Skill Formation in the Japanese Manufacturing Industry:

An Empirical Analysis of Diversified Regular Workers

Etsuko HAYASHI

[Abstract]

Under the pressure of an aging society, Japanese manufacturing industries are evolving new shop floor Human Resource Development (HRD) strategies to overcome young male labour shortage for the core workforce. These strategies feature implementing effective skill formation and its succession programs on a significant scale that will open internal labour markets to (1) aged and female workers, (2) college/university graduates, and (2)'pre-retirement experienced senior workers as instructors for skill succession to maintain international competitiveness in accordance with the industry's two basic skill types: (1) "horizontal multi-skilling"; mainly characteristic of assembly workshops and skills are formed mainly by job enlargement, and "vertical multi-skilling"; mainly needed for (2) steel working and (2)' mechanical workshops where proficient skills are required.

Regarding "vertical multi-skilling", the empirical study indicates that companies' HRD policies have changed to utilize, on one hand, college/university graduates to create knowledge-driven workplaces based on the computer systems. On the other hand, some competitive companies utilize aged workers to foster systematic training style, which occasionally adopt traditional quasi-*yoseiko* style, that is, systematic apprenticeship style in-firm training for high school graduates. A distinctive point of the latter is that the prototype of the products developed in such traditional style in Japan is deployed world-wide to produce final products to fit each market by a highly automated production system. This creates Japan's manufacturing competitive edge as a result.

Contents

Introduction

This paper examines how workforce demographic change in the Japanese manufacturing industry influences shop floor Human Resource Development (HRD) and the global competitiveness through empirical research conducted from the viewpoint of skill formation and its succession. The paper also examines changes in the labour market and the employment system in the industry through the historical perspective influenced by technological and socio-economic environmental changes.

The Japanese manufacturing industry has been recognized as one of the world's leading industries in terms of its high productivity and proven quality. Its HRD strategy features well-organized on-the-job training (OJT), a series of intensive off-the-job training (Off-JT; classroom training) programs, and individual workers'self-development. In particular, continuous daily OJT contributes the most to company-based skill formation.

OJT in the Japanese workplace not only involves the new employee repeating the experienced employee's actions, but "Japanese-type OJT" can be defined as follows: "the activity by which a senior employee or supervisor trains his or her subordinates systematically and continuously through demonstrating improved working techniques, with the expectation that the subordinates will also improve their ability through their own efforts and through mutual encouragement with co-workers, in order to attain and maintain the planned level of job performance. This process includes demonstrating or elucidating the required levels of job knowledge, skills, and attitude" (Hayashi, 1994).

With respect to skill formation in general, instead of de-skilling or narrowly-specified-skilling of individual workers by rigid and precise job segmentation, large Japanese manufacturing companies have chosen "multi-skilling" of workers as a central skill formation strategy, with extensive training programs through OJT and Off-JT (See **Figure 1**). Information Technology (IT) has also influenced various aspects of company-based skill formation in the Japanese manufacturing industry. Skilled workers' contribution in the 1980s was to translate their implicit skills/knowledge into explicit knowledge through the programming of IT devices such as Numerical Machining Centers (NMC) and industrial robots. As a result, their advanced analog skills accumulated as numerical-controlled digital knowledge in their organizations.[1] Nevertheless, there is plenty of room in which competitive firms certainly rely on the subtle implicit skills/knowledge of experienced workers.

Japan now faces the most advanced and rapid case of an aging society among the industrial nations. Population aging is indeed a process affecting almost all developed countries. It is due to increased longevity and the ageing of the baby boomer generations resulting in an increased number of older people. As Leney *et. al.* (2004) pointed out that many European countries also experienced declining birth rates in the latter part of twentieth century leading to a decrease in the relative size of the younger age groups.

Japan's case is a very serious national problem exacerbated by its critically low birth rate. The cause of the problem can be attributed to the changing life-style of women and securing their long-term employment status combined. The fact is that the total fertility rate is 1.32 at present,[2] although 2.07 needed in order to maintain the present population level. The HRD policy revision outlined below stems from the manufacturing industry's

growing recognition of the tight labor market especially for young Japanese males, and is deeply concerned with ensuring the industry's survival in this anticipated fast aging society.

The industry is now in the process of evolving shop floor HRD strategies to overcome or bypass the young male labor shortage for the core workforce. These strategies feature implementing effective skill formation and its succession programs on a significant scale that will open its internal labor market to (1) aged workers as well as female workers, (2) college/university graduates and (2)' pre-retirement experienced senior workers as instructors for skill succession in accordance with the industry's two basic skill types: (1) "horizontal multi-skilling" and (2) & (2)' "vertical multi-skilling". The empirical study indicates that in the process of restructuring the manufacturing industry, the companies' HRD policies have changed to positively utilize aged workers as well as selected young workers in accordance with their skill characteristics. The tendency represented by these cases is beginning to prevail in the Japanese competitive manufacturing industry.

Research Methodology

The main methodology used in this paper consists of an analysis of existing literature and research, historical overview on skill formation in modern Japan, and the results of empirical research including some interviews to human resource managers in Japanese manufacturing firms and questionnaires to the workers. In addition, analysing the characteristics of regional or national manufacturing culture in particular, interdisciplinary international comparative studies have provided significant indications to this paper. The literatures mentioned below and the result of fact finding factory visits including some interviews to human resource managers and vocational training leaders/coordinators in Germany conducted in May and August 2006 also contributed this paper in terms of comparative manufacturing culture. All in all, the changing phase of the characteristics of the Japanese skill formation system to maintain the firms' competitive edge will be delineated in this paper.

Triggered by Piore and Sabel (1984), there had been lively debates over the feature of change in world economy since the middle of 1980s, the discussion focused on regional or national culture of production, co-operation, commitment and innovation, in particular, which might be attributed to the firms' success. The characteristics of the Japanese manufacturing system and its supporting culture have been discussed in this context; some distinguished works include Koike and Inoki (1990) that points out the similarities and differences of skill formation style in the workplace between Japan and the South-East Asian countries through comparative empirical research. Many foreign researchers of industrial and labor studies have admitted recognizing advantages of the Japanese skill formation style from this book. Kioke (1983, 1994, 1999 and 2005) analyzes from the viewpoint of problem solving and formation of intellectual skills of Japanese blue-collar workers on the shop floor. The study includes appraisal system of the production workers and correlative 'white-collarized' wage curve; the increasing monthly salary of Japanese blue-collar workers is similar to that of European white-collar workers.

Mechanical Engineering scholar, Ito (1997) advocates the importance of understanding manufacturing culture that not only facilitates the man-machine interface but also creates competitive advantages by designing value-added machinery which focuses on sophisticated human sensitivity based on his international comparative research in Germany and Asian nations/regions including Japan, Korea, and Taiwan. On the other hand, as Geographer and Planner, Gertler (2004) examines how the cultures that shape

the practices of firms and the tracks of regional and national economies are actually produced. The analysis shows how the internal and inter-firm organization of production, use of technologies, and the industrial knowledge supporting these practices are strongly influenced by their social and industrial context. The analysis also points out that distinctive national 'models' are not converging around a single global norm.

It is noteworthy that both Ito (1997) and Gertler (2004) conduct their empirical research in the machine tool industry in Germany from their own specialties and unanimously point out that German advantageous points are highly achieved technology and technical excellence in their products and production processes. Basic as well as innovative machine design backed by long-term and close supplier-user relationship, accuracy-oriented machining and assembling based on sufficient experience, proficient individual technology and highly trained individual skills (Ito, 1997: pp.80-81). Possible side-effect which include the long engineering time and the higher production cost caused by inflexible institutional regulations upon labor market, which in turn maintain stable employment relations and minimize labor turnover, is offset by the higher quality and greater productivity (Gertler, 2004: p.96).

It also should be noted that nation-wide vocational education/training system has supported the competitive advantage of manufacturing in Germany. The collaborated work between the state and the private sector and the relatively long-period vocational training has sustained the nation-wide highly individual skill levels (BMBF, 2003). This will be mentioned in particular in the last section of the empirical research as a reference in comparison.

1. An Overview of Skill Formation in Japan

This section provides a short history of skill formation in Japan. In particular, in-firm skill formation in large Japanese manufacturing industries will be focused on, in order to obtain a deeper understanding of present skill formation processes. The history of skill formation in Japan can be understood through investigation of the conditions present at each stage of industrial development, including the labor supply, technology, and the education system. These conditions, therefore, will be carefully examined in this section.

1.1. Short History of In-firm Skill Formation in Japan: from 1890s to 1920s

In this subsection, industrialization and shortage of skilled labor will be focused on the first stage of in-firm skill formation.[3] By the end of the 19th century, solid foundations of the industrialization of modern Japan had been established: Rostow (1960) states that Japan's industrialization "took off" in this period. Industrialization in Japan, the heavy industry in particular, was accelerated by the impact of the Sino-Japan War (1894-95), the Russo-Japan War (1904-05), and World War I.

At the beginning, large shipyards started their work done through indirect employment system called the *oyakata-kokata* relationship (a relationship akin to that of father and son). However, there were problems with this approach, most notably with respect to skills: the technical requirements called for trained labor which *oyakata* could not guarantee, and thus factories began to set up their own training programs in the late 1880s.

