INSTITUTIONALIZING THE TECHNICAL MANPOWER FORMATION IN MEIJI JAPAN

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I. THREE POINTS OF ANALYTICAL FRAMEWORK

IN THE early stages of Japanese industrial development, even the simple factory operation based on Western technology was a new experience. Factories making use of Western technology had to go through a series of trial and error before absorbing the technology well enough to use it regularly in good progress of production. The large-scale importation of technology was made through government policy but the people actually involved in it were those who had technical knowledge and practice.

In the early stage of industrialization, technical manpower came from employed foreign engineers, foremen, and skilled workers who educated Japanese on the job. Thus, introduction of technology and technical education were closely unified. Only after the early stage of introduction of Western technology were formal educational institutions established to train technical manpower.[1] The process of creating such institutions, however, was by no means simple. It was a more complex process than developing a general education system for furthering the literacy and basic knowledge of all people or that of setting up the imperial universities to create a modern type of elite, which of course consisted of training future government officials. Institutionalization of technical manpower agencies was not determined by government policy alone. Japan's experience in institutionalizing these agencies has been clarified by detailed studies of the influences on government policy-making, environmental conditions, relation between government policy and technical manpower agency activity, and on the quality and quantity of the manpower produced by the agencies.

In this essay we will look at the institutionalization of technical manpower agencies in Meiji Japan through a sociological framework in answer to these three questions.

(1) Whether the formation of this type of manpower was institutionalized according to three stages of technical introduction and development—that of (a) full introduction, (b) partial introduction and imitation, and (c) an orientation to internalize foreign technology. These three stages of technical introduction and development correspond to three stages of industrial development.

(2) How a kind of hierarchy formed by level and/or stratum of technical

[1] For a general history of the engineering profession in Japan, see [4, pp. 32–63] [5, pp. 134–64].

manpower, divided up during the institutionalizing process. This problem is closely related to those pertaining to the advent, formation, and settlement of social classes in modern Japan as well as to the contributing role of institutions for social development.

(3) Each institution for the formation of technical manpower, when established, had its particular functions and purposes. The purposes were primarily vague because they sometimes had different purposes which, though, included items to promote industrialization of Japanese society. With the lapse of time, however, functions and purposes often changed in quality. The problem here is what were the conditions involved in the change and degeneration of the purposes and social roles, and what process the change went through.

By tracing the process of institutionalization of technical manpower formation in Meiji Japan with this three-point sociological framework as an analytical criteria, a flat historical description can be avoided, that would merely be a chronological presentation of related laws and specific institutions. When developments in Meiji Japan are analyzed based on the interrelationship of three analytical points—(a) the relation between the stage of foreign technology introduction and the institutionalization of technical manpower, (b) the differentiation of a stratified typology for technical manpower in terms of institutionalization, and (c) the changing aspects of agencies for the formation of technical manpower—the following points must be taken into account:

First, how did educational agencies (c) contribute to the formation of a social class structure (b) concomitant with the development of industrial society? If the dominant pattern of class structure of the pre-industrial stage is maintained, contemporary modern educational system, it is said, reinforces old social systems. Conversely, should the old system collapse, new educational system would be a factor in forming a new class structure.

Second, it is necessary to ask whether the technical variables of (a) are independent or dependent. Introduction of foreign technology per se was decided by individuals and organizations, and adaptation to technology introduced from Western countries is determined by some moments of social factors. Technology is often regarded as an external condition of social systems, but this is not always adequate to explain social phenomena in the period of social change. The universalism-particularism principle works on particularly subjective standard of adaptation of technology introduction from a heterogeneous society. The cultural factors involved in internalizing technology often determine the pattern of introduction, and the pattern varies according to who introduces it and the channels through which technology is introduced. In the same sense, (a) is not always an independent but sometimes a dependent variable of (b) and (c). Sometimes, distinct social situations in each stage of development interact with the overall cultural foundation and are crystalized in (b) and (c) which then determines (a). With these points in mind, the analysis should turn to the institutionalization of technical manpower formation in Meiji Japan.

II. LEGACY OF TOKUGAWA ERA

In the latter part of the Tokugawa era before the Meiji Restoration (1868), introduction of foreign technology was limited to specific types contrasting to Meiji in which a wide range of technology was adopted in the major industries, based on learning of Western knowledge, especially of Dutch one. Before the Restoration, introduction of foreign technology was partial and sporadic, coming only through trial and errors in translation of scientific and technical literature and study with experiences of repair and assembly of damaged foreign ships and machines. Good examples were the construction of a reverberatory furnace and Japanese participation in the dismantling and assembling of a wrecked Russian ship.

Japan's introduction of foreign technology, though fragmentary and partial way, was at that time a result of an incessant effort by officials (samurai) of the Tokugawa shogunate and some progressive fiefs. For them the introduction of foreign technology was a competitive matter, and they employed artisans to actually handle the technical tasks.

Those who led in the introduction of foreign technology were educated men, well versed in the Chinese classics, the most important learning in those days, and in Western knowledge. The artisans behind them had experience and skills retained in Japan's traditional industry. The officials and artisans belonged to two different social classes in Tokugawa era. Some of the artisans, through contact with Western technology, became craftsmen and tradesmen and then grew up as skilled workers. The officials, however, did not constitute as an obvious occupational group of technologists, because they were originally warriors (samurai), bureaucrats and men with Western knowledge, before they were to be engineers.

At the close of the Tokugawa era, shogunate tried to introduce large-scale Western technology. A typical example of this trend is seen in shipyard construction. Shipyard construction usually necessitates civil engineering, dredging, and factory-building technology prior to shipbuilding technology itself.

