Distribution of Engineers in Private
Enterprise in Mid-Taishō
– Their Role at the Inception of Entry
into Heavy and Chemical Industries –

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INTRODUCTION

This article is a continuation of “Distribution of Engineers in Private Enterprise in Late Meiji” (hereafter referred to as “earlier article”), published earlier in this journal.¹ As in the earlier article, I shall make use of lists² of graduates from universities and higher technical schools to discover the number of school-graduate engineers, classified by industry and by key enterprises, employed in 1920; from a study of the changes in the ten years

¹ *Keieishigaku* [Japan Business History Review], vol. 14, no. 2, (October 1977).

² My basic source materials were the 1920 edition of *Gakushi kaiin shimeiroku* [Registry of Names of University Graduate Members], as well as school yearbooks from the higher technical schools in Tokyo, Osaka, Sendai, Kumamoto, Nagoya, Yonezawa, and Kiryū, school yearbooks from Kyoto Higher Polytechnic School, Akita Mining Technical School, and Meiji Technical College, as well as the 1920 roll of Waseda University alumni. These were comple-

since 1910, studied in the earlier article, I shall proceed to study how the growth in large-enterprise management in this period, and the diversification into, or new entry into, heavy and chemical industries was reflected in the employment of engineers within the various enterprises.³

The year 1920 corresponds to the year of the recession that set in as a reaction to the end of World War I; accordingly, the distribution of engineers in that year can be taken to show the situation when the great demand for engineers reached its highest watermark as a result of the prosperity of established businesses during the war and the starting up of new businesses in the heavy and chemical industries as a means to replace

mented by *Nihon kōgyō yōran* [Handbook of Japanese Industry], 9th impression (pub. by Kōgyō-no-Nihonsha, 1919); *Teikoku Daigaku shussin-roku* [Registry of Imperial University Graduates] (1922); and *Kuramae kōyūshi* [Kuramae Alumni Magazine] (1926). Detailed statistical data have been published in my “1920-nen no daigaku-sotsu gijutsusha bumpu” [Distribution of University Graduate Engineers in 1920], *Tōkyō Keidai gakkaiishi* [The Journal of Tokyo Keizai University] no. 152 (Sept. 1987) and “Shoki kōkō-sotsu gijutsusha no katsudō bun’ya, shūkei kekka” [Areas of Operation of Early Higher Technical School Graduates and Total Results], *ibid.*, no. 108 (Sept. 1978).

³ This and the earlier article are parts of a research project dealing with the relationship between Japan’s industrialization and the increase in engineer numbers, research based on a chronological analysis of technician distributions every ten years, starting in 1880. Besides the articles mentioned in the preceding footnote, others already published are: “Shoki ryūgaku gijutsusha to Ōbei no kōgaku kyōiku kikan” [Engineers among the First to Study Abroad and European and American Engineering Education Institutions], in *Tōkyō Keizai Daigaku jimbun shizen kagaku ronshū* [The Journal of Humanities and Natural Sciences, Tokyo Keizai University], no. 710 (Dec. 1985), and *Kigyōnai gijutsusha soshiki no keiiseiki* [Period of Formation of the Organization of Engineers within Enterprises], *Tōkyō Keidai gakkaiishi* [The Journal of Tokyo Keizai University], nos. 109/110 (Dec. 1978). See also “Gijutsusha no zōka: bunpu to Nihon no kōgyōka” [Growth and Distribution of Engineers for Industrial Development, 1880-1920], *Keizai kenkyū* [The Economic Review], vol. 39, no. 4 (October, 1988); and “Japanese Technical Manpower in Industry, 1880-1930: A Quantitative Survey,” a paper presented to the 2nd Anglo-Japanese Business History Conference, Longon, September, 1988.

scarce imports caused by the war. On the supply side, engineers were being produced in abundance during the preceding ten years from the new engineering faculties of Kyūshū Imperial University and Tōhoku Imperial University, while higher technical schools were created in Nagoya (1908 [year in parentheses indicates the year of the first graduating class]), Sendai (1910), Yonezawa (1913), Kiryū (1919), and a mining school in Akita (1914). In private schools, the Science and Engineering Department of Waseda University (1912) and the Meiji Technical College (1914) were established. From the conditions obtaining for both supply and demand, it is clear that the employment of engineers in private enterprise in mid-Taishō had, as one would expect, numerically increased as compared with employment at the end of the Meiji period, dealt with in the earlier article.

In the first part of this article, I shall present a statistical survey of the number of engineers in 1920 who had graduated from universities and higher technical schools, classified by industry and key enterprises, and then see how the increase in engineers, the changes in industrial structure, and the starting up of new enterprises reflected upon the distribution of engineers. Then, taking these statistics as a basis, we shall consider several problems in the employment of engineers within an enterprise, problems peculiar to this period. In the second part we shall look at individual enterprises to see, through the distribution by year of graduation of the additional number of engineers, the spread of seniority stratification. In the third part we shall look at managers at the top of the seniority strata who were of technical origin, and study the distribution of their years of graduation. In the fourth part we shall study the extent, if any, to which movements of engineers took place from government offices or already established enterprises, movements that made possible the starting of new enterprises. In the fifth and last part, we shall consider the employment situation of science faculty graduates, who were the answer to the establishment of testing and research centers within enterprises that began at this time.

1. DISTRIBUTION BY INDUSTRIES AND ENTERPRISES

DISTRIBUTION BY GOVERNMENT AND PRIVATE ENTERPRISE

Table 1 shows the results of classifying, by the industries in which they were registered, the number of engineer graduates of universities and higher technical schools whose occupation was known, for the two years 1910 and 1920.⁴

**Table 1. Number of Engineers, by Government Offices
& Private Industry**

Ministry	1910			1920		
	Univ. grad.	Tech. school grad.	Total	Univ. grad.	Tech. school grad.	Total
<i>GOVERNMENT</i>						
Home Affairs	50	11	61	136	70	206
Prefectures etc.	124	171	295	230	394	624
Colonies	109	51	160	83	96	179
Finance	34	135	169	43	165	208
Schools	160	189	349	328	266	594
Army	30	68	98	90	73	163
Navy	94	154	248	197	221	418
Agriculture & Commerce	100	98	198	194	206	400
Communications	87	33	120	138	84	222
Railways	271	243	514	346	405	751
Others	16	7	23	10	19	29
SUBTOTALS	1,075	1,160	2,235	1,795	1,999	3,794

⁴ Because I include in the 1910 totals early engineers who had the experience of study abroad and other experience prior to the establishment of universities and higher technical schools, the totals do not agree with the sum

Industry	1910			1920		
	Univ. grad.	Tech. school grad.	Total	Univ. grad.	Tech. school grad.	Total
<i>PRIVATE</i>						
Railways	72	77	149	192	304	496
Marine Transport	23	5	28	51	34	85
Construction	12	11	23	80	51	131
Commerce	27	152	186	196	549	745
Mining	204	304	513	668	1,111	1,779
Metals	9	38	47	280	355	635
Shipbuilding	141	106	250	457	614	1,071
Machinery	27	78	106	100	454	554
Electrical Machinery	34	70	104	173	597	770
Electical Power/Gas	94	132	231	295	566	861
Ceramics Glass	23	66	90	69	233	302
Chemicals	24	68	93	224	346	570
Paper	13	54	68	58	149	207
Foodstuffs	17	131	149	84	96	180
Textiles	46	250	300	141	962	1,103
Others	80	421	506	162	717	879
SUBTOTAL	846	1,963	2,843	3,230	7,138	10,368
GRAND TOTAL	1,921	3,123	5,078	5,025	9,137	14,162

totals of university graduates and higher technical school graduates. In the higher technical school graduates for 1920, I include graduates of Waseda University's Science and Engineering Department. The reason for this is that at that period the department offered a four-year program for students completing junior high school, and enterprises also treated the graduates as being the same as higher technical school graduates. (See *Waseda Daigaku hyakunenshi* [One Hundred Years of Waseda University], vol. 2, 1981.)

In 1920, the total number of engineers reached 14,000, approximately 2.8 times more than the number ten years earlier. The composition of university graduates *vs.* higher technical school graduates was approximately 35% *v* 65%, and the rate of increase for the ten years was slightly higher for the latter.