Movement towards the direct recruitment system was initiated in the heavy and chemical industries in government shipyards and a few large companies such as the Shibaura and Kawasaki Iron Works. At the first stage, this direct recruitment system was accompanied by the *minarai* training system, or the company-based apprenticeship. This apprenticeship was combined with manual skill training in the workshops and supplementary theory education in the external facilities. However, this training system

could not develop appropriately skilled workers for large-scale heavy industry for the following two reasons: firstly, the scholastic level of the external miscellaneous schools was low, and secondly, provision of training and education by different organizations lacked cohesion.

Hence, these large companies discarded the relationship with external training facilities. The fundamental basis of the first-stage in-firm apprenticeship system (*yoseiko seido*) was thus established in Japan. When the job market became tight due to the depression in the 1920s and beyond, employment stability of skilled workers (*i.e.* the extent to which they remain with the same company) increased. So this in-firm apprenticeship system (*yoseiko seido*) spread among large companies.

At the early stage of this system, young workers were trained by "primitive" on-the-job training,[4] and were educated in the company school in industry-related subjects and general subjects. The earliest examples of these in-firm schools were: Yahata Iron Work Young Workers' School (established in 1910), Factory Workers' Schools of Hitachi (1910) and Shibaura (1915).

The training and education in these schools were given in the boarding school system and discipline was regarded highly. The subjects taught there included general knowledge of industry, machinery, electricity, casting, and craft; they were taught in a practical way, so that workers could apply them to the production processes easily. Among the general subjects, mathematics and natural sciences were taught in relation to the production processes (Okamoto *et al.,* 1971, pp.131-146, and pp.155-167).

Although the production process related subjects were dominant due to the nature of in-firm schools, the schools also functioned as a significant supplementary system of secondary schools for young workers, whose educational background considered in general of graduation from elementary school at that time. The necessity of these schools stemmed from the industrialization in heavy industry and lack of skilled workers able to manage the modern technology of the time. The development of these in-firm schools implies the under development of the public vocational system.[5] Hence the industry training in the small sized companies continued to occur via the traditional apprenticeship or spontaneous self training by primitive on-the-job training.

1.2. Short History of In-firm Skill Formation in Japan: 1945-1960s (From the post-war period to the economic growth era of 1950s and 1960s)

Japan's defeat in World War II shattered its economic standards; production and consumption per capita plunged to approximately 60 percent of the pre-war level. By the time of the Peace Treaty of San Francisco in 1951, however, Japan had almost reached pre-war economic standards.

The Economic White Paper of 1956 described the prevailing mood clearly: "The post-war period has ended; the growth as reconstruction is over. Our foremost task now is to start building a new Japan, eagerly importing the West's technical innovations." (pp.42-43) Japan began its long economic boom sailing with the fair wind of an internationally favorable business climate. Policies were geared towards investments and growth; the economic growth rate in the 1950s and 1960s Japan almost exceeded 10 percent.

The economic growth in the 1950s and 1960s was mainly due to the robust development of heavy and chemical industries which were based on the new technology of the time, such as the automatic control system and high polymer chemistry. These technological innovations influenced both production workforce and human resource management. The significance of craft skills was decreased in general, and the constitution of the workforce was divided into two: specialization occurred both in

production work and its management, and in monotonous work which had increased, due to increased automation.

The revision and democratization of the education system was accelerated not for economic reasons but by socio-political factors. Nevertheless, the opportunity for every Japanese to receive secondary education was adequate to meet the demand for a workforce to respond to the rapid economic growth based on technological change in the 1950s, 1960s, and beyond.

In such post-war conditions, in-firm on-the-job training (OJT) and recurrent training became the two major methods of industrial training in Japan. OJT in the post-war period and beyond in Japan should be distinguished from "primitive" on-the-job training mentioned in the previous subsection, being well-organized training method practiced within the workplace.

To a certain extent, technological change obviated the necessity for long-term apprenticeships on the shop floor in order to become a skilled worker. Further, the need for supplementary education of general subjects also decreased with the high participation rate of lower secondary school graduates on the shop floor. OJT thus became the major method of in-firm training, and recurrent off-the-job training (Off-JT) came to be conducted whenever new technology was introduced to the workshop, to improve both technical skill and related knowledge (Okamoto *et al.,* 1971, p.8).

The gradual establishment of the framework of organized OJT was completed by the end of the 1950s to the 1960s, and OJT became effective, in combination with the personnel appraisal and self-assessment systems. Each large Japanese company came to possess its own training center for group training, and after the latter part of the 1960s, OJT was accelerated by the ZD (zero defect) and QC (quality control) activities.
Industrial training for executives, managers, and supervisors in medium-sized companies was slow to spread but eventually pervaded. Small-sized companies, however, could not afford to carry out industrial training, except for nurturing programs offered by parent companies to sub-contractors and some programs prepared by the Chamber of Commerce and Industry. Recurrent training needs in small-sized companies still remained.

1.3. In-firm Training in Focus

1.3.1. The Apprenticeship System and Industrial Schools in Japan

Regarding skill training, the in-firm apprenticeship system (*yoseiko seido*), mentioned in the previous subsection (see **Subsection 1.1.**), spread widely in the war-time Japan due to the massive demand for productivity increase brought about by the war. Although development of skilled workers had been prevented by the conscription system and had declined during the latter half of the war, it revived and became popular again in the 1950s.

The Japanese government altered the Vocational Training Law in 1958 in expectation of technological innovation at that time. The government intended the scale of public vocational training system to be enlarged by the 1958 Law, to be compatible with the expanding in-firm apprenticeship system (*yoseiko seido*). However, because of the rapidly rising tendency to complete upper-secondary education, and the emphasis placed on outdated traditional skills and crafts in vocational training, the public vocational training system has declined since then. Although a thorough revision of the Law was enacted in 1969, the decline in public vocational training has continued (Okamoto, *et al.,* 1971, p.9).

Regarding in-firm training, the traditional in-firm apprenticeship system (*yoseiko seido*) in large companies began to decline, and some new systems appeared in the 1960s. One was provision of upper secondary school level education and training within the

company, and the other was the pervasion of the in-firm career development program and related training schemes.

With regard to the former, the most common practice among large manufacturing companies was to give industrial high school level education in addition to the previous apprenticeship (*yosei*) training. This is the second-stage of apprenticeship with in-firm industrial high school.[6] Early examples of industrial schools providing high school level education belonged to Hitachi (1910) and Komatsu Seisakusho (1917). The number of these industrial schools increased in the 1950s and 1960s; among the newer schools are schools which belong to Matsushita Electric Industrial Co., Ltd., Toyota Motor Corporation, and Nissan Motor Co., Ltd.[7] The purpose of these industrial schools was to develop core, regular production workers equipped with the skills and knowledge to cope with the latest technology, as well as to instill discipline and a sense of corporate identity.

The advantage of in-firm training, compared with public vocational training, lies in the fact that it is relatively easy to access information from the latest technology, and put it into practice immediately. Further, a wide range of skill formation programs are implemented in large companies and the combination of these with a series of formal and informal personnel appraisal systems, including the in-firm career development program, has effectuated the training system.

In-firm training has disadvantages, for example, quality differentials among companies of different size, and the emphasis of corporate identity to the consequent detriment of the development of vocational identity. Nevertheless, the in-firm training system in Japan has developed prosperously, and a well-disciplined and highly skilled workforce has been maintaining the competitive edge of Japan's manufacturing industry in the world economy. It was probably the secondary education system that prevented Japan's industrial training from failing during the rapid economic growth period of the 1950s and 1960s. Although the large extent to which subjects taught in high schools determine future occupations may seem controversial, it is evident that the increase of completion of upper-secondary education at that time provided workers of high potential adaptability.

1.3.2. OJT and Recurrent Training

Training within the company, namely, in-firm training has played a prominent role in workers' skill formation, together with the development of enterprise internal labor market in Japan. The public vocational training system, on the other hand, has declined because of the rapidly rising tendency to complete upper-secondary education, and the emphasis placed on outdated traditional skills and crafts in its training program.

The main method of in-firm training now being implemented for general workers in large Japanese companies is as follows: recruitment of high school graduates, providing them with relatively brief basic skill training, and allocating them to appropriate sections based on their aptitudes. OJT, combined with small group improvement activities, are expected on the shop floor. In order to make this combination workable, a systematic in-firm career development program is provided with Off-JT at times, in conjunction with advancement in the in-firm qualification system in relation to promotion, and personnel transfer aiming for skill development.

OJT in Anglo-American organizations refers to the allocation of a new employee to an experienced employee, or supervisor, who will show the newcomer how to do the job. It is perceived to be the cheapest and most rational way to transfer the knowledge and skills which are required for the employee's routine work. This is also applicable to jobs in which a number of "tricks and trade" are used, which cannot be picked up except through direct experience (Hodgetts, 1985, p.272).

It should be noted that Japanese-type OJT not only involves the new employee repeating the experienced employee's actions as mentioned above, but can be defined as follows: The activity by which a senior employee or supervisor trains his or her subordinates systematically and continuously through demonstrating improved working techniques, with the expectation that the subordinates will also improve their ability through their own efforts and through mutual encouragement with co-workers, in order to attain and maintain the planned level of job performance. This process includes demonstrating or elucidating the required levels of job knowledge, skills, and attitude (Hayashi, 1994, p.72).