Two shipyards were constructed, one in Nagasaki, Kyūshū (Japan's southernmost island) in 1856 and the other in Yokosuka, near Tokyo in 1864. Both began their operations as steelworks.

The Dutch were in charge of supervision and technical guidance at Nagasaki, and the French at Yokosuka. At the same time shipyard construction was completed and operations started, two institutions for teaching Western technology as a trial of technical manpower formation were set up, the Nagasaki Kaigun Denshūjo (1855–59) and the Yokosuka Kōsha (1855–67), and neither was designated by a name that would indicate they were educational organizations such as "academy" or "school."

Of special note is the fact that the two institutions were proposed by Japanese samurai who had worked under the leaderships of the Dutch at Nagasaki Ship-

yard and also by François Leon Verney, the French chief at Yokosuka Shipyard.

These two institutions show us that technical manpower at the end of the Tokugawa era was formed through the integration of Western technology and manpower and the establishment of institutions to train technical manpower. In other words, Western technical manpower was employed to introduce industrial production facilities and equipment almost at the same time institutions for training technical manpower were set up.

With the collapse of the shogunate, the Yokosuka Kōsha was temporarily closed. But the Meiji government reopened it and set up two training courses—one for skilled workers and the other for foremen. Education at the Yokosuka Kōsha was a continuation of trial and error; it was very difficult to use Japanese workers with no experience in Western factory production and to give them the experience and the skill need or to teach what were a foreman's functions in a modern industrial hierarchy. But this experience helped set up a model to create technical manpower on an on-the-job training basis, as well as on the formal teaching basis.

III. TECHNICAL MANPOWER FORMATION BY THE MINISTRY OF TECHNOLOGY

It is well known, in Japan and by foreign Japanologists, that modernization in early Meiji was achieved under government leadership in only a short period of time. No doubt government-led modernization was most conspicuous in the industrial technology phase, because modernization of industrial technology was the most effective means for "industrial promotion," one of the most important programs of the Meiji government. Without going into the details of the government's industrial promotion policy in early Meiji, we will inquire the content of technical education and industrial training by the Ministry of Technology (1870–85).[2]

The Ministry of Technology started with ten departments, which was later reorganized into seven: mining, railroad, telegraph, lighthouse, engineering, maintenance, and the College of Technology (Kōbu Daigakkō). Three departments (shipbuilding, steelmaking, and surveying) were either made independent or absorbed by other departments.

The College of Technology, initially the Department of Technology (Kōgakuryō), was an organization for higher technical education. The Ministry of Technology opened the Department of Technology under the name of Kōgakkō (technical school) in 1873, when it invited nine British professors to teach at the school. In 1877, the name Kōgakkō was changed to Kōbu Daigakkō (College of Technology). All graduates of the six-year course were given a degree in engineering, equivalent to bachelor of engineering.

The plan for establishing the Kōgakkō, worked out in 1871, stated that the

[2] Chronological reports by the Ministry of Technology are included in [7].

selected students at the Kōgakkō had a chance to study abroad and that if the students were proficient enough in their work, they could replace the foreign engineers employed by the Japanese government. Hence the need for setting up the Kōgakkō as soon as possible [9, pp. 4–5].

Japan needed the college for the following three reasons:

First, the Japanese government employed many foreign engineers, foremen, and craftsmen for the installation and operation of machinery and equipment, necessitated by the importation of large-scale industrial technology. The breakdown on where these foreigners were employed is shown in Table I.

From 1873 to 1875, the total of government-employed foreigners was over five hundred, and about 40 per cent of them were in engineering. Government's financing for wage expenses was enormous, since the salary of a foreigner with an important tasks was almost the same as a government minister. The College of Technology was necessary not only to alleviate the government financial burden but to internalize Western technology to develop domestic industrial technology. Establishment of the college and other factors helped to gradually reduce the number of government-employed foreigners in the latter half of the 1870s, to less than two hundred in the 1880s.

Second, foreigners, particularly the British, played an important role in working out the college's establishment policy, developing its curriculum, and teaching. Actually, they served as researchers, professors, and technical instructors. As Table II shows the Ministry of Technology employed the largest number of foreigners, and the British made up the majority of all foreigners employed by the ministry and this was also true for all government-employed foreigners in 1874. The German were the second largest group in the Ministry of Education, and the French the largest of all foreigners in the Army Ministry and Navy Ministry.

TABLE I
GOVERNMENT-EMPLOYED FOREIGNERS BY OCCUPATION

	Teaching	Engineering	Secretarial Work	Artisans	Others	Total
1872	102	127	43	46	51	369
1873	127	204	72	35	69	507
1874	151	213	68	27	65	524
1875	144	205	69	36	73	527
1876	129	170	60	26	84	469
1877	109	146	55	13	58	381
1878	101	118	51	7	44	321
1879	84	111	35	9	22	261
1880	76	103	40	6	12	237
1881	52	62	29	8	15	166
1882	53	51	43	6	4	157
1883	44	29	46	8	5	132
1884	52	40	44	8	7	151
1885	61	38	49	—	7	155

Source: *Teikoku tōkei nenkan* [Japan imperial statistics yearbook].

TABLE II

GOVERNMENT-EMPLOYED FOREIGNERS IN 1874

	United States	Great Britain	France	Germany	Others	Total
Cabinet	1	1	1	1	1	5
Ministry of Foreign Affairs	6	2	1	1	4	14
Ministry of Domestic Affairs	4	9	7	—	7	27
Ministry of Finance	7	16	—	—	4	27
Ministry of the Army	—	—	36	—	2	38
Ministry of the Navy	—	29	36	—	1	66
Ministry of Education	14	25	10	24	4	77
Ministry of Technology	7	185	13	6	17	228
Ministry of Justice	1	1	4	—	2	8
Ministry of the Imperial Household	—	—	—	2	—	2
Commission of Colonization	7	1	—	3	—	11
Total	47	269	108	37	42	503

Source: *Teikoku tōkei nenkan* [Japan imperial statistics yearbook].