The proportion in government *v* private employment underwent a big change. In 1910, 45% worked in government departments and 55% in the private sector, but in 1920 it had become 27% in the government sector and 73% in the private. Though the number of engineers in government service had increased, the figures show the private sector overwhelmingly dominant in the employment of engineers in this period. The majority of higher technical school graduates had always found employment in the private sector, but this tendency became even stronger in this period, while university graduates, who had shown a greater preference for government service ever since the first year of Meiji (1868), during this period reversed the trend and approximately twice as many entered the private sector as entered the government sector. This is a notable phenomenon in reaction to the expansion of private industry during World War I.

A look at the distribution of private sector engineers according to industries will show that a remarkable change has indeed occurred.⁵ Of the industries that are ranked highest in absolute employment numbers, the 1910 order of ranking of mining, textiles, shipbuilding, and electric power does not change in 1920, but the areas that exceeded the 3.6 times average rate of increase for all private industries were: metals, 13.5 times; electrical machinery, 7.4 times; chemicals, 6.1 times; and machinery, 5.2 times. As a result, the difference between the number of

⁵ In Table 1, diversification divisions within large enterprises, such as Mitsui & Co.'s shipbuilding division, Mitsui Mining's Miike Dye-Stuff plant, South Manchurian Railway's Fushun colliery, its Anshan Colliery, and its Shakakō Works are included respectively in the shipbuilding, chemical, mining, metalworking, and machinery industries.

engineers in these areas and those in the traditionally top-ranking areas decreased remarkably. This reflects the sudden rise in the heavy and chemical industries during World War I and the changes in the industrial structure. In the top-ranking areas, as well, the rates of increase in shipbuilding and in commerce were above the average, but when we next see these figures divided according to individual enterprises (Table 2), we find this is the result of first-level and second-level zaibatsu groups carrying out incursions into the shipbuilding area, or of a strengthening of a new-enterprise planning section in the parent company.

When we look only at private-sector engineers who are university graduates, we see that in 1910 there was a lopsided distribution, with 60% concentrating on the four industries of mining, shipbuilding, electric power and the railways. In 1920, however, the total for these same four industrial categories had dropped to 46% of the total. Part of the reason was that university graduates had invaded even those industries where before there had hardly been any university-graduate engineers, but another factor was that there were many university-graduate engineers entering sudden-growth areas, such as electrical machinery and chemicals.

DISTRIBUTION OF ENGINEERS IN PRINCIPAL PRIVATE-SECTOR ENTERPRISES

Table 2 lists enterprises employing twenty or more engineers in 1920.⁶ Of the 18 firms out of 65 that have no figures in the column for 1910, all except one or two were established after

⁶ In Table 2 (unlike as in Table 1), South Manchurian Railway, Mitsui & Co., and Mitsui Mining include their respective diversification divisions. Mitsubishi Gōshi includes those divisions of the parent firm that remained after shipbuilding and mining split off as shareholding companies in 1917-18, as well as the commercial business. Ōkura-Gumi is the sum total of engineering works and commercial business, while Furukawa is the sum of the gōmei [unlimited partnership] headquarters and the mining operations. Japan Steel Works includes Wanishi Iron Works, and Nippon Kokan includes Asano Iron Works. Mitsubishi Shipbuilding's numbers are prior to the separation of the internal combustion engine and the electric operations. Hitachi

1910, and the areas they belong to are concentrated in iron and steel, shipbuilding, electrical machinery, electric power, and chemicals. This shows that the increase in employment of engineers in the heavy and chemical industries sector at this time was occasioned by the creation of quite large-scale enterprises.

The majority of such newly-established large enterprises came about through: a) diversification investment in the heavy and chemicals sector on the part of old zaibatsu that had in the Meiji years made mining the foundation of their operations, as seen, for example, in the Mitsui group's electro-chemicals (as well as what were equivalent to enterprises: the Mitsui & Co.'s shipbuilding division and Mitsui Mining's dyestuffs manufacturing plant); in Mitsubishi's iron manufacturing (as well as the full-scale operations of Asahi Glass and Mitsubishi Paper Mill, which had been established at the end of the Meiji period, and the separation of the internal combustion engines and electrical machinery from shipbuilding after the period under consideration here); in the Furukawa group's Yokohama Electric Wire Co. (later to join with the smelting plants in the mining industry to become the Furukawa Electrical Engineering Co.; plans to establish Asahi Electro-Chemicals were also underway); and in the Hitachi manufacturing plant that split off from Kuhara Mining; or b) the creation of enterprises aimed at the formation of new zaibatsu, as seen, for example, in the Suzuki Shōten group's Kobe Steel and Harima Shipyard, or the Asano group's Nippon Kōkan and Asano Shipyard.⁷ Still, it is worth noting that com-

separated from Kuhara Mining in 1920. Shimadzu Works includes Nippon Battery, and Nagoya Electric Light includes Kiso Electric Industry. The 1910 figures for Tōyō Cotton Spinning Co. and Dai Nippon (Cotton) Spinning are totals for each of the companies before their merger.

⁷ Included in the sudden increase in engineers employed by Takada Co., Mogi Gōmei, and Suzuki Shōten in the commercial business divisions are workers already on the payrolls of the manufacturing plants, as well as engineers from the new-enterprise planning and development sections of the head offices. Asano Gōshi does not appear in Table 2, but it also had a considerably large number of engineers. I might add that companies like Hongoiko

pletely new enterprises that did not belong to any such groups, such as Tokyo Gas & Electric, Kawakita Electric Enterprise, and Japan Dye-Stuff, had already grown so much that they had by this time hired several dozen engineers each.

Just looking at the figures for university graduates, one finds that the ratio of engineers working for enterprises in the four zaibatsu groups of Mitsui, Mitsubishi, Sumitomo and Furukawa to the number of engineers in the entire private sector was approximately 30%, almost the same ratio as ten years earlier.

A comparison of the ranking for numbers of engineers on the payroll, by enterprise, between 1910 and 1920, shows Mitsubishi Shipbuilding and South Manchurian Railway unchanged in first and second place, but Mitsui Mining has passed Mitsubishi Mining for third place, while Kawasaki Shipyard has risen to fifth place ahead of Furukawa and Shibaura. Mitsui & Co. in eighth place, and Kuhara Mining in ninth place have overtaken Sumitomo and Fujita-Gumi.

Table 2. Numbers of Engineers Classified by Private Enterprises

Company Name	1910			1920		
	Univ. grad.	Tech. school grad.	Total	Univ. grad.	Tech. school grad.	Total
South Manchurian R'lway	49	49	98	142	207	349
NYK Line	16	2	18	24	10	34
Ōkura-Gumi	5	7	12	29	19	48
Mitsui & Co.	7	35	42	57	101	158
Takada Co.	16	20	36	23	67	90
Mogi Gōmei				12	30	42

Coke & Iron (in process of being formed) within the Ōkura group, fall into a similar pattern.

Company Name	1910			1920		
	Univ. grad.	Tech. school grad.	Total	Univ. grad.	Tech. school grad.	Total
Suzuki Shōten				22	35	57
Mitsubishi Gōshi				11	14	25
Mitsui Mining	29	45	74	112	212	324
Mitsubishi Mining	42	34	76	132	157	289
Sumitomo Gōshi	18	31	49	27	58	85
Furukawa Gōmei	36	36	72	75	161	236
Kuhara Mining	5	33	38	53	88	141
Fujita-Gumi	22	23	45	44	52	96
Kaijima Mining	1	6	7	4	16	20
Meiji Mining	8	6	14	11	16	27
Iwaki Colliery	2	6	8	7	17	24
Hokkaido Colliery	11	7	18	37	34	71
Nippon Oil Co.	8	7	15	12	20	32
Hōden Oil Co.	6	11	17	7	22	29
Tanaka Mining	2	6	8	16	16	32
Sumitomo Copper Rolling	3	4	7	16	43	59
Yokohama Electric Wire				7	17	24
Sumitomo Cast Steel	4	11	15	18	22	40
Japan Steel Works	0	15	15	30	66	96
Kobe Steel				22	18	40
Nippon Kōkan				12	13	25
Mitsubishi Iron Mfg				20	25	45
Mitsubishi Shipbuilding	55	66	121	195	247	442
Kawasaki Shipyard	42	17	59	115	140	255
Ishikawajima	4	9	13	11	35	46
Osaka Iron Works	17	7	24	27	62	89
Yokohama Dockyard	9	3	12	35	25	60