Except for female workers who are generally expected work for relatively short term, as Shirai (1982, p.110) mentions, the fulltime male workers become core workforce in the company, and are expected to remain until their mandatory retirement age of 60-65 at present time. This form of employment for fulltime workers is called "non-fixed term employment" as Labor Standard Law, Article Fourteen, enunciates.[8] These fulltime workers are not expected to obtain specific skills or knowledge of the jobs prior to employment but are expected to have a flexible workforce with basic ability which fulfills job requirements through in-firm education/training system.

1.4. Current Topics on Labor Markets in Japan: an Aging Society

Meanwhile, the productive-age population in Japan (15 to 64 years of age), peaked 67.7 million in 2005, will decrease to 63.0 million in 2025, according to Statistics Bureau, Ministry of Internal Affairs and Communications.[9] Japan now faces the most advanced and rapid case of an aging society among the industrial nations; a very serious national problem exacerbated by Japan's critically low birth rate. Although the total fertility rate of 2.07 is needed in order to maintain the present population level, it is 1.32 at present time. Also, the rapidly rising tendency to commence tertiary education, particularly to enter four-year universities is another source of anxiety.[10] Labor shortage of production workforce has become a critical concern in Japan.

A significant point when considering the employment issue in Japan, it is said that female, elderly, and foreign workers hold the key to the solution. As far as fulltime workers in the large Japanese manufacturing companies are concerned, effective use of female and elderly male workers serves as a key at revival of a manufacturing industry at the present stage. The characteristics of these workers related to socio-economic environment and manufacturing culture in Japan are also discussed in this paper through the empirical research.

The human resource development (HRD) policy revision outlined below, stems from the manufacturing industry's growing recognition of the tight labour market especially for young Japanese males, and is deeply concerned with ensuring the industry's survival in this anticipated fast aging society. The industry is now in the process of evolving shop floor HRD strategies to overcome or bypass the young male labour shortage. These strategies feature implementing effective skill formation programs on a significant scale that will open its internal labour market to (1) female fulltime workers, and (2) college/university graduates and (2)' pre-retirement experienced senior workers as instructors for skill succession, to maintain international competitiveness in accordance with the industry's two basic skill types shown as follows. (1) "Horizontal multi-skilling": mainly characteristic of assembly workshops where skills should be acquired horizontally, and (2), (2)' "vertical multi-skilling":mainly needed for steel work and machinery sections in which vertically sharpened specific skills are required (see **Figure 2**).

The empirical study indicates that in the process of restructuring the matured industry, companies' employment policies have changed from developing "multi-skilled specialists

" from young male high school graduates, to developing these specialists of young female or male college/university graduates in accordance with their skill characteristics. The empirical study on "vertical multi-skilling" also indicates that some competitive companies have revitalized traditional quasi-*yoseiko* style, that is, the third-stage systematic apprenticeship style in-firm training for high school graduates, where experienced aged workers actively participate as instructors. The empirical study results, the main body of the research on current issues, will be examined in the latter half of this paper.

2. Empirical Research

In this section of empirical research, the first subsection examines "horizontal multi-skilling" in the automobile industry where fulltime female workers' skill formation and its implication for aged workers will be focused on. In the second subsection, "vertical multi-skilling" for college/university graduate steel making workers' knowledge-oriented skill formation and its limitation with supplementary countermeasures will be discussed. Regarding "vertical multi-skilling", pre-retirement experienced senior workers have been working as instructors for skill succession. An automotive components company, where quasi-apprenticeship style training is implemented for maintaining international competitiveness, will be examined in the third subsection.

2.1. Empirical Research 1 "Horizontal Multi-skilling": Fulltime female workers and aged workers in the automobile industry

The first body of the empirical research was conducted at *H Factory of MD Motor,* located in Yamaguchi prefecture, at the western end of Honshu Island in Japan, in July 1999. The purpose of this case study was to examine one of the earliest cases of female fulltime production workers' employment, including the night shift, in the large Japanese automobile companies. In respect to the research methods, the following three were used: first, unstructured interviews to the HRD manager and the supervisors on the shop floor; second, assembly line observation; and third, questionnaires were used in gathering data from 42 (out of 55) female workers in the factory.

Through the first body of empirical research on the parts production workshop and final assembly lines in a large automobile company, the author found as follows. The production line was being reformed to be suitable for female workers by decreasing many heavy tasks in the workplace; for instance, lifting heavy machinery or parts, reducing differences in levels on the conveyer line, and eliminating unnatural standing posture. It is noteworthy that these changes would also have a beneficial effect for aged workers. In other words, the industry is simulating the forthcoming shop floor evolution needed to adequately reflect the available work force in an aging society by the experimental use of female workers at the present time.

So far, these female workers are allocated on the conveyer lines such as parts assembly lines, door assembly sub-lines, and final check-up lines. Most of these lines require devoted "horizontal skills" which are thought to be fit tasks for women. As a matter of fact, the specific problems related to fulltime female workers in the Japanese long-term employment system, such as childbirth and childcare in relation to job security and sex discrimination in promotion, have to be overcome by holistic Equal Employment Opportunity programs.

In addition to the above-mentioned perspective, the following two points should also be noted through the questionnaire results: the gender role at home and the existence of a few fast trackers. First, according to the questionnaire results, the young female workers, especially newly high school graduates, tend to reply that they intend to

continue to work on the day-and-night shift, while the upper 20s and older are apt to answer that they prefer to work on the daytime shift only. These results could be analyzed to indicate that the young workers are content with their monetary remuneration compared to their male counterparts of the same generation in the Japanese wage system.[11] On the other hand, the latter group members are in the middle of the childbirth and childcare generation. Their physical fatigue caused by both factory work and house chore can be easily imagined. In addition to establish a balanced official childcare system, the division of household labor by gender also should be revised to create a gender-free workplace.

Second, there were two "fast-trackers" at the factory. At that time, they were dispatched to the company's technical college for two years to acquire higher technical skills and shop floor management skills, and were expected to become supervisors in near future. The management at the factory intended to promote them as quickly as possible to demonstrate a model of female skilled workers. These workers themselves were also highly motivated according to the questionnaire results.

2.2. Empirical Research 2 "Vertical Multi-skilling": College/university graduate production workers in the steel industry

Prior to investigate the second body of empirical research on the steel making and steel working industry, industrial characteristics, *i.e.* manufacturing culture in the steel industry, should be noted regarding the following two points. Firstly, most of the skills in the process industry are now highly computerized and those workplaces require knowledge-driven intellectual workers. This is the primary reason why the steel industry prefers to employ relatively high academic background workers on the shop floor.

Yet, there is plenty of significant room which requires long-term experience such as work in front of the huge furnace. There is indeed a choice that the company takes division of labor; intellectual and muscle work. The Japanese steel makers, however, have taken the integrated way to foster their own steel workers and it takes long time for them to become highly skilled as a result. Secondly, it may sound paradoxical but the more steel making systems are computerized and the final products are high-tech-oriented, the more implicit "fine-tuning" based on experience is required to improve the precision of the required subtle differences which maintains the company's competitive advantage. The middle-aged experienced workers' contributions as instructors to the college graduates are still effective in this sense.

The second body of the empirical research was conducted at *F Plant of NK Steel,* the second largest steel maker in Japan at that time, located in Hiroshima prefecture in July 1999. The purpose of this case study was to examine one of the earliest cases of university graduate production workers' employment in the large Japanese steel industry. In respect to the research methods, the following four were used. First, unstructured interviews to the HRD managers and the supervisors on the shop floor; second, taking lectures about new steel making technology from the plant engineers; third, plant observation; and fourth, questionnaires were used in gathering data from 223 (out of 289) newly employed (1997 and 1998) both high school and university graduate production workers in the steel plant. The empirical research was followed by a continuous research conducted in March 2001 and September 2005.

The steel making and steel working industry is now enjoying strong demand led by expanding new global market. However, about ten years ago, when a series of this empirical research on skill formation commenced, the industry was struggling with cost reduction caused by inexpensive imported steel products from developing countries, and changing to accommodate the establishment of high-tech based production systems as

well as shifting to make highly competitive steel pipes and plates for special use.

Through the completion of restructuring their business as a whole, the company faced serious HRD problems. Due to the slowdown in business and the high-tech plant innovations, the plant had excessively reduced the number of new employees over two decades. The management realized the problem that highly skilled production workers have started to reach their mandatory retirement age. As is shown in **Figure 3**, the demography delineates that half in number of the production workers in F Plant are between 45-55 years of age (see **Figure 3**). The skilled worker shortage would become serious among their successors in very near future.

It should be noted that it takes about ten years to become a highly skilled worker with mastery of both in computer-related digital skills and physical experience in front of the huge furnace. For instance, a multi-skilled steel worker called *bohshin,* the traditional name of steel production master, experiences a series of specific steel production work for long time. In the present day, even if the workers are able to rely on the numerical data in the steel making process, "fine tuning" for adjusting temperature of molten steel, making an alloy for special use such as high-end car bodies and so forth, which create international competitive edge of the products, requires a clue acquired by long manual work experience in front of the furnace. In short, the skills required in the steel making plant are highly vertical specific skills based both on computer-related digital knowledge and manual work. Moreover, steel making is thought to be an unpopular job among the young generation mainly because of its hard and heated workplace conditions.