Third, prior to the establishment of the College of Technology, the idea was that graduates of the college would go for further study abroad and become the core of an elite of technocrats and professors. In fact, eleven selected graduates of this college in 1880 were sent to Britain for three years. Besides the College of Technology, Tokyo Imperial University and other advanced educational institutions under the Ministry of Education had technical training departments, but these were included in the Faculty of Science at the University of Tokyo by 1886 with only four courses: civil engineering, machinery, applied chemistry, and mining-metallurgy. The courses and/or subject matters at the College of Technology, however, covered the major fields of industry, civil engineering, shipbuilding, electricity, architecture, applied chemistry, and mining-metallurgy. From 1879 to 1886, the College of Technology sent out 213 graduates.

One important feature at the College of Technology was its emphasis on practical training as well as theory. Students obtained valuable experiences from direct participation in factory construction and other Ministry of Technology projects. The curriculum called for all students to participate in on-the-job training during spring and summer vacations and put the major part of their time into such training during the fifth and sixth years of the course.

After the Ministry of Technology was dissolved in 1885, the College of Technology was made part of the Faculty of Technology (Kōka Daigakkō) at the Tokyo Imperial University, the institutional system of which was improved through the 1886 Ordinance for Imperial Universities.

After absorbing the College of Technology, the Faculty of Technology of the Tokyo Imperial University gradually strengthened its academic research nature, its traditional educational policy and curriculum differing from the College of Technology which stressed practical training. But both the Faculty of Technology of the Tokyo Imperial University and the College of Technology under

Ministry of Technology equally contributed toward developing government technocrats.

The Faculty of Technology thus monopolized the supply of technologists until the second imperial university was established in Kyoto in 1897. One reason for this is that other faculties, mainly the Faculty of Jurisprudence, of the Tokyo Imperial University, were the major source for high-ranking government officials. This means that Tokyo Imperial University, the only imperial university, had a monopoly over the creation of high-ranking government officials who would work for national goals.

When the nation's industrial revolution began around 1900, the Faculty of Technology, however, became more and more unable to meet the rapidly growing demand for technologists, particularly from private enterprise. Then, more advanced technical colleges (*kōtō semmon gakkō*) than secondary education, though lower of a educational level than the imperial universities, were set up throughout the country. Analysis of these colleges and the technical schools (*kōgyō gakkō*) of a secondary level will be explained in Section VI.

From the early 1870s the Ministry of Technology was training well-qualified engineers at the College of Technology, and also trying to train all levels of skilled workers. Because top-flight engineers and skilled workers were needed to use industrial technology from Western countries, the college initially offered on-the-job industrial training by foreign engineers and in its early stage adopted a small-scale formal training system. The Ministry of Technology set up training classes in each department in order to train department officials.

One of the examples of the effort to have better-organized, large-scale training system is shown in the Telegraph Department which set up a training school (*shūgi gakkō*) with two courses—one for experienced technicians (*gishu*), the other for new entrants (*shūgi-sei*). A total of 1,859 persons were trained in this school from 1871 to 1885.

The most outstanding feature of industrial training before the 1870s was the training of upper class technicians and an obscure differentiation of engineer status. Even engineers who worked in workshops or at sites could climb to a considerably high level in the bureaucratic ladder system formalized in early Meiji. Some engineers had an opportunity to become nonmanual white collar workers and study abroad, which denotes that operating skills were very important in the early period of foreign technology introduction. By the 1880s at the latest, however, the promotional system was changed to make the conditions for engineer qualification more readily understandable.

IV. MARKET FOR HIGHLY TRAINED ENGINEERS

Both the College of Technology and the Faculty of Technology (Tokyo Imperial University) were set up for high-level education that would produce a technological elite. The official purpose initially was to train technical officials for government, but openings for graduates in industrial and technical administrative organizations and government enterprises gradually decreased. Also, private

enterprise began to develop rapidly at the turn of the century. Here we will try to show by using statistical data what kind of jobs high-level engineers obtained when the employment market changed.

As Table III shows, there were 339 graduates of the Tokyo Imperial University Faculty of Technology in 1890, of which 32.2 per cent got jobs in private enterprise and other areas and 35.4 per cent in central and local government [15, p. 35]. The rate of graduates finding jobs in government might be estimated higher than 35.4 per cent because the "private enterprise and other" category includes businesses which were previously government-run enterprises. But the rate of graduates employed by the private sector thirty-one years later increased to 53 per cent, as shown in Table IV. Because data in the table includes graduates from faculties of technology other than Tokyo Imperial University, vacancies for government officials probably declined for graduates of imperial universities established later. But change in employment for Faculty of Technology graduates was more likely brought about by the swift development of private enterprise. Table IV also shows the employment situation for graduates of the Faculty of Jurisprudence. This deserves special notice because even the rate of graduates employed by private enterprise went as high as 40 per cent. In addition, the proportion for private enterprise increased in engineers employment distribution at the beginning of this century.