Company Name	1910			1920		
	Univ. grad.	Tech. school grad.	Total	Univ. grad.	Tech. school grad.	Total
Asano Shipyard				16	34	50
Harima Shipyard				7	12	19
Kisha Seizō	7	5	12	13	12	25
Niigata Engineering	0	12	12	4	28	32
Tokyo Gas/Electricity				8	74	82
Shibaura Engineering	15	46	61	24	175	199
Tokyo Electric	4	5	9	27	63	90
Nippon Electric	4	6	10	5	12	17
Hitachi Works				17	89	106
Kawakita Electric Enter.	1	2	3	17	47	64
Tōzai Mfg				8	17	25
Shimadzu Corp.	0	2	2	8	16	24
Tokyo Electric Light	12	5	17	18	13	31
Osaka Electric Light	3	4	7	11	25	36
Nagoya Electric Light	4	9	13	4	48	52
Uji Electric	7	3	10	18	30	48
Kyūshū Electric Light				4	21	25
Kinugawa Hydro-Electric				12	8	20
Inawashiro Hydro-Electric				14	22	36
Asano Cement	4	4	8	15	18	33
Asahi Glass	2	5	7	25	41	66
Kantō Sanso	2	2	4	11	13	24
Dai Nippon Fertilizer				13	20	33
Nippon Chisso				9	16	25
Denki Kagaku				10	11	21
Japan Dye-Stuff				14	17	31
Ōji Paper Mfg	6	21	27	15	31	46

Company Name	1910			1920		
	Univ. grad.	Tech. school grad.	Total	Univ. grad.	Tech. school grad.	Total
Fuji Paper Mfg	4	12	16	12	42	54
Mitsubishi Paper Mfg	1	7	8	14	25	39
Dai Nippon Sugar Mfg	5	7	22	3	24	27
Taiwan Sugar Mfg	2	21	23	10	26	36
Meiji Sugar Mfg	1	5	6	6	30	36
Tōyō Cotton Spinning	9	36	45	20	118	138
Osaka Gōdō Spinning	0	25	25	3	42	45
Kanebō	14	33	47	19	81	100
Dai Nippon Spinning	9	38	47	27	85	112
Fuji Spinning	9	18	27	12	31	43

2. DEVELOPMENT OF SENIORITY STRATIFICATION

As can be seen from Table 2, in 1910 Mitsubishi Shipbuilding (it was then called Mitsubishi Limited Shipyard) was the only enterprise with 100 or more engineers on the payroll, and there were only six enterprises with 50 or more on the payroll; in 1920, however, there were eleven with 100 or more on the payroll, of which three—Mitsubishi Shipbuilding, South Manchurian Railway, and Mitsui Mining—were employing 300 or more. Enterprises with 50 or more engineers had reached a total of twenty-six.

In the earlier article I listed four factors in general that led to increases in the number of engineers within one and the same enterprise: a) increases in the number of places of business; b) use of graduates with a variety of academic backgrounds, following greater differentiation in job functions; c) organizational differentiation; and d) the formation of seniority strata as a result of hiring new graduates year after year. I demonstrated

that these factors were already at work in the late Meiji period in the large enterprises in such areas as mining, cotton spinning, and electric power that had several dozen engineers in their employ.⁸ In the Taishō period with which this article is concerned, these factors will, it is conjectured, have spread to ever increasing numbers of enterprises.

Let us examine the first factor. We find that mining companies like Mitsui, Mitsubishi, Sumitomo and Furukawa have ended expansion into mines in the Kyūshū area and have actively opened up mining sites in Hokkaido. Mitsubishi Shipbuilding has confirmed its policy of having two locations, in Nagasaki and in Kobe. Tōyō Cotton Spinning Co. and Dai Nippon Spinning Co., through amalgamation, had over ten mills, and the number of engineers sharing the workload amounted to over 100.

Looking at the second and third factors, we find that the iron-and-steel, shipbuilding, electrical machinery and other rapidly increasing manufacturing plants in this period required a deployment of engineers among the different work places because each plant contained a variety of internal processes with differing technical characteristics. Such diversification into completely different industries as Mitsui Mining's diversification into dyestuffs, Mitsubishi Shipbuilding's into electrical machinery, and the South Manchurian Railway's into mining and into iron manufacturing can be considered the result of the first to third factors combining to bring about an increase in the employment of engineers.

Probably the major cause for the increase in engineer numbers in the period under consideration within enterprises is the fourth factor, the formation of seniority strata. Except for the new enterprises, most of the large enterprises had been established by the late 1880s and therefore already had approximately a thirty-year history of employing engineers; those engineers who were among the first to be employed would be in their

⁸ See page 3 of the journal mentioned in Note 1 above.

fifties, and some of them would have retired, while some would have entered the ranks of management (as I shall discuss in the next part). Meanwhile, the hiring of new graduates would follow, one year after another, so that in each individual enterprise seniority strata of engineers automatically came into being within the enterprise. This was the outcome of natural forces; when it was, exactly, that the annual planned hiring of graduates from different university departments—considered to have become the general practice in the Shōwa years—and the practice of replacing old workers by young workers through the retirement-at-50's policy first started, is not too clear from previous research. Because I consider this question to be one part of a larger problem related to the origins of the “Japanese-style system of management,” I am particularly desirous of attempting a brief examination of the matter.

The Mitsubishi Shipyards, which had hired the largest number of engineers from the Meiji period on, annually employed graduates from shipbuilding and mechanical engineering departments of universities and higher technical schools; this is supported by research data.⁹ But there is little data on such new graduates for other enterprises.¹⁰ Furthermore, even just on the basis of research materials used for this article, it is clear that by the middle of the Taishō period movement of university and higher-technical school graduate engineers between almost all of the large enterprises, including Mitsubishi Shipbuilding—in other words, temporary employment—was being carried out on a considerable scale. Hence seniority strata based on year of graduation of the engineers on an enterprise's payroll at any given point of time cannot be taken from the raw figures of

⁹ *Mitsubishi Nagasaki zōsenjo shi* [History of Mitsubishi's Nagasaki Shipyard] and *Mitubishi shashi* [The Mitsubishi Company Journal].

¹⁰ Shinji Sugayama, “1920-nendai jūdenki keiei no kakyū shokuin-sō: Hitachi seisakusho no jirei bunseki” [Low-Level Employees in Heavy Electrical Machinery Management in the 1920s: Case Analysis of Hitachi Works], *Shakai keizaishigaku* [Socio-Economic History], vol. 53, no. 5. (Dec. 1987).

the number of newly hired engineers by year of graduation, but is the result of adjusting these figures with the number of those who have entered and left that enterprise during the year. With the figures understood, therefore, as not telling the whole picture, Table 3 gives the number of university graduate engineers, by year of graduation, on the payrolls of the principal enterprises in 1920.

Table 3. University-Graduate Engineers on Payrolls of Principal Enterprises in 1920, by University Department and Graduation Year

	Dep'ts	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13	'14	'15	'16	'17	'18	'19	'20
S. Manchurian RR	civil	19	3	2	1	0	2	0	2	1	1	1	0	3	2	7	3	1
S. Manchurian RR	mech.	11	0	1	0	5	1	3	0	2	2	2	1	1	1	0	1	0
S. Manchurian RR	mining	2	0	0	4	0	2	1	0	0	0	0	1	1	2	0	1	3
NYK Line	total	12	0	1	1	0	1	0	0	1	1	1	0	1	0	0	2	1
Mitsui & Co.	mech.	2	2	0	1	0	2	1	3	2	3	2	3	4	5	1	3	2
Takada Co.	total	5	1	3	2	1	0	0	0	2	2	0	0	2	2	0	2	0
Suzuki Shōten	total	2	0	0	0	2	0	1	3	1	0	1	0	2	3	5	0	0
Mitsui Mining	min/met	12	0	1	1	4	3	3	1	2	0	3	2	2	3	5	5	4
Mitsubishi Mining	min/met	17	1	1	0	6	6	2	8	6	2	6	8	5	9	9	8	1
Sumitomo	min/met	1	1	0	1	1	1	2	1	0	0	2	1	2	1	0	4	1
Furukawa	min/met	6	3	1	1	0	0	2	4	0	4	6	2	4	3	4	7	3
Fujita Gumi	min/met	4	4	2	1	3	1	1	1	1	2	3	1	2	2	3	0	0
Kuhara Mining	min/met	2	0	1	2	2	2	0	3	3	1	1	1	6	5	3	1	0
Hokkaido Colliery	min/met	5	0	2	2	0	0	1	1	1	3	1	1	2	2	0	0	4
Sumitomo Cast St'l	mech.	1	0	0	1	1	0	1	0	1	0	2	1	0	1	0	1	0
Japan Steel Works	mech.	2	0	1	0	0	1	1	2	1	0	1	1	2	1	2	1	0
Kobe Steel Works	mech.	1	0	0	0	0	0	0	1	1	0	2	2	2	4	5	0	0
M'bishi Iron Mfg	min/met	5	0	0	0	1	0	0	0	0	1	2	0	2	0	3	0	0