With recognition of the above-mentioned critical conditions, the HRD manager of the plant experimentally recruited mid-career, academic-level-free production workers in September 1997. As an unexpected result, a number of young university-graduated mid-career workers applied the job openings mainly aiming for the quest of long-term job security, where normally high school graduates dominate the work force. These mid-career university graduate production workers can be categorized as an exceptional result of the Japanese recession time in 1990s.[12]

However, recent 2-year technical college graduate workers who acquired basic computer-related skills are now emerging in this situation as highly skilled core workforce candidates.[13]In accordance with the organizational restructuring needed to keep the industry's international competitive edge, a small number of highly skilled core work force armed with both information technology (IT) and manual skills, is being progressively required on the shop floor.

Additional information should be provided regarding *F Plant of NK Steel.* The company merged with *KW Steel* in 2002 and changed the plant and company names to *West-Japan Steel Work* of *JF Steel.* High-tech oriented basic strategy of the company has not changed with larger scale and the strategic alliance with *TK Steel* in Germany has continued as specific automotive steel sheets providers in Europe. With regard to skill formation, the author found a difference between Japan and Germany; the Japanese steel company tends to employ high school and college graduates who acquired IT basic skills and train the new entrants' manual skills intensively, whereas the German counterpart employs mechanically trained vocational school graduates. This is mainly because of the difference between the two vocational training systems. Specifically, well developed comprehensive German *dual system,* which requires final examination led by the Chamber of Commerce and Industry with traditional *Guild* influence, has established mechanic-oriented vocational training in the industry.[14] As for the Japanese counterpart, as examined in **Section 1.2.,** industrial training has been given mainly in-firm and the relatively newly established public vocational training system has been regarded as a

subsidiary measure. Basic IT skills and general mechanic and/or electronic subjects tend to be taught there.

2.3. Empirical Research 2' "Vertical Multi-skilling": Apprenticeship-style training in the automotive components industry

The third and last empirical research conducted at an automotive components company in Aichi prefecture. The company mainly deals with automotive products, such as car air conditioners, starters, power-train control systems, meters, and car navigation systems. The purpose of this case study was to examine the contrast between very high-tech products the company produces and its relatively traditional skill formation style. In this company, the accumulated know-how for a long period of time and middle-aged workers' highly advanced skills are being used for fostering young promising successors.

It is noteworthy that *D* company, a leading automotive components and systems manufacturer in Japan, learned its skill formation style from the German *Meister system* of *RB* Company, the world largest automotive components manufacturer, in 1953.[15] The Japanese sometimes call highly skilled worker as *Meister* and the intensive industrial training system as the "*Meister system*". Regarding the latter, it is well known that the formal industrial training system is called the *dual system* in Germany. Strictly speaking, the dual vocational education and training system in Germany is the comprehensive industrial training system which involves close collaboration between the public and private sectors. The lowest-level qualifications are obtained by the graduates who passed the examination conducted by the Chamber of Commerce and Industry after two-to-three years' apprenticeships. *Meister* is the top-level qualification which can be obtained after many years' concentrated specific experiences. It is notable that these systems are deeply rooted in the European *Guild* tradition.

However, as far as the factory training in the *dual system,* namely, apprenticeship carried out on the private firm's shop floor (*i.e. the* "*Meister system*") is concerned, the essence of the system is effectively adopted by the Japanese company. The case of quasi-*yoseiko* system in the *D* company mentioned below is a typical such example. In fact the role of the in-firm vocational training school, including the industrial high school for junior-high and high school graduates with *yoseiko* style apprenticeship, which was popular among the Japanese manufacturing firms more than 50 years ago has made significant effect in this company.[16] There are only three industrial high schools operated by the large manufacturing firms at the moment; Hitachi, Toyota Motor, and this automotive components company. Although those company-owned industrial high schools cost a lot, it has been proved that advanced skills succession is implemented effectively there from the results of the official skills competition.[17]

Moreover, the author found an important point regarding skill formation that the company is well aware of the advantageous points of traditional seniority-oriented workplace practices described in the Japanese-type OJT; in particular, the role of work groups in promoting continuous learning, teamwork, participation, and flexibility.[18] The average age of the employees is 39.9 years of age, and is not so high among large Japanese manufacturing firms.[19] As will be examined later, the recruitment policy of the company has changed from employing massive high school graduates to recruiting small number of young people since 1994. The company selects and fosters young employees mainly to make accurate prototypes of the products. The company adopts the apprenticeship-type training and education system for young employees. A distinctive point is that the prototype of the products developed in such traditional style in Japan is deployed world-wide to produce final products to fit each market by a highly automated production system. It can be said that *D* company is well aware of coming

aging society and countermeasures have been already carried out in the organization.

The empirical research was conducted, firstly, at the company's Technical College, and secondly, at the Prototype Department and the Department of Machine and Tools of *D* company in July and September 2005 respectively. A critical point of this case study was to examine traditional apprenticeship-style training is applied for creating world competitive new products. In respect to the research methods, the following two were used. Interviews with the lecturers of the college, who were all former experienced workers on the shop floor, about the characteristics of the apprenticeship-style education system and training observation in the college were implemented for the first. Unstructured interviews with the managers and supervisors on the shop floor of each department and plant observation was carried out for the latter.

The following three points can be pointed out as significant findings from this empirical research. Firstly, human resources are circulating and skills are up-dated through the company technical college, including traditional *yoseiko* apprenticeship style. Secondly, skill succession is already built-in in the company-wide Human Resource Development (HRD) system as well as each divisional HRD program. And thirdly, multi-skilled production workers, led by small number of highly multi-skilled specialists, create world competitive value-added products.

In addition to this, the prototype of the products developed by the intensively trained highly skilled workers is processed and assembled by utilizing computer network in the department of machine and tools, cooperated with the Research and Development (R&D) section.[20] The company has built up such cooperative system optimized for particular products and production volumes. At the same time, the company has deployed the automated assembling system world-wide to produce the final products to fit each market. Considering manufacturing culture differences, the company enthusiastically trains core workers from overseas, i.e. future team leaders of the subsidiaries, at the Technical College in Japan.

Nevertheless, the company seems not too much rely on overseas local workforce but on the automated system invented by its own department of machine and tools with periodical maintenance. According to the manager of the department, 683 workers directly belong to the Department of Machine and Tools at that time and one thirds of the members always go overseas in turn for installment, maintenance, and trouble shooting of the automation systems. It can be said that such automated manufacturing system promotes the firm's competitive edge in the global market with less defects and is less costly as a result.

2.3.1. Characteristics of Strategic Skill Formation *D1*: Circulation of in-firm developed human resources

Regarding the first point, **Figure 4** provides a significant clue: Career Development for the Technical College Graduates; human resources are circulating and skills are up-dated through the Technical College of the company where traditional *yoseiko* apprenticeship style of training is included. At the central part of **Figure 4,** there are three schools under the category of Technical College. Among the three, the industrial high school graduates and advanced vocational school graduates will become future leaders of production workers in each production plant, as delineated upper left. Some of those talented graduates will be given special man-to-man training for participating in the World Skills Competition, and then their exclusively high-level skills will be utilized to develop new products by allocated to Prototype Department or Machinery & Tools Department which are closely related to the company's R&D section, as described down

below. Some highly skilled workers become training instructors afterward for future successors, as delineated upper right. Thus, human resources are circulating and accumulated skills are utilized effectively in this company.

2.3.2. Characteristics of Strategic Skill Formation *D2*: Career development in the strategic division

The second point is that skill succession is already built-in in the company-wide human resource development (HRD) system as well as each divisional HRD program. According to the interview with the managers and the training scheme chart, there is close relationship between skill attainment and advancement in the personnel qualification system in the firm. Workers who start with the trainee grade of the in-firm personnel qualification system, which is related to promotion indeed, gradually advance their career ladder to the junior grade, and then to the senior grade as their skill levels advance (see **Figure 5**). In fact, it is also true that excessively close relationship between skill attainment and promotion might have side effects because shop management requires more human skills than mechanical skills. Supervising, however, must be backed by highly achieved mechanical skills. There is a dichotomy between the two and the latter is slightly over hanged in this company. It is noteworthy that this also creates the characteristics the firm's manufacturing culture.

Moreover, the in-firm skill attainment examination is set each stage of career advancement. The degree of difficulty of the examination is higher than the relevant national skill qualification level at the latter half of junior and senior grades. Such career development system is prevailed over the firm and the Department of Machine and Tools is playing an important role as the headquarter for deployment of new technology and related skill formation; the department supports the company-wide skill deployment program through several ways such as information exchange with other departments, deployment of new technology to each production plant, and sustaining company-wide skill competition (see the bottom of **Figure 5**). All in all, such skill formation system, led by small number of highly multi-skilled specialists, creates world competitive value-added products.