However, these tables were compiled from data for employment of engineers at specific times. Considering that they did not always stay at the same place throughout their careers, it is necessary to judge occupational composition at a fixed time after determining what occupational mobility is. A survey on such mobility reports follows [10, pp. 21–27]. Forty per cent, or 295 of the 720 graduates of the College of Technology (Ministry of Technology) and the Faculty of Technology (Tokyo Imperial University) who were in private enterprise before

TABLE III

EMPLOYMENT AREAS OF GRADUATES OF FACULTY OF TECHNOLOGY, TOKYO IMPERIAL UNIVERSITY

(November 1890)

Place of Employment	Number	%
Central government	102	30.1
Local government	18	5.3
National & public schools, hospitals, etc.	23	6.8
Private schools	4	0.1
Banks	1	—
Foreign countries	17	5.0
Private enterprise (manufacturing, mining)	110	32.2
Private business	21	6.2
Retained in faculty	3	0.1
Died	21	6.2
Unknown	19	0.6
Total	339	100.0

Source: *Kōgakukai-shi,* Vol. 112 (1891), p. 314.

TABLE IV

EMPLOYMENT FOR GRADUATES OF FACULTIES OF TECHNOLOGY AND JURISPRUDENCE, TOKYO IMPERIAL UNIVERSITY IN 1921

Place	Technology		Jurisprudence	
	No.	%	No.	%
Government*	1,713	33.9	3,289	46.3
University, research institute	477	9.4	176	2.5
Private enterprise (B)	2,840	56.2	2,869	40.4
Free lance†	24	0.5	763	10.8
Total (A)	5,054	100.0	7,097	100.0
Mining & manufacturing (C)‡	2,684		1,203	
C/A		53.1%		17.0%
C/B		94.5%		41.9%

Source: [10, p. 14].

* Includes special banks and South Manchurian Railway Corporation.

† Mostly lawyers and patent attorneys.

‡ From (B).

1905, had jobs in three different organizational types—(1) private enterprise, (2) government organization or government enterprise, and (3) research or education. One hundred twenty-seven graduates had moved from government enterprises into research or education, 45 from private enterprise to government organization or government enterprises, 43 from private enterprise to government organization or government enterprises and then back to private enterprises, and 33 from private enterprise to research or education. Recompilation of basic data shows the following situation of initial and final employment: 128 were initially in private enterprise and 188 finished their careers in private enterprise. One hundred forty-two engineers had initial employment in government and government enterprise and 57 had their final employment in this area. Twelve engineers were initially employed in research and education, and 44 ended employment in this category. Engineers whose careers ended in private enterprises were the largest. Engineers moving into private enterprise were 42 per cent of those who first started their occupation in other than private enterprise. This great number of engineers moving from government to private enterprise indicates that technology, introduced by the government, was transferred to the later emerging private sector.

V. THE TECHNICAL SCHOOL'S CHANGING FUNCTION

With the birth of a bureaucratic hierarchy in both government and private industry, the labor force for technicians become stratified. But although great gaps existed between manual and nonmanual work in the 1880s not until the twentieth century did the management hierarchy rigidify.

Separation at that time took place only within the government hierarchy. But it had strong effects on the character of educational institutions for technical manpower. This is shown in the changing function of schools for training some

kinds of technicians and foremen, differing from the education for professional engineers. The organization was the Tokyo Craftsman School (Tokyo Shokkō Gakkō) began in 1881 to (1) offer income raising education to students from poor families, (2) reform apprentice education, (3) train industrial managers, (4) restore declining industry, (5) provide a model for a nationwide system of craftsman school to be set up in the future, and (6) train teachers for future craftsman school [13, pp. 59–62]. However, some changes were made in the Tokyo Craftsman School's directives for producing teachers, foremen, and factory superintendents [14, p. 4]. The six initial objectives in the draft plan for establishment were contradictory, particularly in the function of modern apprentice education and education for factory managers.

At the start, the Tokyo Craftsman School invited professors from Tokyo Imperial University and prepared a high-level curriculum. The school changed its name to the Tokyo Technical School (Tokyo Kōgyō Gakkō) in 1890 and became a higher educational organization as Tokyo Technical College (Tokyo Kōtō Gakkō) in 1903. In 1931 this college was made a university, the Tokyo Institute of Technology (Tokyo Kōgyō Daigaku). During the process of going from a middle to high educational institute, the Tokyo Craftsman School did not completely achieve its original plural purposes. Craftsman education became the duty of subordinate schools, and teacher training went to the technical teacher training institute. As a preparatory step, an attached technical school was established additionally on the same campus. This means that the craftsman and apprentice school and the technical teacher training institute shouldered some of the original goals of Tokyo Craftsman School. The Tokyo Craftsman School differentiated foremen and technician education as one of its objectives because of its high-level curriculum and low social level of craftsmen at the time of inauguration. People during that period often said "You don't need education to be a craftsman," and anyone in manual labor was not very high on the occupational ladder in the early 1880s.

Making the Tokyo Craftsman School an institution of higher education not only raised its educational standard but also removed the stigma of the word "craftsman." Thus while Japan's industrialization was going through its various development stages, formal education for craftsmen and foremen was neglected for a long time. In 1894, a mid-level industrial and technical school was founded but it did nothing to contribute to the training of craftsmen and foremen. The formal educational system did not create any schools whose primary purpose was job training of this kind. Training of craftsmen and foremen took place mainly within government and private enterprise.

As mentioned earlier, graduates from the College of Technology (Ministry of Technology) and the Faculty of Technology (Tokyo Imperial University) worked mainly in the public sector, in central and local government, government factories, and schools. Japan's institutions for higher education unified under the imperial university system in 1886 aimed primarily at producing modern manpower that would promote and orient the government's role in administration, industry, and education, and the elite who would carry out this role was limited in size. At

the same time, a large-scale modernization policy was enforced mainly in government institutions helping to allocate imperial university graduates mainly to the public sector.

