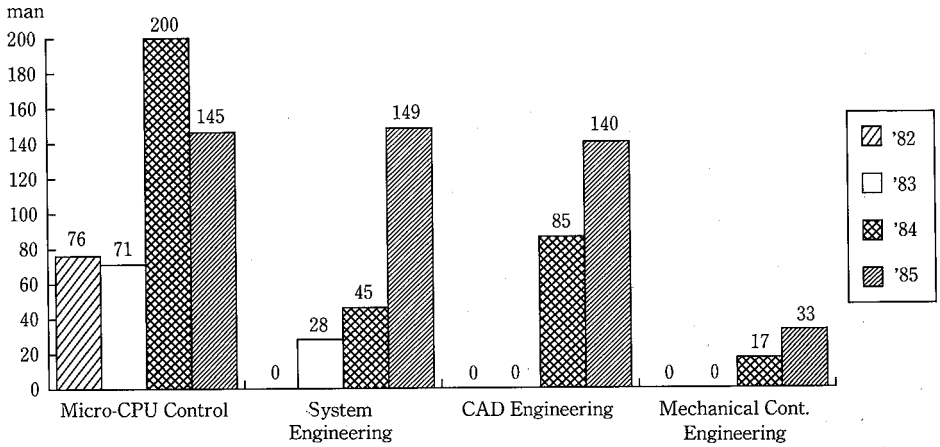


Fig. 15 Number of Trainees & Average Training Term (Senri Techno Center)

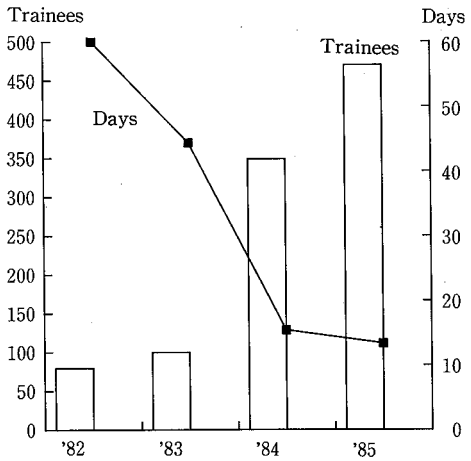


Fig. 16 Results of Training in Micro-Computer Technology (Senri Mech-Toro Center)

Year / Trainee / Day / Course	1982			1983		
	Trainee	Day	Total Trainee•Days	Trainee	Day	Total Trainee•Days
System Design	24	70	1680			
Basic Planning	30	50	1500			
Programming	22	60	1320			
Standard Subject				49	55	2695
Specialized Subject				22	70	1540

1982, the number of trainees had increased rapidly. In total, 1,144 persons had undergone the new training course. Contrary to the increasing number of trainees, the average training term/ per man decreased from 60 days to 13 days. The training course in 1982 and 1983 offered the trainees short intensive courses in micro computer technology from the beginning level to the top level. (Fig. 16)

This center had succeeded in developing original software for human development and training programs. "Creative Cooperation," a new subsidiary company was set up, based on this original software. This company with a start up capital of 450 million Yen was authorized by "the Worker Dispatch Act (1975)." Its main businesses are the following; human power dispatch, consignee of general office work, security patrol, operation of data processing machines and others. Fig. 17 provides an outline of improved and finished practical training course for high technology engineers in 1990. Essential subjects by course are basically the same system as shown in Fig. 13.

6. Conclusion

The fiscal investment and loan program supported by the government had enabled the shipbuilding industry to expand its production facilities. This was the most typical industry of rapid growth. The demand in the world market declined sharply after the oil shock. NICs pressured the Japanese shipbuilding industry and weakened its competitive power.

However, overproduction appeared due to the change of world circumstances. Companies had to make adjustments and integration of production facilities including scrapping unproductive facilities.

Japanese industry developed its competitive power by improving the price, quality, after-sale service, keeping the appointed date of delivery and stability of supply. The traditional mass production system for standardized goods had become less effective in a mature market. The main strategic target concentrated on improving the competitive power by differential production policy and production cost reduction by innovative technology.