2.3.3. Characteristics of Strategic Skill Formation *D3*: Changes in the number of new entrants

As the result of reviewing massive recruitment policy, the number of new entrants to the company has been dramatically reduced from 1994, those of high school graduate in particular (see **Figure 6**). The critical point is that the company reduced the number of regular production workers but maintains that of core workers with high skill levels through the in-firm technical college system. According to the manager of public relations, around 10% of the total production-related employees are the in-firm technical school graduates since the industrial school system established in 1953. Thus, these alumni members substantially support the company.

In this company, their quest for skill formation seems to be endless. **Figure 7** shows the image of Integrated Multi-skilled Specialists delineated by the managers of the prototype manufacturing and that of machinery and tools departments; according to the managers, exclusively trained multi-skilled specialists must be entirely multi-skilled, both in mechanics and electronics. All in all, the competitive company has established the HRD system in which the vital skills are accumulated. Even if employees change one generation to another, their succeeded skills are continuously revised, utilized, and improved. This is the way that strong manufacturing culture in the Japanese company is developed.

Conclusions

Throughout the abovementioned historical and empirical analyses of skill formation in the Japanese large manufacturing industries based on skill types, horizontal and vertical multi-skilling, the following points can be remarked as conclusions of this paper.

First, regarding horizontal multi-skilling, female and elderly regular workers have started to secure their constant and repetitive jobs along with their traits and aptitudes, where "devoted" horizontal skills are required, in the final assembly lines in the automobile company. In the first empirical research, the production line reform for both female and elderly workers by decreasing many heavy tasks in the workplace, such as lifting heavy machinery or parts, reducing differences in levels on the conveyer line, and eliminating unnatural standing posture to facilitate their jobs was examined. It can be said that anticipating aging society, the industry is simulating the forthcoming shop floor evolution needed to adequately reflect the available work force in an aging society by the experimental use of female workers at the present time.

Secondly, vertically developed profound skills were investigated in steel making industry. It is said that it takes about ten years to become a highly "vertically" skilled worker such as bohshin, the traditional name of steel production master who experiences a series of specific steel production work. The long steel recession period lasted until the end of 1990s, however, had prevented from accepting new entrants to the industry for about two decades. A significant point is that, during the recession period, the workplaces have restructured to become highly computerized and most part of the steel making process is done by numerical controlled equipment. Under such situation, the recent steel boom led by strong demand of global market revitalized the industry; labor shortage has been fulfilled by young high school and college graduate workers armed with computer skills.

The steel industry has realized that highly competitive final products such as high-tech steel sheets for automobile is incubated in R&D division and formed in the steelworks by highly vertical manual skills and digital knowledge. It is noteworthy that new technology which has become fully computerized cannot be competitive anymore because it is already standardized in the global market. Moreover, the recent changes in global steel alliance structure caused by a huge transnational company have given significant impact to the industry's strategy. Maintaining the industry's competitiveness always expects product differentiation and thus requires frontier-level high-tech research along with highly trained manual skills. Hence the company emphasises vertical manual skills and has begun to train the young college graduate workers systematically by using experienced aged workers who have mastered high-grade manual skills. Some elderly experienced workers have been re-employed or extended their mandatory retirement age of transition period, 60 to 65 years of age in the present time, to teach know-how of their techniques to young workers.

The third empirical research delineates an advanced structure of the in-firm training system. The quasi-apprenticeship style training in the automotive components company looks retrogressive to the post-war period at a glance. However, the company knows that vertically sharpened manual skills for grinding and milling of prototype works, in other words, being capable of creating extraordinarily precise prototypes generates the company's competitive edge in the global market.

As was examined in **Figure 4,** innovative idea of advanced technology incubated in the R&D division is embodied in the prototype department by intensively trained young mechanics fostered through quasi-apprenticeship style training in this company. These prototypes are then used for manufacturing massive final products through the in-firm

developed automation system created in the machine and tools department. These production systems are installed in the overseas subsidiaries and thus the original manufacturing system deploys world-wide.

The role of experienced workers in this company is to become progressing frontier specialists and/or mentor-type supervisors in accordance with their aptitudes. Different from the abovementioned steel industry, these workers' careers are already built-in the career development programs (CDP) in the organization. As a result, the company seems to be with great composure and not to take any specific countermeasures to meet the forthcoming aging society. On one hand, the company has reduced the number of new entrants to cut labor cost since 1994 and replaced these jobs with the automated production system. As for creating new products which makes competitive advantage, on the other hand, the company has invested a lot in R&D and also in small number of selected human resources including the quasi-apprenticeship style training. The traditional apprenticeship style has been sophisticatedly revised to become planned and programmed in terms of both efficiency and effectiveness. It can be said that 'back to the basic' means 'evolution to the future' in this company.

To maintain the human resources investment system effectively, long-term employment along with performance appraisal system seems to be inevitable. On one hand, the enrolment of diversified workers onto the shop floor has brought significant changes to the Japanese employment system. On the other hand, the quest for long-term employment security by individual workers is still deeply rooted among the workers. Although there are various kinds of workforce in the large company, at least the key fulltime workers will improve their skills along with promotional advancement and other personnel treatment, by their long-term commitment to one particular company. The company secures the developed workforce as human capital which functions for a long period of time, and tries to obtain profit from its training investment. Consequently, how to maintain quality and quantity of human capital is a current issue in human resource management (HRM).

In order to keep the long-term employment security concept fundamentally applicable, the human resource development (HRD) strategies of the industry and the significantly changing labor market structure must both be adequately taken into account: the "trade-off" of long-term employment security and a skill-related merit rating system may become mandatory. So the industry is trying to maintain long-term employment in a labor environment where strategic skill formation has been appropriately revised and introduced into a skill-related ranking system (*i.e.,* in-firm ability-based qualification system). In this framework, individual workers must keep abreast of successive wave of new or upgraded technology in order to maintain long-term employment security.

It should be noted that such competitive companies tend to employ a significant number of contingent workers to save quasi-fixed labor costs. Such a tendency has generated a new type of dualism, regular workers versus contingent workers, and that causes remuneration differences and skill succession difficulties in Japanese society today.

This study indicates that the success of the industry's skill formation and succession scheme is contingent upon going through a significant long term evolution caused by a number of complex factors: the existing economic circumstances, continuing advances in the technological environment, a highly competitive global product market, and an increasingly tightening young labor market. The resulting new HRD strategy, which has widened the internal labor market to include significantly different types of workers, has been developed to ensure the successful ongoing evolution of a highly skilled and flexible workforce. The empirical study also clearly indicates that HRD policies will continue to evolve according to significant changes in both the national economic and

demographic environments. Thus, there is a need for continuing observation and adjustment in this process.

---

[1] Nonaka and Takeuchi (1995) are well known by their creation of the terms 'tacit knowledge' and 'explicit knowledge' which delineate the key to success of the Japanese production firms. The argument is that the Japanese know how to transfer traditional implicit skills and, conventional but useful work custom into written knowledge, namely, 'instruction manuals' to be shared for all in the workplace. Their argument stems from Japan's IT introduction experience on the shop floor in the early 1980s.

[2] This is the total fertility rate in 2006 (the latest data from the National Institute of Population and Social Security Research: http://www.ipss.go.jp/syoushika/seisaku/html/111b1.htm).

[3] In researching this subsection, the following books were mainly referred to: Sumiya and Koga (ed.) (1978), Okamoto *et al.* (ed.) (1971), and Yui and Hirschmeier (1977). Regarding the last one, the English version of this book, Hirschmeier and Yui (1975) is available, but the contents differ slightly; a more detailed explanation is available in the Japanese version.

[4] The young workers were trained by doing and/or by observing senior workers' performance. Although this is the basic on-the-job training (OJT), OJT in the post WW II Japan is more systematically organized, as will be discussed in **Subsection 1.3.2.** To differentiate the former from the latter, the word "primitive" was used here.

[5] According to Okamoto (1970, rev. 1990, p.71-84), a substantial public vocational training system was established in Europe in the 1930s. For example, the vocational training program started in public technical schools in France and Belgium, the combination of in-firm training and vocational school education in which related subjects were taught in Germany and a similar system was observed in the technical college system in UK. Regarding an overview of vocational education and training (VET) in EU countries today, European Commission (2005) contains comprehensive information.

[6] The system is very similar to the present dual system, namely, the combination of in-firm training and vocational school education in Germany, although the framework of the nation-wide vocational education and training (VET) system is entirely different.

[7] Regarding the industrial high schools for junior-high school graduates with yoseiko style apprenticeship, there are only three industrial high schools operated by the large manufacturing companies at the moment mainly because of the large running cost; they are Hitachi, Toyota Motor, and D company, an automotive components manufacturer examined in **Section 2.**

[8] Regarding part-time workers in Japan, as Sano (1989) observes, in acting as a shock absorber against impacts from the external labor market, they enable the fulltime core workforce to develop its skills. In other words, the flexibility of the enterprise internal labor market has been maintained by this peripheral enterprise labor market (Sano, 1989, p.61).

[9] See Statistics Bureau, Ministry of Internal Affairs and Communications "Annual Report on the Labour Force Survey". See also the following web site of Ministry of Internal Affairs

and Communications, http://www5.cao.go.jp/j-j/wp/wp-je05/05-3-1-01z.html for the tendency of the Japan's population decrease compared with other industrial nations at a glance (written in Japanese).