On the other hand, one of the objectives of the Tokyo Craftsman School was to educate men who would develop private industry. The school was expected to contribute to industrial development not only by its investment in government but also in private enterprise and to train manpower that would directly take part in the nation's industrial revolution. But the school failed to meet these goals. According to Table V, showing the changes in employment for graduates of Tokyo Craftsman School and its successors, graduates who got jobs in private enterprise were only one-fourth of the total until 1889. The majority of graduates could find jobs in government and government enterprise, but, in subsequent years, the flow of graduates into the private sector increased. After Tokyo Craftsman School became a higher-level technical school, the Tokyo Technical College, the number of graduates entering private enterprise rose conspicuously, to 63 per cent from 1916 to 1926. On the other hand, the number of graduates who went into teaching gradually decreased. This may be due to the fact that the college transferred its teacher training function to the subsidiary teachers school. To explain the decrease in governmental sector entry and the increase of people going into private enterprises, two points must be emphasized. The first that, as the status hierarchy in the bureaucracy was rigidly fixed, Tokyo Technical College graduates could no longer be promoted to higher positions and were even in some cases purged from highly responsible jobs . One graduate of Tokyo Craftsman School found a job in the nonmanufacturing sector of the government, and, was given a low position, his salary remaining the same for ten years. But he later succeeded in getting a higher salary after showing his

TABLE V

EMPLOYMENT FOR TOKYO CRAFTSMAN SCHOOL, TOKYO TECHNICAL SCHOOL, AND TOKYO TECHNICAL COLLEGE GRADUATES BY 1935

Work Place	Period of Graduation			
	Tokyo Craftsman School (1886–89)	Tokyo Tech. School (1894–1904)	Tokyo Tech. College (1904–15)	Tokyo Tech. College (1916–26)
Government & gov't-run enterprises	36(30.8)	204(22.1)	376(16.2)	321(13.3)
Universities and schools of lower levels	24(20.5)	66(7.1)	60(2.6)	76(3.2)
Private enterprise	30(25.6)	440(47.6)	1,223(52.8)	1,521(63.2)
Private business	8(6.8)	53(5.7)	217(9.4)	116(4.8)
Other	19(16.2)	161(17.4)	440(19.0)	371(15.4)
Total	117(100.0)	924(100.0)	2,316(100.0)	2,405(100.0)

Source: [13, pp. 1075–78].

Note: Other includes the graduates who advanced into higher education, who were retained at the same school, who went into military service, whose jobs were unknown, and those who died. Figures for 1890–93 are omitted because statistics for work place distribution were incomplete. Figures in parentheses are percentages.

certificate of graduation to his boss. There was no standard then by which to properly judge educational level and content of Tokyo Craftsman School, then the only technical school in Japan. Many higher positions were monopolized by Tokyo Imperial University graduates. In 1890, the Jurisprudence Faculty of Tokyo Imperial University was awarded special privileges under the Civil Service Appointment Ordinance stipulating examinations for higher officials, certifying credentials and promotion. This made it difficult for Faculty of Technology graduates to get important government jobs.

The second point is that private enterprises were established and expanded in the latter nineteenth and the early twentieth century. In the latter 1880s, some government shipyards, textile factories, and mines were sold to private companies at very low prices. Around then, small-scale companies, including subcontractors sharing in the production for government enterprise, began to emerge. These small private companies gradually grew in the early 1900s and employed more graduates from Tokyo Technical College. A few Technical College graduates set up and managed factories on their own, except from 1904 to 1915. Thus as is clear from the difference in occupational distribution of graduates, the Tokyo Imperial University Faculty of Technology and Tokyo Technical College had different functions.

VI. STRATIFICATION OF TECHNICAL MANPOWER

The Apprentice School Rules (1894), the Technical School Ordinance (1899), and the Professional College Ordinance (1902) strengthened institutional formation of technical manpower in middle and higher education. This institutionalization and the expanding supply of manpower encouraged a social stratification of technical workers. Of all educational ordinances and rules promulgated in the late nineteenth and early twentieth century, the Professional School Ordinance was the latest. But educational organizations under control of this ordinance were already in existence in the nineteenth century and Tokyo Craftsman School was one of these before it was made the Tokyo Technical College. Encouraged by the success of Tokyo Technical College, the government created three additional technical colleges prior to 1902. Technical schools became institutional foundations in 1902 as a part of institutionalization of middle schools for general, nonvocational education and secondary education on one hand, and had a close relationship with changes in apprentice schools on the other hand.

Apprentice schools were originally set up to modernize the collapsing traditional apprenticeship. For this reason, apprentice schools were, at the outset, mostly set up in local areas near traditional industries. In this connection, a report by the Ministry of Education said: "To date the apprenticeship has been the only way of producing craftsmen in this country. . . . Its educational method is extremely different from that of organized education. Under this system, most apprentices were employed by masters and learned their skills by imitating what the master did. A person could not obtain the knowledge required for such a job through any other method. A move thus began to offer systematic education

to beginning craftsmen and people recognized the need for a plan to train craftsmen. Thus, two types of craftsman training schools were born, the apprentice school (*totei gakkō*) and the supplementary vocational school (*jitsugyō gakkō*). Apprentice schools were set up to train apprentices in place of a dying apprenticeship..." [6, p. 235]. More emphasis was placed on apprentice schools than the vocational supplementary schools set up earlier. Two types were planned. One was to be set up in areas with traditional industries, such as wood working, metal working, and ceramics, the other for modern industry to be set up in urban areas with a population of more than 10,000. The former was the production area type, the latter the urban type. For some time after the ordinance was enacted, priority was given to the production area type apprentice schools but when the Vocational School Ordinance was set up in 1899, apprentice schools were considered the same as technical school. At the same time, the government decided to have a policy for the active advancement of urban technical schools. As a consequence, technical schools became more important than apprentice schools as far as middle technical education was concerned, and urban type apprentice schools with machinery and electrical courses took on greater importance. As a sequel to a revision of the Vocational Schools Ordinance in 1920, most production area type apprentice schools were closed, and most urban type apprentice schools converted to class B technical schools with an attendance period of one year less than class A technical schools. As of 1909, the number of technical schools (which became class A technical schools in 1920) was smaller than the apprentice schools, but the number of technical school students greater than the apprentice school students. In 1920 when most apprentice schools were closed, there were 126 of them with a total students enrollment of 17,707.