	Dep'ts	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13	'14	'15	'16	'17	'18	'19	'20
Mitsubishi Shipbuilding	naval	10	5	2	4	1	3	3	2	3	1	2	0	7	5	6	4	3
	mech.	8	0	1	2	3	0	3	1	1	4	8	3	3	9	10	18	11
	elec.	1	0	1	1	0	1	1	1	0	3	2	3	3	5	2	4	4
Kawasaki Shipyard	naval	7	4	0	0	2	4	3	3	0	1	1	0	0	1	0	0	0
	mech.	4	1	1	1	1	3	5	7	1	3	2	1	3	1	3	6	3
Osaka Iron Works	naval	1	0	1	3	1	1	3	0	0	0	0	1	0	2	0	0	0
	mech.	4	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2
Yokohama Dockyards	naval	1	1	0	0	1	1	1	0	0	0	0	0	2	0	1	1	2
	mech.	3	0	0	1	0	0	1	0	0	0	1	3	4	2	1	1	2
Shibaura Engin'g.	elec.	3	1	2	1	2	1	0	2	1	2	0	1	1	1	0	0	2
Tokyo Electric	elec.	4	0	0	0	0	0	0	0	1	4	1	4	1	0	3	0	2
Hitachi Works	elec.	1	1	0	0	0	1	1	2	5	0	1	0	0	0	2	0	1
Kawakita Electric	elec.	1	0	1	0	2	2	1	0	0	1	0	0	1	2	2	3	0
Uji Electric	elec.	2	0	0	2	0	0	1	1	0	0	0	0	0	3	0	1	0
Asahi Glass	chem.	1	1	0	0	1	0	1	2	1	1	5	2	5	2	3	0	1
Tōyō Spinning	mech.	5	2	1	1	0	0	0	0	1	3	1	1	1	1	1	0	0
Kanebō	mech.	2	4	1	4	1	1	0	0	0	0	1	0	0	0	0	0	0
Dai Nippon Sping.	mech.	6	0	1	1	0	1	0	0	2	0	0	2	4	2	1	2	1

Code: civil = civil engineering; chem. = applied chemistry; min/met = mining and metallurgy; mech. = mechanical engineering; elec. = electrical engineering

Seen from the two aspects of the increase in the supply of graduate engineers and the expansion of enterprises, the general trend towards relatively more recent graduates on payrolls than older graduates is natural. Acting on this premise, I would define seniority stratification to be advanced in those enterprises that have hired graduate engineers annually or nearly annually over many years. Because enterprise demand for engineers is generated in every specialized course of study for which there is no

substitute, data has been produced on graduates from the “mainstay” university departments providing the most numerous groups in each enterprise. For South Manchurian Railway, however, which was diversifying internally, I have chosen three university departments, while in shipbuilding firms I have chosen the two departments of shipping and mechanical engineering, and for Mitsubishi Shipbuilding I have selected as well graduates in the electrical engineering line.

Graduates in the most recent year, 1920, have not been taken into account, because I judged that some of the enterprises may not have finalized their hiring yet. Let us then examine the graduates in the fifteen-year period between 1905 and 1919, using the low number of years when no graduates were hired as a yardstick of seniority stratification, as mentioned above.

The only case that shows no zero—in other words, the only one from which at least one engineer was hired every year, is mechanical engineering in the case of Kawasaki Shipyard. Yet the other mainstay university department for that same firm, naval engineering, provided no new employees in seven out of the fifteen years, thus presenting the unbalanced picture of many graduates being hired in the earliest years and few in later years. The explanation for this is not known.

In the group of those with *one* zero-year, we find Mitsubishi Mining's and Fujita-Gumi's mining and metallurgy graduates and Mitsubishi Shipbuilding's naval engineering graduates, while Mitsubishi Shipbuilding's mechanical engineering graduates also showed a fairly average *two* zero-years. Others in the *two* zero-year group were Mitsui & Co.'s mechanical engineering graduates and Mitsui mining's mining and metallurgy graduates.

In the *three* zero-year group we have South Manchurian Railway's civil engineering, Furukawa's mining and metallurgy, and Mitsubishi Shipbuilding's electrical department graduates. And in the next group, that of *four* zero-years, we have South Manchurian Railway's mechanical engineering, Sumitomo Gōshi's mining and metallurgy, Japan Steel Works' mechanical engineering and Shibaura Engineering Works' electrical department (both

these firms are in the Mitsui group), and (in the Mitsubishi group) Asahi Glass's applied chemistry graduates.

Thus the enterprises ranking first in terms of total numbers of engineers—Mitsui & Co., Mitsui Mining, Mitsubishi Shipbuilding, Kawasaki Shipyard, and so on—hardly ever failed to employ university-graduate engineers in the specialized areas that were the main concerns of these enterprises, in the fifteen years preceding the point of time this study is concerned with. As can be seen from the relatively large number of graduates hired up to and including 1904 (see Table 3), these enterprises are thought to have been able to adopt a systematic hiring policy, by which the enterprises consciously tried to hire each year so as to avoid distorted hiring of graduates; the reason for this would be that they had long histories of hiring university-graduate engineers, and the reputation of new graduates from university engineering faculties was high. In this regard, firms belonging to the group of enterprises ranking next after these large ones in terms of total engineer numbers in 1920—Takada Company, Suzuki Shōten, Osaka Iron Works, Tokyo Electric, Hitachi Works, etc.—contrast strikingly in that there are conspicuous wide variations in the graduation years of engineers on their payrolls. These wide variations would seem to indicate, from the way they suddenly increased the numbers of engineers in the later years, that they did not have any leeway for thinking about spacing out the graduation years more evenly.

At Mitsui & Co., Mitsui Mining, Mitsubishi Mining, Mitsubishi Shipbuilding, and Kawasaki Shipyard, where seniority strata of engineers had been formed many years earlier, we can assume they had a policy of hiring graduates every year, for the purpose of maintaining and continuing their seniority strata automatically. Such a hiring policy would, no doubt, also automatically increase the total number of engineers in these enterprises. As a result, within these enterprises there would be formed a remarkably large group of engineers.

At this point, two questions arise. The first is, could there possibly have been, within these enterprises, an increase in spe-

cial technical tasks to correspond with the increase in the number of engineers? The second is, supposing seniority order within an enterprise were maintained by promotion in accordance with the number of years since graduation, then the top-ranking positions would have to be occupied by graduates with the earliest years of graduation, but since the number of posts decrease the higher they are, in these enterprises with a large number of engineers who had graduated ten or more years earlier, could there possibly have been enough posts to accommodate so many engineers?

One must refrain from drawing too hasty a conclusion, but as far as can be seen from the engineer numbers and the distribution of graduation years, it would seem that in the middle of the Taishō period these two problems did exist within enterprises. But they were, so it seems, solved in a positive manner in the trends toward starting new enterprises in the area of the heavy and chemical industries that were in evidence during this period both within enterprises and outside them. This matter will be examined concretely in Part 4, but the abundance of mining and metallurgy engineers in Mitsubishi Mining was put to good use in the establishment of Mitsubishi Iron Manufacturing Company. And Mitsui & Co.'s stockpile of mechanical engineers is believed to have formed the base for building the Tama Dockyard to serve as the production division within the enterprise, and then later for establishing Tōyō Rayon. Mechanical and electrical engineers within Mitsubishi Shipbuilding had accumulated as a result of seniority stratification, but a considerable number of them transferred to the two new firms established shortly after 1920: Mitsubishi Internal Combustion Engine Manufacturing and Mitsubishi Electric Corporation; while the diversification into rolling stock and rolled steel within Kawasaki Shipyard Co. was, it is thought, an easy matter, thanks to the thick stratum of mechanical engineers the firm had.