[10]According to the Basic School Census 2005 announced by the Ministry of Science and Education, 51.5% of new Japanese high school graduates (male graduates: 53.1% and female graduates: 49.9%) enter two/four year colleges/universities.

[11]The remuneration system in Japan, especially for fulltime workers in large companies, relates to age, length of service, and worker's ability. Although the portion of ability is increasingly dominant, age and length of service factors are still significant particularly for young workers who have little specific skills. The wage of fulltime automobile workers is relatively high compared with that of other job mainly because of the mid-night shift allowance. Probably, the newly high school graduate female fulltime workers at *H Factory* feel that their wage is considerably high compared with the former male classmates who work in the different industries.

[12] This phenomenon can be analyzed as follows. The main reason for the students (and their parents as well) to enrol in higher education is to obtain a "good job" in the job market. For a certain number of university graduates, however, they were unable to obtain the jobs they intended to secure due to the difficult Japanese economic circumstances at that time. As a result, so-called expectancy mismatch occurs between the employer and the employee, which is leading to a high turnover of young university graduates, which in turn has become social problem. Some of these university graduate workers became production workers in large companies in their quest for employment security, as the second body of empirical research by the author in the large steel plant indicates, where high school graduates still dominate the workforce.

[13] The interview to the instructors of public vocational schools (technical college level) of the region whose graduates constantly enter *F plant* was conducted in March 2001. It also should be noted that over 96% of the Japanese lower secondary school graduates enroll in upper secondary schools, and nearly 50% of the Japanese upper secondary school graduates enroll in tertiary education institutes.

[14] The interview to the coordinator of *TK Steel* vocational school instructors was conducted in May 2006 in Duisburg, Germany. Regarding the dual system, see **Subsection 2.3.**

[15] This information comes from the interview with the skill instructors of *D* company at the technical college in July 2005.

[16] Regarding yoseiko seido (the traditional apprenticeship system in Japan), see **Subsection 1.1.** and also **1.3.** in **Section 1.**

[17] Regarding the World Skills Competition, which is often called the *Gino* (Skills) Olympics in Japan, see its official website as follows: http://www.worldskills.org/site/public/index.php

[18] See Introduction for the Japanese-type OJT.

[19] The data of the average age is cited from Toyo Keizai basic data of the stock listed firms (September 2006). See http://www.toyokeizai.net/data/kihon.php?shoken_cd=6902

[20] Regarding close cooperation among the R&D, Prototype, and Machine and Tools sections, see **Figure 5.**

Bibliography

BMBF [Federal Ministry of Education and Research]. (2003). *Germany's Vocational Education at a glance (4th ed.).* Bonn: BMBF Publik.

European Commission. (2005). *Achieving the Lisbon Goal: The Contribution of VET.* Leney, T. *et al.* Final Report to European Commission 1-11-04.

Gertler, Meric S. (2004). *Manufacturing Culture: the Institutional Geography of Industrial Practice.* NY: Oxford University Press.

Hayashi, Etsuko. (1994). "Skill Formation and Human Resource Development in Japan: A Case Study of Strategic Adaptation to Technological Change in the Japanese Automobile Industry". Unpublished Ph.D. Dissertation to the University of Sydney.

_____. (2003). "Strategic Skill Formation and HRD System in the Japanese Manufacturing Industry: Developing Knowledge-Driven/Learning Organization in the Restructuring Era" In Ito, Y., E. F. Moritz and K. Ruth (eds.). *Synergy of Culture and Production* vol.2. *Localized Engineering for Globalized Manufacturing?* pp.165-184.

Hirschmeier and Yui. (1975). *The Development of Japanese Business, 1600-1973,* Harvard University Press, George Allen & Unwin.

Hodgetts, Richard M. (1985). *Management: Theory, Process, and Practice (4th ed.).* Orland, FL: Harcourt Brace Jovanovich.

Ito, Yoshimi. (1997). *Seisan Bunka-ron [Manufacturing Culture].*Tokyo: Nikkagiren Shuppan-sha.

Koike, Kazuo and Takenori Inoki (eds.). (1990). *Skill Formation in Japan and Southeast Asia.* Tokyo: University of Tokyo Press.

Koike, Kazuo. (1983). "Internal Labor Market in Large Firms". in Shirai, T. (ed.) *Contemporary Industrial Relations in Japan.* pp.29-61. University of Wisconsin Press.

_____. (1994). "Learning and Incentives Systems in Japanese Industry"."In Aoki, M. and R. Dore (eds.). *The Japanese Firm: Sources of Competitive Strength.* NY: Oxford University Press.

_____. (1999 and 2005). Shigoto no Keizaigaku *(Economics of the Job) (2nd and 3rd ed.).* Tokyo: Tôyô Keizai Shimpo-sha.

Nonaka and Takeuchi. (1995). *The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation.* NY: Oxford University Press.

Okamoto, Hideaki. (1970). "Shokugyo Kunren to Shakai Kozo [Vocational Training and the Structure of Society]". *Sekai no Rodo [Labor in the World].* Vol.20, No.1, (January 1970). pp.24-31; Rev. Okamoto, Hideaki. (1990). *Keiei to Rodosha [Management and the Workers].* Tokyo: Nihon Rôdô Kenkyu Kiko [Japan Institute of Labour]. pp. 71-84.

_____. (1990). *Keiei to Rodosha [Management and the Workers].* Tokyo: Nihon Rodo Kenkyu Kiko [Japan Institute of Labour].

Okamoto, Hideaki et al. (eds.). (1971). *Sangyo Kunren Hyakunen-shi [A Hundred Year History of Industrial Training].* Tokyo: Nihon Sangyo Kunren Kyokai [Japan Industrial and Vocational Training Association].

Rostow, Walt W. (1960). *The Stages of Economic Growth: A Non-Communist Manifesto.* Cambridge: Cambridge University Press.

Sano, Yoko. (1989). *Kigyonai Rodoshijo [The Enterprise Labor Market].* Tokyo: Yuhikaku.

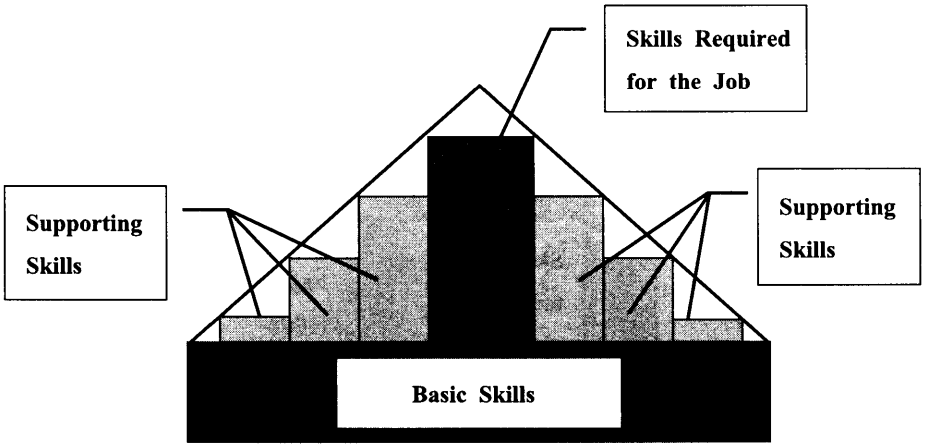
Shirai, Taishiro. (1982). *Gendai Nihon no Romu Kanri [Contemporary Personnel*

Management in Japan]. Tokyo: Toyo Keizai Shimpo-sha.
Sumiya and Koga (ed.) (1978) *Nihon Shokugyo Kunren Hatten-shi [The Development of Vocational Training in Japan].* vol. I & II. Tokyo: Nihon Rodo Kenkyu Kiko [Japan Institute of Labour].
Yui and Hirschmeier. (1977) *Nihon no Keiei Hatten: Kindaika to Kigyo Keiei [The Development of Japanese Business: Modernization and Business].* Tokyo: Toyo Keizai Shimpo-sha.

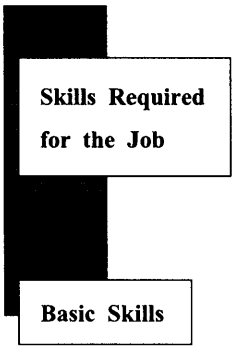
Figure 1 **Image of the Multi-Skilled Specialist**

At the automobile company, production skill is defined as "the ability that enables modern technology to be put into practice by use of physical, intellectual, and mental human functions".

Production workers are required to have sufficient basic skills, a specific skill on top of this, and the main specific skill is supported by many critically related skills.

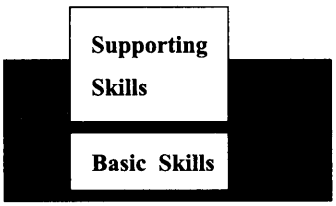


[A very stable pyramid type worker profile]



This old fashioned type worker cannot catch up with any technological changes because of a lack of supporting skills.