Middle technical educational institutions were mostly technical schools for the following reasons: First, emphasis was on a policy of developing those technical schools with the courses that could meet the demand of the modern industrial sector, and supply technical manpower to industry. Second, technical schools were ranked as secondary educational institutions, an intermediate level between compulsory primary and higher education. Third, apprentice schools (local and urban) whose position in school system was not clear were closed or unified in order to institutionalize the technical schools of the secondary level.

After 1920 technical schools made rapid progress, largely because technical school graduates could obtain secondary education qualifications and became able to go on to higher education (something almost impossible for apprentice school graduates). Because technical schools were institutionally recognized, it was highly possible for graduates to become lower level engineers even if they found a job in private enterprise without going to technical colleges.

In the Meiji era, foremen and superintendents were not trained so fast and their positions institutionalized in the formal organization of private enterprise. Rather, the difference between officials and workers, mainly between nonmanual and manual workers, and between white collar and blue collar workers, was fixed. This difference meant a quasi-discrimination in social status, and was a critical point in the careers of secondary education graduates when they sought

jobs in private enterprise whether they were officials or workers or whether they were first workers but later promoted a few years later. Treatment of graduates from secondary educational organizations varied according to enterprise, but representative enterprises generally treated them as officials. In the latter part of the Meiji era, emphasis shifted from apprentice schools to technical schools. Some apprentice schools were closed after 1920 and converted to class B technical schools, and some of them were raised to class A technical schools (classified as an ordinary secondary education). Enterprises creating demand for technical manpower at these educational levels were not always in favor of technical school progress. Some managers of enterprises preferred apprentice schools and class B technical to class A technical schools, because the former emphasized on-the-job training and practice [8, p. 286]. In the 1920s and after, so many technical school graduates became white collar workers that the supply was temporarily excessive. This is attributable to the following two reasons. First, the supply of middle level technical school graduates failed to meet the demand for foremen and superintendents, although this was where the major candidates came from. Second, middle-level engineers were in sufficient supply because technical colleges were developed under the auspices of the Professional College (*semmon gakkō*) Ordinance enacted in 1902. The first caused the functions of foremen and superintendents not to be systematized in the rational planning and scientific control of the production process, and they were accordingly limited to the supervision of idle manual workers. Foremen and superintendents were selected from manual workers and became personnel management-centered rather than job-oriented.

Another consequence was a deterred development of technicians for the nation's industrial system. This term "technician," though often given in the Meiji era and even today, is unrealistic and ambiguous. This explanation is used for lower grade engineers and, in the technical field it applied to graduates of secondary schools and/or junior colleges. All these explanations are for convenience sake. They do not really explain the true course of events in the Japanese industrialization process.

Technical schools, recognized as middle-level technical education, served to supply lower level engineers and aided the recruitment of nonmanual workers for industry. This helped form a social stratification of technical manpower and enabled technical schools a solid place within the hierarchy. It is also necessary to emphasize the role of technical colleges, set up after the enactment of the Professional College (*semmon gakkō*) Ordinance in 1902, which contributed to the fixation of technical manpower stratification.

In 1901, Tokyo Craftsman School became a high-level technical school, called the Tokyo Technical College. In the next year, an ordinance on non-college professional schools was enacted. This coincided with the time when professional colleges of commerce, agriculture, forestry, and medical science were made high-level educational subjects. Ten technical colleges were set up before 1919 and eleven after 1920 through 1924, mostly in local areas with no industrial zone. In the Taishō era (1912–25), four major industrial zones developed rapidly in

Japan when manufacturing industries came in. Technical colleges were set up in those industrial zones in a relatively early stage of development. They were set up in succession also in other areas. The technical colleges set up earlier were made up of faculties for raw materials, energy, traditional industries, and light industries (e.g., mining, metallurgy, ceramics, spinning, and silk production). These technical colleges initially contributed to industrial development in local areas, but industries in the four major industrial zones did not have the capacity to absorb most higher level graduates. Surplus engineers recruited from technical colleges in local areas thus went into other areas.

Most of latecomer technical colleges had faculties for heavy industry, such as electric power, machinery, and applied chemistry. The birthplace of most technical college graduates both in industrial and local areas was far from their colleges and places of employment. Thus graduates' geographical mobilities between these places and their subsequent inter-organizational mobilities helped diffuse technical know-how and technology throughout the country [4, pp. 48–56]. The quantitative expansion of technical colleges helped form a stratum of college graduates just below that of the elite university graduates. As a result, formation of three or four strata of engineers in the broad sense progressed according to differences in educational level and period of attendance. It is not too much to say that the stratification of engineers provided the conditions under which a "degreeocracy" [11, Part 1], one of the most important characteristics of the Japanese social structure, became a permanent part of the ranking system of technical manpower.