Fig. 17 Cases of Curriculum

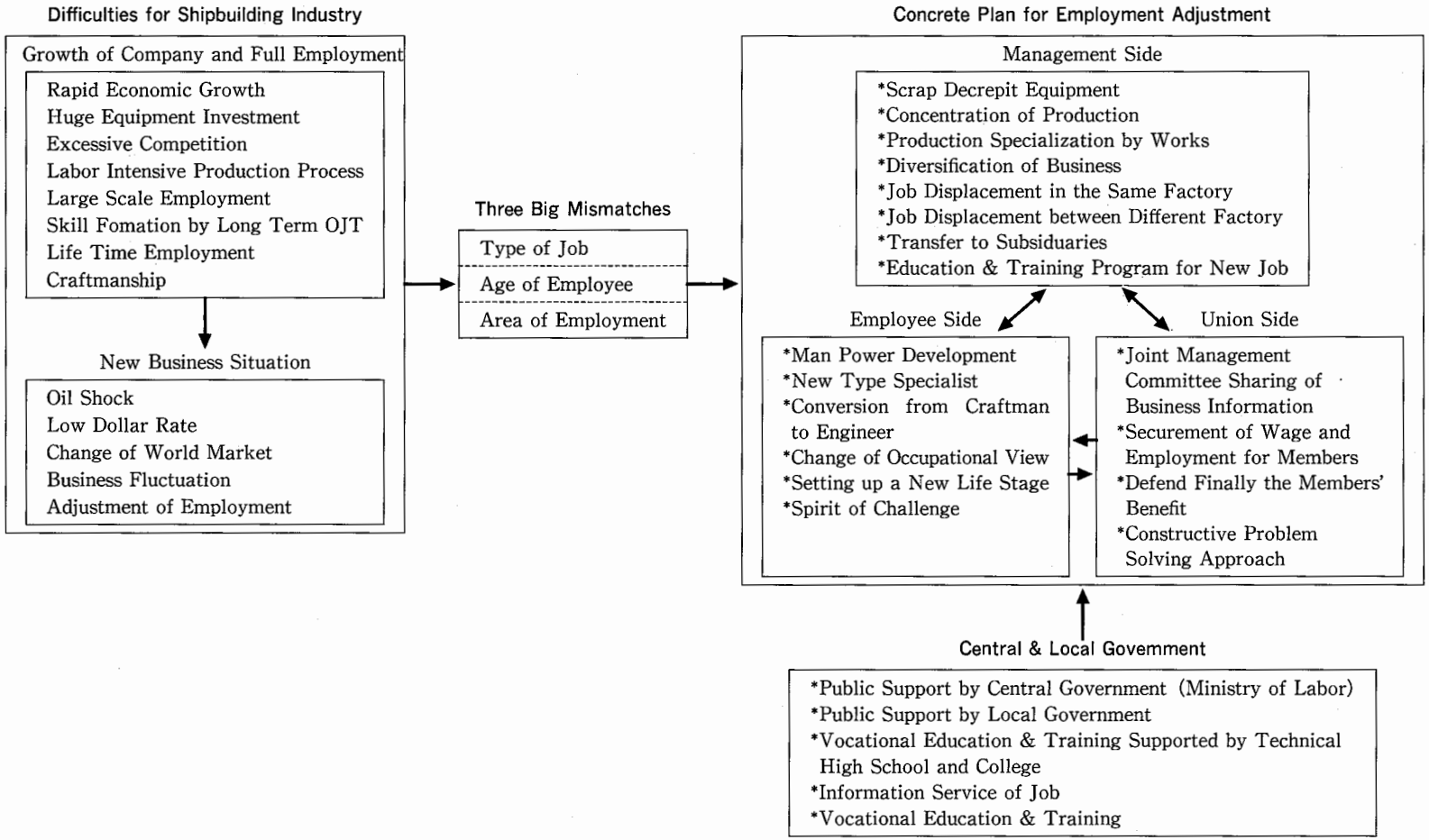
Course Name	Course Name	Course Name
Designing for Electric Control (60 days)	Supervisor : Civil Engineering Works & Construction (45 days)	Operating Technology for Welding Robots (30 days)
1. Specialized Sujects *Basic Electric-Electoronic Technology 72H *Outline of Electric Machine 40H *Logical Circuit 24H *Electric Materials 8H *Regulation for Electricity 16H *Generation/Transmission/Supply of Electricity 24H *Outline of Electric Control Construction 28H *Analog Circuit/Sensor Technology 28H *Technology for Measurement 20H *Control Technology 16H 2. Practice Subject *Sequence Control 19H *Personal Computer Programing 80H 3. General Education *Basic Industrial English & Basic English Speaking 40H *How to Write Business Document 15H *Physical Training 25H *Basic Training for Businessman 25H	1. Specialized Subject *Anaysis of Soil Quality and Soil Engineering 40H *Instruments & Materials for Construction 40H *Concrete Engineering 40H *Structure Dynamics 40H *Measurement Engineering 20H 2. Practice Subject *Practice for Measurement 20H *Practice for Material 20H *Operating Personal Computer 40H 3. General Education *Basic Industrial English & Basic English Speaking 40H *How to Write Business Document 10H *Physical Training 25H *Basic Training for Businessman 25H	1. Specialized Subject *Safety Control for Industrial Robots 40H 2. Practice Subject a) System Design for Numerical Control 100H ⊙Operating Personal Computer ⊙Language, Common Data ⊙Guide for System ⊙Library Management b) Welding Technology for Industrial Robots 80H ⊙The Beginning ⊙Multi-Joint Robot Operation c) Diagnosis of Breakdown 20H d) Maintenance 20H
Total 480H	Total 360H	Total 280H