That was not all. The nucleus of engineers who had graduated ten or more years earlier, and whose numbers had accumulated in the Mitsubishi and Kawasaki shipbuilding firms, transferred

to the new shipbuilding firms that were started up during World War I (such as the Mitsui, Asano, and Suzuki shipyards) and brought about the transfer and dissemination of technology. This will also be examined in Part 4.

3. ENGINEERS AMONG TOP MANAGEMENT

When seniority strata have been formed within an enterprise, a ranking of engineers is produced: the earlier the year of one's graduation, the higher one's position in the managerial structure. The highest positions in the managerial structure is another way of saying "top management," and those engineers who have joined top management are probably chosen from those who belong to the group of earliest graduates. In order to examine whether or not this was really true in actual fact in 1920, I have listed, on the basis of the same resource material used to produce earlier tables, and to the extent they could be identified, the full names and years of graduation of engineers who were part of top management in the principal enterprises. The criterion for being judged a principal enterprises was taken to be a registry of 10 or more (approx.) engineers who had graduated from universities or higher technical schools, for discussion of seniority strata would be meaningless unless there were a fair number of engineers.

The range of officials regarded here as top-level extends to directors (*torishimariyaku*), managers (*shihainin*), chief engineers (*gishichō*), heads of engineering sections (*kōmubuchō*) and main factory manager (*shuryoku kōjōchō*). Up to the middle of the Tai-shō period, even in fairly large enterprises the number of executives was ten or less, and most of these positions were taken by part-time capital investors. Since the zaibatsu parent companies were organized as unlimited or limited partnership companies, it was almost impossible for engineer employees to become one of the executives. In such cases, since ordinary business was entrusted entirely to engineers who held the titles of manager or chief engineer, their responsibilities and authority were, it

may be supposed, comparable in weight to those of presidents or vice-presidents in present-day large enterprises.

In the list that follows, (pres.) will stand for president, (man. dir.) for managing director or *semmu-torishimariyaku*, (exec. dir.) for executive director or *jōmu-torishimariyaku*, (dir.) for director, (man.) for manager, and (ch. eng.) for chief engineer. The number after a name will show the year of graduation. "tech" is an abbreviation for "higher-technical-school graduate"; those without this abbreviation are university graduates. The last item before their position is the academic specialization; if the person graduated from an overseas university, however, this item is replaced by the word "overseas."

TRANSPORT INDUSTRY

South Manchurian Railway: Ryūtarō Nomura, 1881, civil engineering [hereafter, "civil"] (pres.); Shimbei Kunisawa, 1889, civil (vice-pres.); Yasujirō Shima, 1894, mechanical engineering [hereafter "mech."] (member of board); Hikozi Mori, 1891, mech. (manager of Shakako Works); Minoru Umeno, 1896, civil (refinery manager).

NYK Line: Toshinobu Suda, 1881, mech. (man. dir.).

Dai Nippon Railway: Wataru Amemiya, 1894, chem. (pres.); Tsuchitarō Shimizu, 1899, civil (ch. eng.).

Keiō Electric Railway: Chūshirō Odagiri, 1896, civil (exec. dir.).

Tōbu Railway: Tokuji Yoshino, 1896, elec. (man. dir.); Shōkichi Miyagishima, 1882, civil (ch. eng.).

Keihin Electric Railway: Masao Soga, 1901, tech elec. (ch. eng.).

Keihan Electric Railway: Saikichi Baba, 1900, elec. (dir., ch. eng.).

CONSTRUCTION INDUSTRY

Ōkura-Gumi: Kumema Ōkura, 1888, civil (dir.); Tsuneo Tokumi, 1896, civil (exec. dir.).

Ōbayashi-Gumi: Tanenobu Oka, 1879, civil (ch. eng.).

Chūō Kōgyōsho: Ryūsaburō Itō, 1882, civil. (pres.).

Hakata Bay Harbor Construction: Kōjirō Kawakami, 1898, civil (man. dir.).

MINING INDUSTRY

Mitsui Mining: Takuma Dan, 1878, overseas (member of board); Naoya Yamada, 1885, mining (dir.); Tamaki Makita, 1895, mining (exec. dir.).

- Hokkaido Colliery*: Kiichirō Takagi, 1895, mining (exec. dir.).
- Mitsubishi Mining*: Kyūgo Nambu, 1878, overseas (member of board); Aitarō No. i, 1894, mining (exec. dir.); Yōji Shigematsu, 1892, mining (exec. dir.).
- Sumitomo Gōshi*: Kumajirō Honjō, 1897, physics (man.); Hajime Miyakawa, 1897, tech mech. (ch. eng.).
- Furukawa Mining*: Kōsaku Asano, 1900, applied chem. (man. dir.); Kisaburō Yamaguchi, 1902, overseas (exec. dir.); Kazue Kibe, 1898, mining (dir.); Isuzu Sugimoto, 1901, mining (dir.); Fukunosuke Yamada, 1902, mining (dir.); Masayuki Odagawa, 1883, civil (foreman).
- Fujita-Gumi*: Seiichi Saitō, 1884, mining (dir.); Kennosuke Tsujimoto, 1901, mining (superintendent).
- Kuhara Mining*: Tsunahiko Takeuchi, 1899, mining (member of board).
- Dai Nippon Mining*: Kyōsaku Takeda, 1893, mining (pres.).
- Kaijima Mining*: Kenji Kaijima, 1905, tech mech. (pres.); Eijirō Yokokura, 1899, mining (ch. eng.).
- Meiji Mining*: Shintarō Ishiwata, 1900, mining (pit boss).
- Taishō Mining*: Ryōta Tanimura, 1899, mining (head of technical division).
- Matsushima Colliery*: Shōnosuke Hoso, 1897, mining (exec. dir.).
- Jōban Colliery*: Kamekichi Kurata, 1898, mining (exec. dir.).
- Shimazu Family Colliery*: Semma Miyazaki, 1898, mining (ch. eng.).

METAL INDUSTRY

- Tanaka Iron*: Koroku Kamura, 1892, mining (dir.).
- Sumitomo Cast Steel*: Haruhito Kudō, 1902, mech. (man.).
- Sumitomo Electric Wires*: Den'ichirō Nishizaki, 1897, mech. (man.); Hirao Rikō, 1896, elec. (factory head).
- Kobe Steel*: Mantarō Matsuda, 1891, tech mech. (ch. eng.).
- Nippon Kōkan*: Kaichirō Imaizumi, 1892, mining (dir., ch. eng.).
- Kiso Electric Iron Mfg*: Tsunesada Samukawa, 1902, elec. (man. dir.); Masaaki Mine, 1885, elec. (exec. dir.).
- Mitsubishi Iron Mfg*: Chinji Harada, 1882, mining (chairman of board); Yōzō Tsumaki, 1896, mining (dir.); Teijirō Hori, 1898, mining (exec. dir.).
- Tobata Cast Metal*: Yoshisuke Aikawa, 1903, mech. (pres.); Masamitsu Murakami, 1904, mech. (exec. dir.).

SHIPBUILDING INDUSTRY

- Mitsubishi Shipbuilding*: Hidemi Maruta, 1883, overseas (head of shipbuilding division); Taisuke Shioda, 1890, naval (exec. dir.); Takeshi

Hamada, 1891, tech mech. (exec. dir.); Masao Miki, 1888, tech mech. (head of Kobe plant).
Kawasaki Shipyard Co.: Yasutō Tanaka, 1886, naval (dir., shipbuilding foreman); Tan Saka, 1880, mech. (dir., machine manufacture foreman).
Ishikawajima Shipyard: Kaichi Watanabe, 1883, civil (pres.); Tokuji Uchida, 1896, mech. (dir., man.).
Yokohama Dockyard: Shigeya Kondō, 1909, overseas (man. dir.); Tamatarō Tōjō, 1897, naval (exec. dir.).
Osaka Iron Works: Gisaburō Emura, 1898, mech. (ch. eng.); Seikichi Takagi, 1901, naval (head of shipbuilding division).
Harima Shipyard: Minato Tsuji, 1904, mech. (dir.); Eika Mikami, 1906, naval (ch. eng.).
Asano Shipyard: Masamoto Hara, 1901, naval (dir.); Ryō Katō, 1901, naval (dir., head of technical division); Sakutarō Andō, 1905, naval (head of shipbuilding division); Atsuyoshi Mihashi, 1905, mech. (dir., head of machine manufacture division).
Uraga Dockyard: Jun'ichirō Imaoka, 1898, naval (man. dir.); Kiichirō Shibaoka, 1897, naval (head of shipbuilding division).
Hakodate Dockyard: Toyokichi Kawata, 1895, mech. (pres.).
Kasado Shipyard: Ishinosuke Furuyama, 1899, mech. (head of factory).
Uchida Shipyard: Mitsuzō Takeda, 1906, naval (ch. eng.).