VII. ORGANIZED TRAINING IN INDUSTRY

As stated, large-scale technical introduction from Western societies was carried out by policies of the Meiji government. At the same time, technical education was introduced simultaneously. Technical education was mainly on-the-job training, and the organized school education was carried out only at training centers in certain government departments in early Meiji. The College of Technology (Kōbu Daigakkō) alone could boast of higher educational faculties, its systems and curriculums merging with the Faculty of Technology of the Tokyo Imperial University in 1886.

The Yokosuka Kōsha, started as a Japanese version of the French École Polytechnique, became a navy school when the Yokosuka Shipyard was turned over to the Ministry of the Navy. Most industrial training centers, including those in the Ministry of Technology, were for the introduction of foreign technology, but were closed in 1885. Industrial training was spread widely through the skills of different levels of technical manpower as it was transferred to private enterprise. The organized industrial training centers were retained even after 1886, and were not transferred to private enterprises because they were oriented toward supplying manpower to government public divisions, such as communication, railways, and merchant shipping.

As discussed in the previous section, secondary level technical education at

the Ministry of Education failed to create skilled workers, superintendents, and technicians, and accordingly, the industrial sector lacked adequate secondary-level technical manpower. Because Tokyo Craftsman School did not achieve its originally intended function, some graduates of the College of Technology and others established the Technicians School (Kōshu Gakkō) of post-compulsory education to develop technicians working in support of engineers. This evening class private institution became a university after World War II. Although an exceptional success, it did not however do more than supply a limited number of skilled workers. As such, the supply of skilled workers dwindled with the expansion of private enterprise from 1890 on, and enterprise vied for skilled workers. In order to secure these workers and improve their skills, the big companies set up their own training schools. Some of these schools, however, were not essentially for technical training, their primary purpose was to prevent skilled workers from leaving for other jobs.

The private training schools may be classified into the following four types by purpose: Type A to prevent skilled workers from leaving and give nontechnical training. Type B to prevent skilled workers from leaving and give technical training. Type C tried to improve vocational ability and give nontechnical training. Type D was for the improvement of vocational ability and technical training.

Type A was a supplementary education typically given to women textile workers. Because most women workers did not finish primary compulsory education, they were given this training as well as lessons to prepare them for marriage. Such educational incentives were useful for recruiting women. Actually, women workers did not have the time to participate, because they had to work in difficult conditions for long hours. The surveillance and control of women workers by a system of penalties was a basic part of personnel supervision at the textile mills.

Type B was the education given to miners. At the mines workers were compelled to work for long hours at extremely low wages and supervision and control of workers was given priority for the boss. But workers did have a chance to develop their skills. Technical training became necessary when labor problems emerged as a social concern and protection of workers was advocated as a government policy. Type B training school was then given to women textile workers as well.

Type C and type D were more advanced with well-organized training systems and facilities, and were used mainly in the machinery industry. Type C training schools emerged when primary education had not spread sufficiently through society, and type D training schools became the mainstay when attendance rates of primary education increased. Training schools of all types increased in the Taishō era. As a 1925 survey (Table VI) shows, there were not always many facilities for promoting organized educational activities. Few enterprises had type D training schools in the Meiji era but the private sector took the lead in the subsequent period. The cases of Nagasaki Shipyard and Yawata Iron & Steel Works are treated in this section as follows.

The Nagasaki Shipyard was sold by the Ministry of Technology to Mitsubishi

TABLE VI
ORGANIZED EDUCATIONAL FACILITIES IN FACTORIES, 1932

Facilities / Industry Type	Technical Training (%)	Supplementary Education (%)	Number of Factories Surveyed
Spinning factories	15.7	20.0	830
Weaving factories	7.9	57.5	238
Textile factories	2.8	8.9	213
Dyeing and weaving factories	2.9	9.6	104
Machinery and instruments factories	14.8	16.8	290
Chemical plants	3.5	6.7	283
Food factories	8.8	11.7	68
Miscellaneous factories	2.0	8.3	144
Special factories	8.6	4.3	23
Government plants	87.8	75.6	74
Average (total)	12.7	21.0	2,267

Source: Sangyō-fukuri-kyōkai, *Kōkōgyō ni okeru fukuri shisetsu chōsa* [A survey of educational and training institution in manufacture and mining] (Tokyo, 1933), Table 1 (selected items).

Heavy Industries in 1884. This shipyard later grew to become one of Japan's largest. Located on the southern island of the Japanese archipelago, the shipyard always had difficulty in employing enough workers. In the 1880s and 1890s when shipbuilding demand surged, all shipyards in the country frantically searched for experienced workers. Nagasaki Shipyard set up a regular employed craftsman system to prevent its workers from going to other companies. This was a kind of factory apprenticeship then adopted by heavy industry. Unlike the traditional apprenticeship in which an apprentice had a personal relationship with his or her master, the factory apprenticeship had a new entrant sign a contract with management, though the acquisition of technical skill was entrusted to the guidance of senior workers in the workshop. In the contract, the worker usually promised not to quit for three years. If the promise was broken, the money received at the time of signing, or deposits saved through a fixed rate deduction from monthly payment were confiscated. To insure fulfilment, the contract called for a new entrant to have a guarantor. The regular employed craftsman system worked to prevent the employee from leaving but was not effective in organizing training. Organized training was emphasized after the system was revised into a craftsman training system, but its fundamental character remained the same. This was because new entrants were learning workers before becoming apprentices.

An organized training school for training workers within industry was established in 1899. The school called Mitsubishi Kōgyō Yobi Gakkō (industrial preparatory school) was set up to improve the training deficiencies of the craftsman training system because of criticism of dysfunction in apprentice and technical schools of secondary education controlled by the Ministry of Education. The new system was designed to offer five years of full time general and technical

education to people over ten years old who had finished primary education.