The second target was the curtailment of non-profit making businesses. The third target was the development of profitable new business by using managerial resources on hand to the maximum, which were capital, man power, technology, production facilities, land, information network and others. The key is to develop new technology to save man power and energy with the new technology, the main shipbuilding business was resumed on a more advantageous condition than its competitors. That is not to say that low cost production is a necessary condition. On the other hand, management actively pursued the development of new business based on a policy of diversification.

Fig. 18 shows the framework of the shipbuilding industry's rationalization. This rationalization had been put in practice in Hitachi Zosen.

The human side of restructuring is the training for surplus employees for the purpose of job conversion. The shipbuilding business must slim down fitting the market needs. The company transferred these employees to new jobs in different business areas. Finishing the course and acquiring new technology are

Fig. 18 Structure of Job Conversion



essential conditions for transfer.

There were two choices for the employee. One choice was that the employee would train himself for high in the company's training program. Another choice was that he would resign from the company. Because he owned land, a house and had close ties with relations in the local community, he preferred to live in his home town.

In short, the job conversion training of about 1,000 persons was successful. At first, the main reason for this success depended largely on the high level of the trainees' basic abilities. Hitachi Zosen as a well-known traditional big business could employ talented young man who finished technical high school. The company could offer relatively high wages and good working conditions in the local Innoshima and Maizuru area.

The traditional training system mainly based on the job training in firm had succeeded in bringing up skilled craftsmen. In the training, young employees acquired basic professional abilities such as knowledge, skill and a positive attitude toward job performance.

Although there was a wide range of age, the average age of trainees was 30 years old. Their brain and body had not lost the flexibility to deal with new technology and circumstances. First trainees were these young men who were given chances of job conversion training by the company. The success or failure of the first trainees' group had a big halo effect on the employees' morale throughout the company. In the case of failure, negative repercussions were immeasurable. The personnel staff paid close attention to prepare the training courses. They tested carefully candidate's basic ability from various angles. They judged the main ability for new technology according to outcome. They applied a new multi-channel education and training approach. In the approach, a new audio-visual system was introduced to overcome the limitations of armchair education. New programs offered sufficient experiments and practices in and out of the classroom. This new program was easy to access for the people accustomed with the method of learning by doing. The trainees could learn and master new knowledge and technology through a well-designed curriculum.

Furthermore each trainee's earnest effort was the essential condition to acquire new technology.

(1) Energetic Challenging Spirit
(2) Respect for Independence
(3) Teamwork

These items indicate good examples of the spirit of the professional engineer.

They were standing at the cross road of success or failure in their own professional life. This job conversion training was a big challenging event in modern Japanese industrial history. We can learn many lessons from the re-

structuring of Hitachi Zosen.

The first is that business activity always depends upon changing complex business circumstances.

The second is that any industry or company always has growth, maturity and decline according to innovation and market situations.

The third is that top management's strategic decision making is the key.

The fourth is that the development of a new training program is an essential condition for job conversion.

The fifth is that having a spirit of optimism is important for all men in different industrial sectors.

The sixth is that man must continually try to polish up his own mental, physical and intellectual power to overcome difficulties.

The seventh is that governmental support to employees during the term of conversion is indispensable.

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Notes

1. *Zosentoukei Yoran 1991* (Outline of Statistics of Shipbuilding). pp. 390-391.
2. *Zosentoukei Yoran 1989 & 1991.* p. 141 & p. 114.
3. "One Hundred Year History of Hitachi Zosen," (in Japanese). p. 646.
4. Japan Productivity Center. (1988). "Thirty Year History of the Productivity Movement," (in Japanese). Tokyo.
5. Mechanical and Electronics Engineer.