GENERAL MACHINE INDUSTRY

Kisha Seizō Kaisha: Shōgo Hasegawa, 1896, mech. (man. dir.); Masasuke Dewa, 1899, mech. (man.).
Nippon Sharyō Seizō: Kenji Kishiyama, 1898, tech mech. (ch. eng.).
Motor Mfg Co.: Tatsushirō Takeshita, 1900, tech mech. (head of engineering division).
Nūgata Iron Works: Kichirō Sasamura, 1892, tech mech. (man. dir.); Tadashi Motogi, 1893, mech. (ch. eng.).
Ikegai Iron Works: Sugiji Ikegai, 1907, tech mech. (dir.).
Kōbukuro Kōsakusho: Tokuchirō Kasai, 1888, tech mech. (man. dir.).
Shimadzu Works: Mizuo Takezaki, 1908, mech. (dir.).
Tokyo Gas & Electric: Masaru Yokohama, 1902, mech. (ch. eng.).
Toyoda Loom Works: Tomigorō Tsuchiya, 1904, mech. (dir.).

ELECTRICAL MACHINE MANUFACTURING INDUSTRY

Shibaura Engineering Works: Keijirō Kishi, 1895, elec. (man. dir.); Ban'ichi Notomi, 1897, elec. (head of engineering division).
Tokyo Electric: Yoshio Shinjō, 1898, elec. (dir., ch. eng.).
Hitachi: Namihei Odaira, 1900, elec. (exec. dir.).

- Nippon Electric*: Kunihiko Iwadare, 1882, elec. (man. dir.); Saitarō Ōi, 1882, elec. (dir.); Toyosaku Tsuchida, 1899, tech mech. (ch. eng.).
Meidensha Electric Mfg: Gorō Fujimoto, 1899, elec. (ch. eng.).
Kawakita Electric Enterprise: Yoshio Kawakita, 1902, elec. (pres.).
Okumura Electric Co.: Kōhei Ogura, 1899, elec. (head of engineering division).
Osaka Electric Bulb Co.: Hiroyoshi Ōshima, 1901, elec. (ch. eng.).
Teikoku Electric Bulb Co.: Reikichi Kabashima, 1902, elec. (man. dir.).
Oana Seisakusho: Hideichi Oana, 1905, elec. (pres.); Kurō Harada, 1906, naval (dir.).
Nippon Battery: Jun'ichi Iwaki, 1914, chem. (ch. eng.).
Yuasa Storage Battery Mfg: Kamejirō Yoshikawa, 1895, chem. (dir.).

ELECTRIC POWER AND GAS INDUSTRIES

- Tokyo Electric Light Co.*: Iwasaburō Nakahara, 1892, elec. (dir., ch. eng.).
Kyoto Electric Light Co.: Torajirō Ogi, 1889, elec. (ch. eng.).
Japan Electric Light Co.: Jūkichi Okatsumi, 1902, elec. (ch. eng.).
Ujikawa Electric: Wataru Kobayashi, 1903, elec. (ch. eng.).
Kinugawa Hydro-Electric: Kunika Ōta, 1903, elec. (ch. eng.).
Inawashiro Hydro-Electric: Heiji Tachikawa, 1902, elec. (head of electrical department).
Ibigawa Electric: Seikichi Takagi, 1899, tech elec. (ch. eng.).
Fuji Hydro-Electric: Gishichi Kumaya, 1900, elec. (ch. eng.).
Katsuragawa Electric Power: Shirō Yamazaki, 1897, elec. (ch. eng.).
Hiroshima Electric Light Co.: Sotosuke Ihara, 1902, elec. (dir.).
Tokyo Gas: Rokurō Miki, 1903, chem. (exec. dir.; ch. eng.).
Nagoya Gas: Sakura Okamoto, 1903, chem. (dir., ch. eng.).

CHEMICAL INDUSTRY

- Osaka Shamitsu*: Kōtarō Shimomura, 1888, overseas (dir., ch. eng.).
Kantō Sanso: Shinzō Endō, 1891, chem. (ch. eng.).
Dai Nippon Artificial Fertilizer: Noboru Yamamura, 1903, agric. (ch. eng.).
Nippon Chisso: Shitagau Noguchi, 1896, elec. (man. dir.); Seiji Ichikawa, 1896, elec. (dir.).
Denki Kagaku Kōgyō: Tsuneichi Fujiyama, 1898, elec. (exec. dir.).
Japan Paint: En Iwamura, 1896, chem. (ch. eng.).
Kansai Paint: Hiroshi Tamamizu, 1905, chem. (man. dir.).
Japan Dye-Stuff: Hisatarō Miyoshi, 1896, chem. (ch. eng.).
Sankyō K. K.: Jōkichi Takamine, 1879, chem. (pres.).
Takeda Pharmaceuticals: Masata Nakazawa, 1894, tech chem. (dir., factory head).

Ōji Paper Co.: Naokitsu Takada, 1893, tech mech. (dir.); Magoroku Hannai, 1891, tech mech. (ch. eng.).
Nippon Cement: Keisuke Shioda, 1895, chem. (ch. eng.).
Onoda Cement: Shinzō Kasai, 1896, overseas (man. dir.); Kyōzō Kanō, 1907, chem. (exec. dir.); Toshimaru Fukuhara, 1901, mech. (dir.)
Osaka Ceramics: Shōemon Ōtaka, 1886, chem. (exec. dir.).
Iwaki Cement: Manji Okada, 1897, chem. (ch. eng.).
Chūō Cement: Yūzō Shinozaki, 1892, tech ceramics (man. dir., ch. eng.)
Nippon Tōki: Saburō Momoki, 1899, tech ceramics (ch. eng.).
Asano Slate: Kaijirō Kondō, 1892, chem. (man. dir.).

TEXTILE INDUSTRY

Tōyō Cotton Co.: Tsunezō Saitō, 1882, mech. (dir.); Shun'ichi Hattori, 1881, mech. (dir.); Aisaburō Mano, 1895, mech. (dir.); Tokutarō Iwao, 1896, tech mech. (dir.); Kazuyoshi Ōtsuka, 1889, tech mech. (dir.).
Dai-Nippon Spinning: Kyōzō Kikuchi, 1885, mech. (pres.); Takashi Saburi, 1886, mech. (ch. eng.); Akinari Matsumura, 1897, mech. (dir.).
Kanebō: Narazō Takatsuji, 1889, mech. (dir.).
Osaka Gōdō Cotton Spinning: Hirota Akiyama, 1887, tech. dyeing (dir.).
Fuji Spinning Co.: Tatsumi Mochida, 1896, mech. (dir., ch. eng.).
Nisshin Spinning: Kajūrō Matsumoto, 1902, mech. (ch. eng.).
Nippon Woolen Text.: Takeshi Tanie, 1895, tech mech. (exec. dir.).
Tokyo Muslin: Hideyo Noborizaka, 1894, tech dyeing (ch. eng.).
Teikoku Seima: Suzuma Suzuki, 1893, tech mech. (exec. dir.).

FOODSTUFFS INDUSTRY

Taiwan Sugar Mfg Co.: Yūkichi Kusakato, 1902, chem. (ch. eng.).
Tōyō Sugar Mfg Co.: Shōji Ishikawa, 1897, tech mech. (dir.).
Meiji Sugar Mfg Co.: Hanji Sōma, 1896, tech chem. (pres.).
Dai Nippon Sugar Mfg: Mitsuo Sawa, 1896, chem. (dir., ch. eng.).
Dai Nippon Brewery: Hisatarō Yagi, 1894, agric. (dir.); Utarō Hashimoto, 1894, tech mech. (head of engineering).
Kirin Brewery: Osamu Imaida, 1896, applied chem. (ch. eng.).
Teikoku Cold Storage: Taneo Nishihara, 1897, tech chem. (dir., ch. eng.).