Yawata Iron & Steel Works went into operation in 1897 as a large-scale integrated mill. This government-run steel mill set up the Yōnen Shokkō Yōseijo (young craftsman training institute) to aid the first five-year expansion program from 1911 to 1916. From the outset the institute was a modern skilled worker training center, because Yawata did not previously have a factory apprentice system. Unlike the Mitsubishi Kōgyō Yobi Gakkō, the Yawata training center was not called *gakkō* ("school"), and its prospectus purposely stressed that it would not use the word for "apprentice" [12, pp. 644–51]. The reason was that the steel company hoped to set up a skilled worker training center completely different from traditional apprentice schools, though the factory apprentice system was gaining popularity, and that it intended to maintain balance between work and education. The attendance period of the Yawata Training Center was two years. In the first year, entrants were requested to take basic education and on-the-job training, and in the second year had to choose one of three courses—ironmaking, steelmaking, or finished products.

Mitsubishi Kōgyō Yobi Gakkō and the Yawata Yōnen Shokkō Yōseijo had a great deal in common. (1) Young entrants with no previous career were selected by examination and only those who finished primary compulsory education were employed. (2) Independent training systems and facilities and a distinguished teaching staff, including educated engineers were provided. (3) They were established because of criticism of formal education, and (4) tried to have the students expect a position as a white collar engineer after training. For about ten years after they were set up, both training schools fulfilled their given objectives. Ministry of Education officials and university professors visited the two training schools and praised them, saying that the two schools were better than the Ministry of Education's technical and apprentice schools. This success, however, lasted no more than ten years, because students were dissatisfied when they found it virtually impossible to be promoted to white collar status, though the schools told them they would. At state-run Yawata, personnel assessment was made in line with criterion of the central government bureaucracy. Nagasaki Shipyard, by then a big enterprise, copied Yawata's organizational management pattern. Coincidentally, the labor movement in the United States and Europe grew stronger at the outbreak of World War I and this stimulated the growth of the Japanese labor movement. Top leaders in the labor movement intervened directly in Yawata's management-labor conflict, and a number of those who supported the labor struggle were connected to the young craftsman training center. Yawata management partly conceded to its workers and worked out a policy of promoting them to white collar positions. It also revised the training school system by partly carrying through its managerial viewpoint. Namely, the system was reformed so that workers already employed instead of just new employees could attend the school on a part-time basis and improve their skill. But the full-time training school did have considerable success.[3]

[3] For a more detailed analysis, see [3, No. 111, pp. 41–49, and No. 114, pp. 63–86].

VIII. SUMMARY

Creating institutions for the formation of technical manpower in Meiji Japan was a complex process. At each stage of industrialization, from the overwhelming introduction of Western technology to the time when Japan's industrial revolution had become fairly thorough, many factors were operant. Some institutions for training technical manpower were informal, lacking any rigid organization but managed to produce high-level engineers. Organizations of this type were present at every stage of Japan's industrialization. However, institutional characteristics changed along with the stage of technical introduction.

The first point covered in the essay is that the process which the three stages go through may be in different forms. First, the institutions and training systems in late Tokugawa and early Meiji were of an on-the-job instruction type and instruction was given by professionals invited and employed by the government. Prominent examples of this type are Kōbu Daigakkō (College of Technology) and Yokosuka Kōsha established in the Yokosuka Shipyard. Both agencies were controlled by the Ministry of Technology. Training systems under the Ministry of Technology were not as well organized but they gave particular emphasis to on-the-job training. In the next stage of diversified introduction of technology, institutions for training technical manpower gradually changed. The curriculum was more thoroughly organized and administration more rigidly in the hands of Japanese government. A fact that shows this most distinctly is the policy of shifting the jobs of professor or instructor in institutions from foreigners to Japanese. In order for students to receive training they had to attend their courses full time. In the third stage of technical introduction, there were great variations in the training situation, something especially true after the abolition of the Ministry of Technology and the creation of an imperial university system, and all manpower training came under the control of the Ministry of Education. The formalization of this system began in 1886. As noted, the various systems of training which increased in type in and after the 1880s had a decisive influence on stratification of technical manpower. This is the second point in the sociological aspects of this essay.

Status differentiation was a distinct manifestation of the school system. In parallel with stratification in the system of public sector except for technical officials, the educational institutions which the official graduated was decisive in determinating his status. At the top of the pecking order were the Faculty of Technology (Tokyo Imperial University) and the College of Technology (Ministry of Technology). The Technical College (Kōgyō Semmon Gakkō) preceded by the Tokyo Craftsman School (Tokyo Shokkō Gakkō) in 1881 was third. The technical schools (*kōgyō gakkō*) set up throughout the nation in the last part of the nineteenth century ranked fourth. Other institutions, especially those established in particular corporations, constituted a different stratum of technical manpower, because they were not recognized formal systems. This is a result of bureaucratic organization in the early Meiji period, often claimed to

be a mere continuation of Tokugawa bureaucracy.[4] However, there were other factors working to stratify technical manpower creation when Japan began the initial phase of modernization. One is the lack of professionalism in engineering compared to the situation in America.[5]

Changing feature of institutional functions is the third point in the framework. The process of upgrading schools was a common phenomenon as was noted. A typical example was the change in the function of the Tokyo Institute of Technology (Tokyo Kōgyō Daigaku), which first was a craftsman school, then a secondary level technical school, and finally a higher education institution. As a consequence, there were no formal institutions effectively training mid-level foremen and skilled workers. It was not until the twentieth century that well-organized systems of on-the-job training developed in industry.

[4] For example, see [2, Chapter 6].

[5] For a detailed analysis of the professional character of American engineers before establishment of technical colleges, see [1, Chapter 1].

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