[A so-called artisan type]



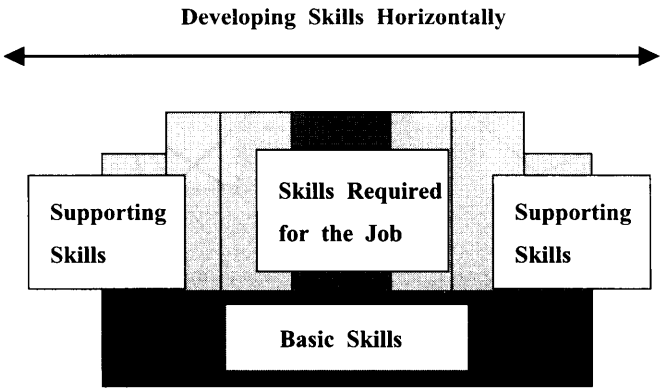
This unskilled or semi-skillled worker does not have sufficient basic skills, and is liable to become a "Jack of all trades".

[A so-called amateur type]

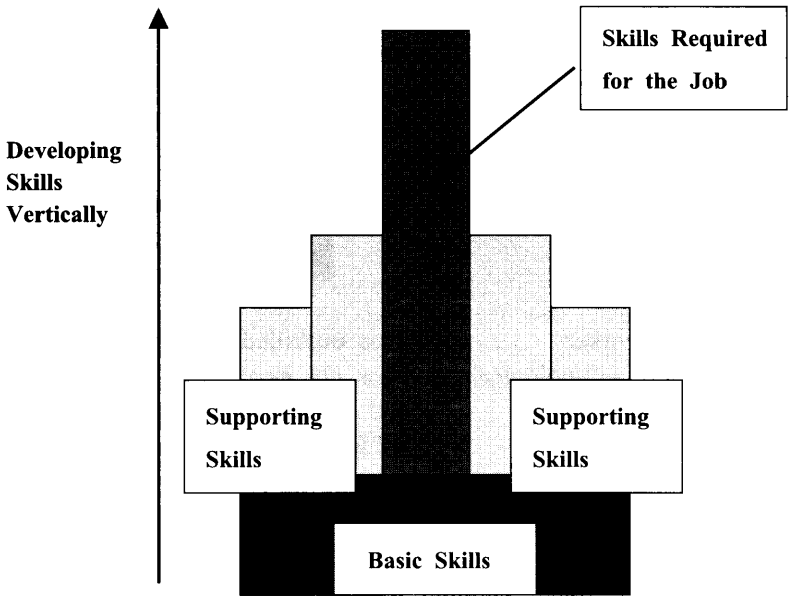
Source: Adapted by the author from "Training towards the New Production Era" (1991: p.13), Training Planning Section, HRD Department, *N Motor Co.*

Figure 2 **The Different Types of Multi-Skilled Specialist Profiles**

There are at least two types of skill formation pyramids: the flat pyramid and the tall pyramid.
(1) The flat pyramid is mainly characteristic of assembly workshops where skills should be acquired horizontally, while (2) the tall pyramid is for mechanics and other workshops, such as foundry and stamping, in which vertically sharpened specific skills are required.

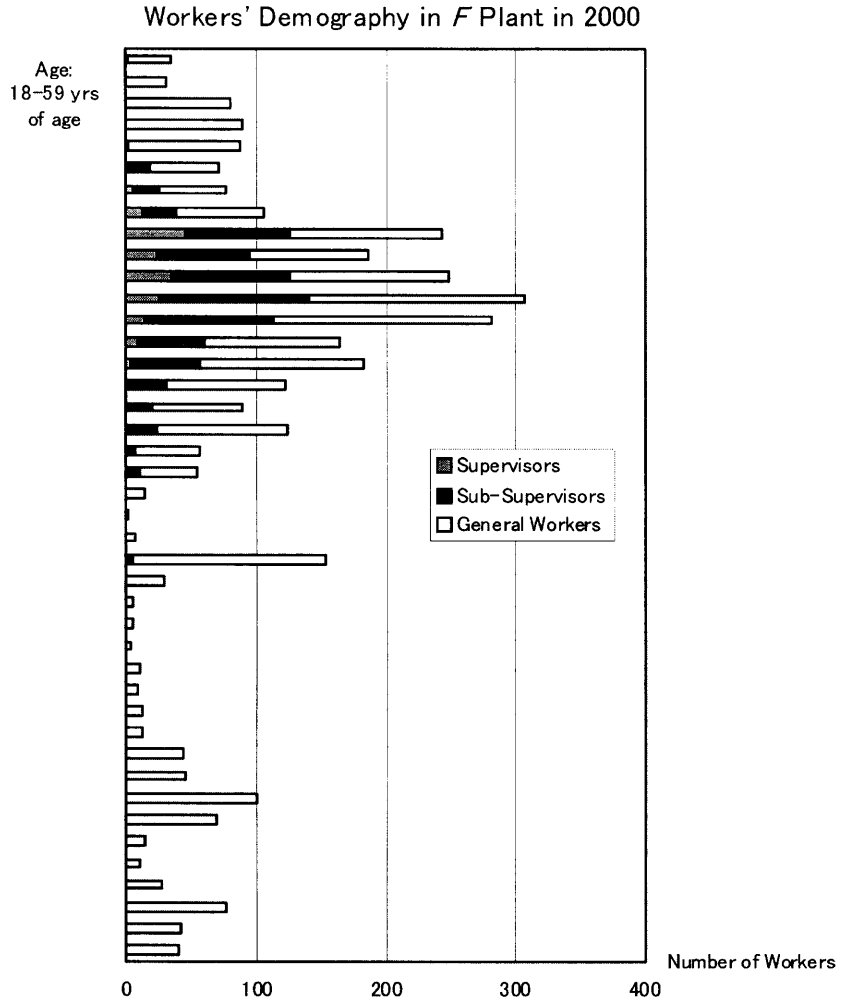


(1) Skill formation profile for assembly line workers
"Horizontal multi-skilling": mainly characteristic of assembly workshops where skills should be acquired horizontally.



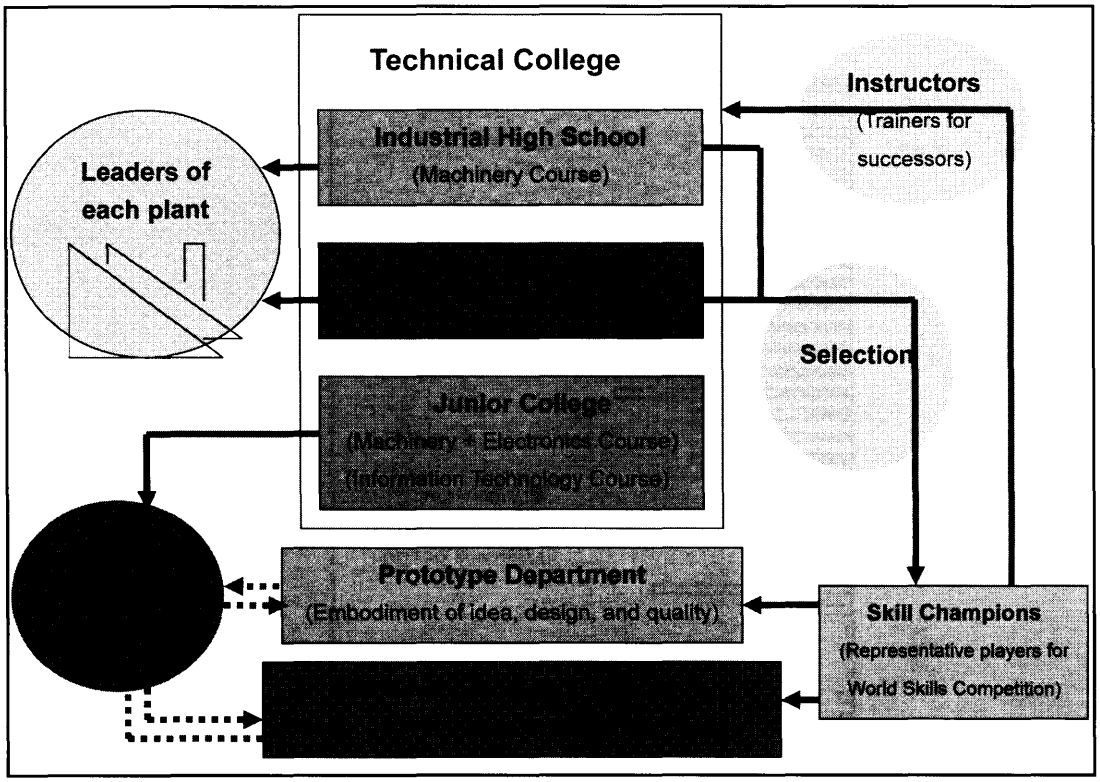
(2) Skill formation profile for mechanics and material processing workers
"Vertical multi-skilling": mainly needed for steel making and steel working workshops, *e.g.* a foundry, in which vertically sharpened specific skills are required.