The above listing includes engineers who were active within management in a variety of industries in the period from the end of the Meiji period into the Taishō period. Not a few of them have left their names in business history through biographies or accounts of company histories. Rather than their

achievements as individuals, however, we are concerned here with their common properties as a group. A look through the list uncovers the following points.

(1) Except for a few firms, the years of graduation of the great majority of engineers who rose to top management in enterprises fell between the years 1887 and 1900. By 1920, they would have between 20 and 30 years of experience since their graduation from university or higher technical school. The engineers who were their seniors, that is, the people who went to study overseas in the years from 1868 to 1877 or who graduated from the Imperial Technical Colleges or from the Artisan school between 1877 and 1886, had for the most part either retired or died, and only a small number of them were key men in the zaibatsu or had their names listed among top management of the South Manchurian Railway. And the absolute numbers of graduates were small in their years of graduation (in terms of various departments in university engineering faculties, in the decade from 1887 there were, on average, five graduates per year, increasing to more than ten graduates per year by 1897-98), and more than half of them had entered government service; because of these facts, it is in general impossible for a large number of people from one and the same university department to be in one and the same firm. Accordingly, in the firms in question these people must surely have belonged to the highest-ranking group of engineers in the seniority strata.

Enterprises in which, by way of exception, graduates from later than 1900 occupy the top levels are enterprises with but recent histories, founded in late Meiji or during the Taishō period.¹¹ In these enterprises, it is rare for engineers of an

¹¹ The years of foundation of relevant enterprises in the list given in the earlier article are: Keihan Electric Railway, 1906; Sumitomo Cast Steel, 1901; Kobe Steel, 1911; Tobata Cast Metal, 1910; Kiso Electric Industry, 1915; Tokyo Gas & Electric, 1910; Osaka Electric Bulb, 1907; Teikoku Electric Bulb, 1909; Fuji Hydro-Electric, 1907; Kinugawa Hydro-Electric, 1910; Inawashiro Hydro-Electric, 1911; and Ibigawa Electric, 1912.

earlier generation to be employed, hence in these enterprises they are assumed to have been at the top of the seniority strata.

(2) Engineers in effect listed among the top management with the titles of manager or chief engineer were found in nearly every enterprise, but few engineers were chosen to be executives such as directors in joint-stock companies or board members in limited or unlimited partnerships, and in these rare exceptions, generally only one engineer became an executive. It is possible to think of the choosing, or not choosing, of engineers from within the firm as an indicator, even, of the extent of separation of capital and management in the firm at that time. At any rate, it can also be supposed that the top engineers at the time may have held a great deal of real authority within the firms, but in the view of the capitalists holding down executive positions they were still employees, and the social positions of the engineers would not have been very high.

Still, South Manchurian Railway, Mitsui Mining, Mitsubishi Mining, Furukawa Mining, Mitsubishi Shipbuilding, Asano Shipbuilding, Tōyō Cotton Spinning, and others had a plurality of engineers among their executives. These were large-scale enterprises and they had a thick stratum of engineers, or they had been in existence a long time and there were a large number of senior engineers (or, as in the case of Tōyō Cotton Spinning, the large number was the result of enterprise amalgamation)—these and other reasons can be thought of, but one gathers that, in the large enterprises in zaibatsu groups, a re-structuring took place in this period and an organizational strategy or policy was adopted that the highest decisions about funds, top-level personnel, and the like, were to be taken in the zaibatsu main offices, which were holding companies, while operation within their branch companies were to be entrusted to executives chosen from among the employees.

On the assumption that personnel changes were carried out completely on the basis of seniority, then it would follow that the year of graduation of those engineers who belonged to top management must be earlier than the year of graduation of

those engineers who held positions just below them (these latter might be referred to as “upper-middle management”). But was this actually the situation in large enterprises in mid-Taishō? To examine this point, I drew up Table 4, which compares the graduating years of engineers on the executive/chief engineer level with those of engineers on the factory head/section head level, for a few representative enterprises for which data could be obtained.

Table 4. Graduation Years of Top- and Second-Ranking Engineers

Company Name	Executive / Chief Engineer	Factory Head / Division Head
Mitsubishi Mining	1894, '94	1882, '85, '88, '98, 1903, '09, '09
Mitsubishi Shipbuilding	1883, '90, '88 Tech, '91 Tech	1892, '95, '99, '95 Tech, 1901, '02
Furukawa Mining	1898, 1900, '02	1897, '98, '98, '99 Tech, 1901, '10
Tōyō Cotton Spinning	1881, '82, '89 Tech, '95, '96	1897, '98, '98, 1900, '07 '09 Tech
Dai Nippon Spinning	1885, '86, '97	1892, '96, '96, 1904, '06, '06
Dai Nippon Brewery	1894	1897, '99, 1900 Tech, '00 Tech, '02
Tokyo Gas	1903	1892 Tech, 1910, '10

(All university graduates, unless specified as technical school graduates)

From Table 4, it can be seen that in Mitsubishi Shipbuilding, Tōyō Cotton Spinning, and Dai Nippon Spinning, without exception the graduating years for the top stratum was earlier than for the factory-head level. In Tokyo Gas it was the same, if one excludes the technical school graduate. But in Mitsubishi Mining, three of the pit bosses were earlier graduates than engineers at the top level, and in Furukawa Mining two of the pit bosses were older. In these two enterprises, at least, the system followed was not one of seniority, pure and simple, and

we can suppose the top management was chosen from the older generation on the basis of their suitability as managers, rather than on the basis of their year of graduation.

4. ENGINEER TRANSFER TO NEW ENTERPRISES IN HEAVY AND CHEMICAL SECTOR

As we saw in Table 2, in 1920, enterprises established in the preceding ten-year period in iron and steel, shipbuilding, electrical machinery, chemicals, etc., were already employing scores of engineers. In addition, by way of diversification within the enterprise, there were examples such as Mitsui & Co.'s shipbuilding division and Mitsui Mining's dyestuffs manufacturing plant. New enterprises such as these had been started on a fairly large scale right from the beginning, and it is unthinkable that they achieved rapid success with the help of only newly-graduated engineers. It is natural to imagine that the formation of a new enterprise became possible by the transfer from other enterprises of engineers who had accumulated earlier experience in some other place. Also, by the use of such earlier graduates as top-level, key managers and as people with technical responsibilities, a seniority stratum similar to those in already existing enterprises was formed right from the beginning above the new graduates. The sources of supply of experienced engineers for new enterprises in the heavy and chemicals sector from the end of the Meiji period and into the Taishō period were not very numerous. The first one that comes to mind is the transfer of engineers from the fertile womb of new-enterprise planning, that is, enterprises in the same zaibatsu group or already existing sections in the same enterprise. In concrete, the redeployment of Mitsui & Co. mechanical engineers into the shipbuilding sector, the transfer of mining, metallurgy, and mechanical engineers from Mitsubishi Mining to Mitsubishi Iron Manufacturing, the shifting of mechanical and metallurgy engineers from Sumitomo Copper Rolling Works to its electric wire branch are only a few of the obvious examples.

Yet even in these cases new enterprises would need specialized

engineers who could not necessarily be obtained from existing sections. Also, in the cases of the Suzuki and Asano groups, despite the existence of other enterprises in their groups, we can safely conclude that there were no engineers of any use to heavy industries such as the new shipbuilding and iron-and-steel industries. In Suzuki Shōten's and Asano Gōshi's cases, most likely the head office itself was required to gather experienced engineers in all relevant areas at the stage of planning the new enterprises. This accounts for the notable increase in both firms' engineer numbers seen in Table 2, but where they came from is a good question. In new enterprises without the backing of enterprise groups, such as the electric power industry and such firms as Japan Dye-Stuff and Tokyo Gas & Electricity, it was even more necessary to make overtures to experienced engineers from existing enterprises.

The second source of supply that comes to mind, then, is the pool of Government engineers. Engineers at naval dockyards would be of immediate help in the shipbuilding industry, for example, and since there was almost no such thing as a private-sector iron-and-steel industry, experienced engineers could not be sought anywhere else but in the iron works of the Ministry of Agriculture and Commerce or in the arsenals of the Army or Navy. The civil engineers needed for hydroelectric power generation could probably be sought in the Ministry of Home Affairs, in prefectural authorities, or in colonial offices.