Figure 3 **The Workers' Demography in F Plant in 2000**



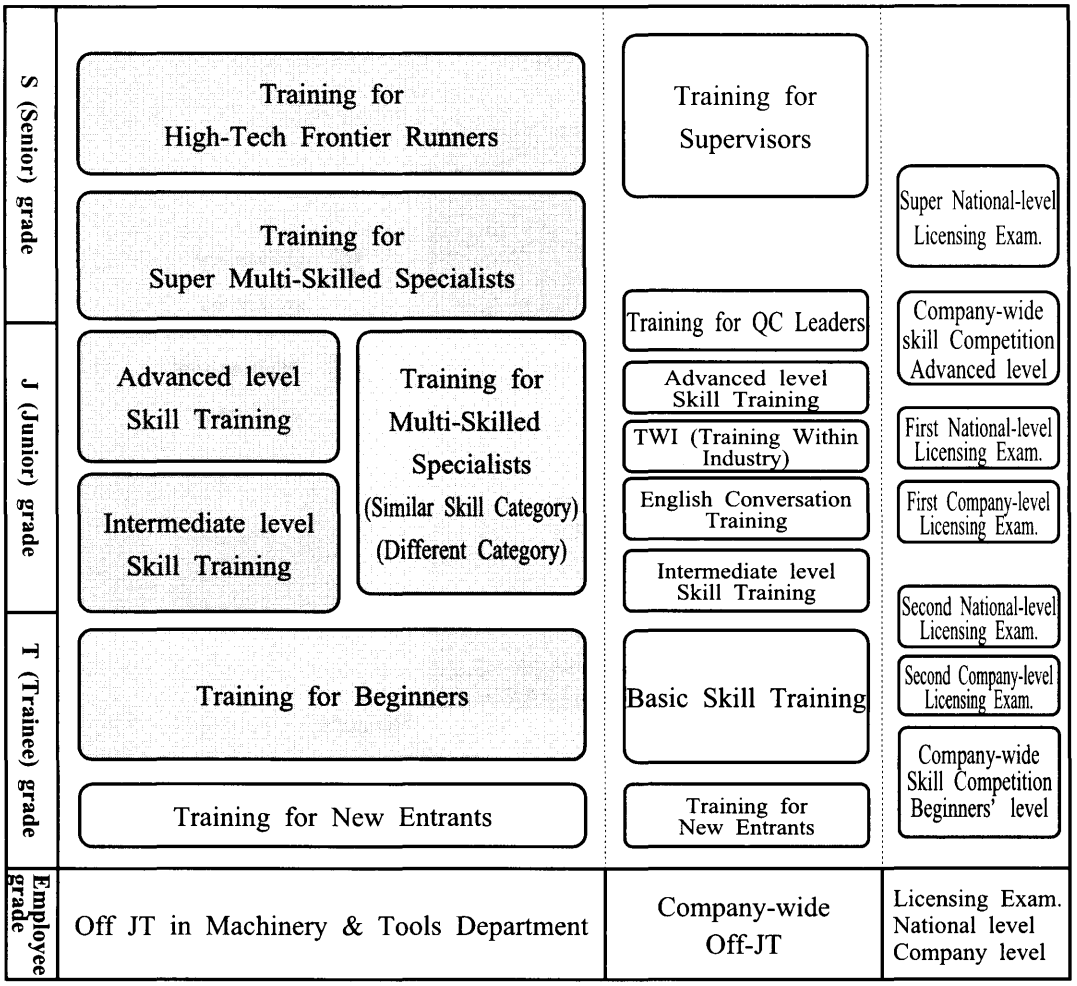
Source: Delineated by the author from the data presented by HRM Department of *F Plant* in 2000

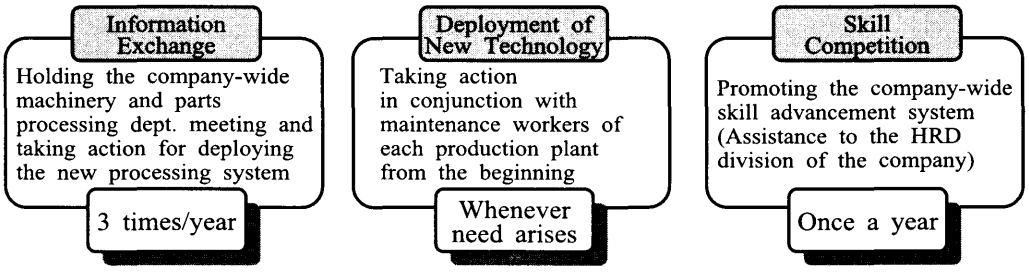
Figure 4 **Career Development for the Technical College Graduates in *D* Company**



Source: Adapted and translated by the author from Special Feature of *D* company in *Weekly Diamond,* 23 July 2005, p.131, with amendment based on interviews with the Technical College instructors in July 2005

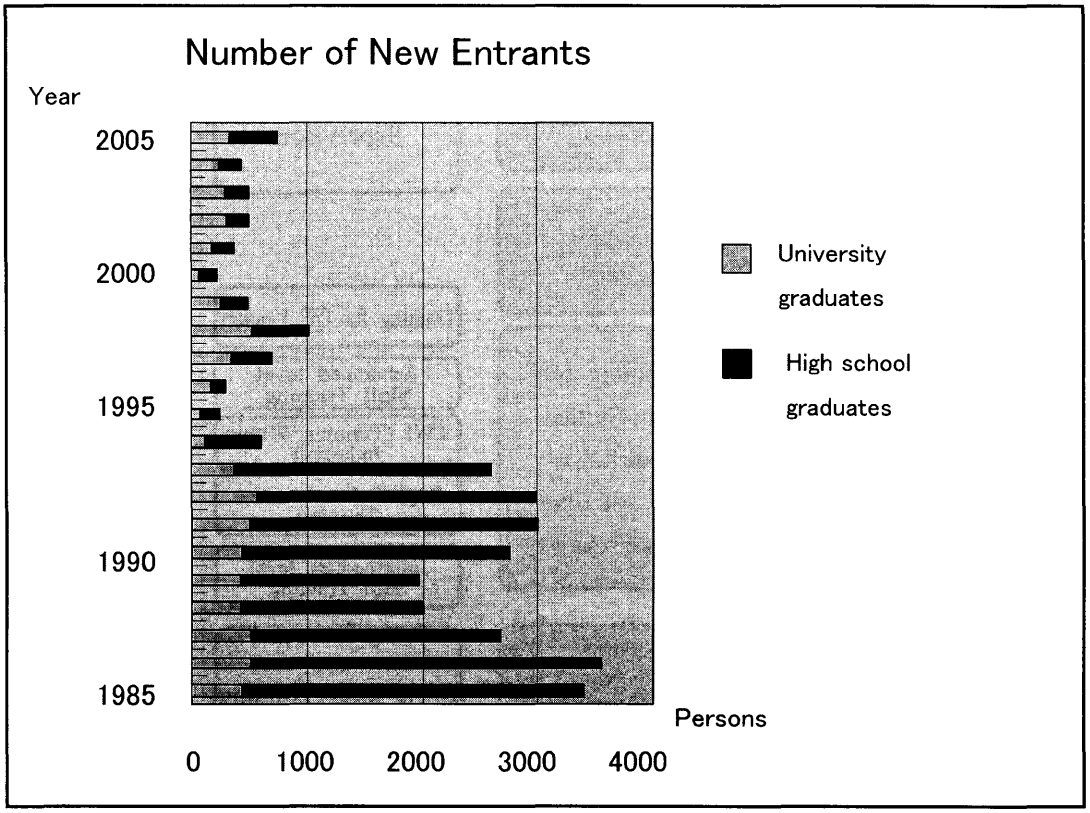
Figure 5 **Training Scheme in Machine and Tools Department**





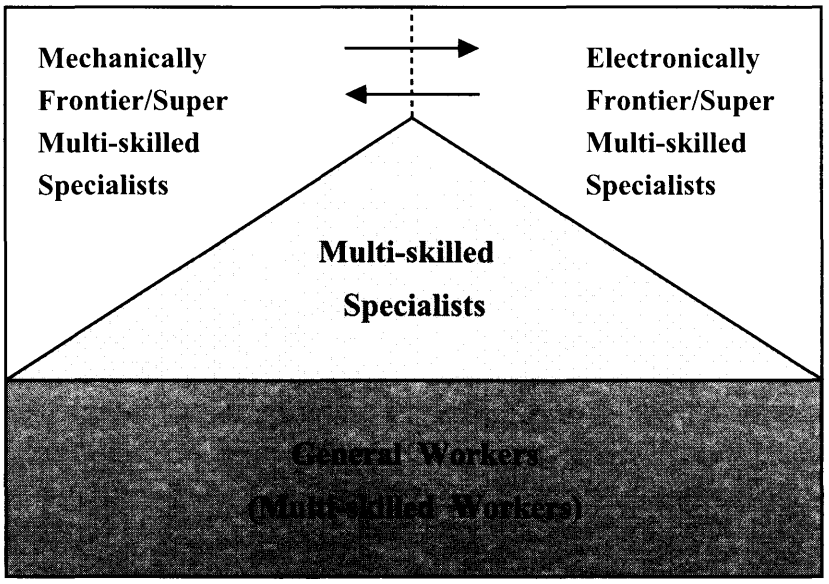
Source: Adapted and translated by the author from the data in the Department

Figure 6 **Changes in the Number of New Entrains in *D* Company**



Source: Delineated by the author based on the data from the company

Figure 7 **Image of the Super Multi-Skilled Specialists in *D* Company**



Source: Delineated by the author from the image
presented by the managers in Prototype Department in *D Company* in 2005