The third source of supply is private industry already well established. In the shipbuilding industry, places like Mitsubishi Shipbuilding, Kawasaki Shipyard, or Osaka Iron Works already had on their payrolls several engineers with ten or more years of experience. Also, as I have referred to this earlier, in shipbuilding circles it had already become common to have movements between these already existing firms of large numbers of naval and mechanical engineers every year. In the hydroelectric power industry, it seems, it had become a regular practice for civil engineers and electrical engineers to move on to the next enterprise once they had finished the construction of a power

plant. Accordingly, it is believed that in these industries the transfer of engineers from established enterprises to new enterprises proceeded without undue resistance.

In order to see how many of the engineers on the 1920 payrolls of newly established enterprises or newly set up business branches were experienced men who had transferred from any of the above three sources of supply, I sifted through the same sources as I used for Table 2, in order to find those in each firm who had graduated from university or technical school in 1910 or earlier (in other words, people with at least ten years' experience in 1920), and inquired into their original place of employment. The result is given below. I have listed, in the order of their positions, all those who were put into top management posts, giving their year of graduation, the subject they specialized in, and the previous place of employment (in parentheses).

Suzuki Shōten University graduates: 1884, civil (Communications Ministry); 1900, chem. (Fuji Paper Mill); 1907, mining (Mitate Mining); 1908, mech. (Navy); 1909, shipping (Mitsubishi Shipbuilding).

Tech-school grads.: 1892, mech. (Army); 1906, mech. (Tokai Paper Pulp); 1907, mech. (Nippon Acetic Acid); 1907, mech. (Japan Steel Works); 1908, mech. (Takada Co.); 1908, applied chem. (Yonezawa Higher Technical School); 1910, mech. (Dai-ichi Engine Insurance).

Asano Gōshi University grads: 1892, civil (Government-General of Korea); 1893, elec. (Tone Power Plant); 1898, mining (Ishikari Colliery); 1903, civil (Kawakita Electric); 1907, chem. (Min. of Agriculture and Commerce, Technical Testing).

Tech.-school grads.: 1905, mech. (Monopoly Bureau).

Mogi Gōmei University grads: 1905, civil (National Railway); 1905, mech. (Takada Co.); 1909, mech. (Sulzer).
Tech.-school grads: 1902, mech. (Takada Co.); 1906, spinning (Army woollen Mill); 1907, mech. (Takada Co. — 2 people); 1908, chem. (Tokyo Gas); 1910, mech. (Takada Co.).

- Ōkura Mining* University grads.: 1893, mining (Ministry of Agriculture and Commerce, Testing Labo.), exec. dir.; 1903, mining (Sumitomo); 1906, mining (Fujita-Gumi); 1906, mining (Iriyama Colliery).
- Hongeiko Coke & Iron* University grads.: 1900, mech. (Hokkaido Colliery & Steamship Co.); 1904, mech. (National Railway). Tech.-school grads.: 1900, chem. (Government Ironworks); 1909, civil (municipal office).
- Sumitomo Cast* University grads.: 1897, mining (Government Iron Works); 1902, mech. (Sumitomo Besshi); 1907, military science (Japan Steel Works); 1909, mining (Navy). Tech.-school grads.: 1909, mech. (Yasuda Ironworks); 1910, mech. (Shimadzu Works).
- Japan Steel Works* University grads.: 1895, mining (Hokkaido Colliery & Steamship); 1898, mech. (Mitsui & Co.); 1901, military science (Navy); 1903, mech. (Hoden Oil Co.); 1906, mech. (Sumitomo Cast Steel); 1908, mech. (Mitsui Mining); 1910, mining (Hokkaido Colliery & Steamship). Tech.-school grads.: 1892, ceramics (Mitsui Mining); 1900 mech. (Navy); 1903, mech. (Navy); 1907, mech. (Nippon Electric); 1907, mech. (Monopoly Bureau); 1908, civil (Government-General of Korea); 1909, mech. (Japan Sugar Manufacturing Co.).

Japan Steel Works, a business financed by Mitsui, was geographically in close proximity to Hokkaido Colliery & Steamship Co., which belonged to the same Mitsui group, and the Kure Naval Arsenal provided comprehensive support to the steel technology. These favorable conditions also appear in the transfer of engineers.

- Kobe Steel* University grads.: 1903, mining (National Railway). Tech.-school grads.: 1886, mech. (Kimoto Ironworks); 1891, mech. (Navy); 1903, mech. (Suzuki Shōten); 1904, dyeing (Customs); 1905, mech. (Osaka Gas); 1905, mech. (Mitsubishi Shipbuilding); 1907, mech. (Ono Shipyard); 1908, mech. (Navy); 1909, mech. (Army); 1910, mech. (Navy).
Kobe Steel was founded in 1911 by Suzuki Shōten. It is

- obvious that the firm collected key engineers from the Army, Navy, and factories in the Kansai (Osaka) area.
- Nippon Kōkan* University grads.: 1889, mech. (Government Iron Works); 1892, military science (Navy); 1906, mech. (Tokyo Gas); 1906, civil (Tokyo City government). Tech.-school grads.: 1905, mech. (municipal office); 1905, mech. (Suzuki Ironworks); 1910, mining (Hasami Mining); 1910, mining (Japan Steel Works).
- Kiso Electric* University grads.: 1885, elec. (National Railway), man. dir.; 1906, elec. (Kanjo Mining); 1908, civil (Katsuragawa Electric Power). Tech.-school grads.: 1902, mech. (Yokkaichi Paper); 1908, civil (Tokushima Hydro-Electric).
- Tōyō Iron Mfg.* University grads.: 1896, mech. (iron foundry); 1902, civil (Home Affairs Min.); 1905, mech. (Kawasaki Shipyard); 1910, mech. (Kawasaki Shipyard). Tech.-school grads.: 1902, mech. (National Railway); 1908, mech. (Kōbukuro Kōsakusho); 1910, mech. (National Railway); 1910, mech. (Navy).
- Mitsubishi Iron Mfg.* University grads.: 1895, mech. (transfer from Mitsubishi Shipbuilding); 1906, elec. (transfer from Mitsubishi Gōshi); 1896, mech., 1898, mining (managing director), 1898, mining, 1901, mining, 1902, mining, and 1908, mining—all transferred from Mitsubishi Mining; 1902, civil (South Manchurian Railway); 1909, chem. (Government Iron Works). Tech.-school grads.: 1901, ceramics (Min. of Agriculture and Commerce, Testing Labo.); 1903, mech. (Fujita-Gumi); 1909, chem. (Kanazawa Gas).

In contrast to other new steel enterprises, which give the impression of having great difficulty assembling key engineers from the national railway and private-sector mining and machine factories to complement the few people with experience in iron or steel manufacturing that they were able to acquire from iron manufacturing plants or from the Army or Navy, a special feature of Mitsubishi Iron Manufacturing is that it found a sufficient number of university-graduate engineers almost entirely from transfers within the Mitsubishi group of enterprises. And

yet the Tōyō Iron Mfg and Mitsubishi Iron Mfg enterprises ended in failure. One might ask if a part of the blame for this did not lie in the composition of the engineers.

- Ōshima Steel Works* University grad.: 1907, mech. (Army).
Tech.-school grads.: 1899, mech. (Iron Works); 1900, mech. (Sumitomo Cast Steel); 1903, mech. (Mitsubishi Shipbuilding).
- Kyūshū Steel Mfg* University grads.: 1899, Mining (Government-General of Korea); 1908, mech. (National Railway).
Tech.-school grad.: 1901, mech. (Meiji Mining).
- Tobata Cast Metal* University grads.: 1903, mech. (Kuhara Mining), pres.; 1904, mech. (Kisha Seizō), exec. dir.
Tech.-school grads.: 1906, mech. (Nichimen); 1909, mech. (commercial business).
- Tōyō Can Mfg.* University grads.: 1898, civil (Navy); 1908, mech. (Takada Co.).
- Sumitomo Electric Mfg* University grads.: 1896, elec. (Communications Ministry), factory head; 1910, elec. (Communications Ministry).
Tech.-school grad.: 1909, mech. (Nippon Sharyo).
- Harima Shipyard* University grads.: 1904, mech. (Hokkaido Sugar Refinery); 1911, mech. (Mitsubishi Shipbuilding, 2 people).
Tech.-school grads.: 1904, mech. (Navy); 1906, mech. (National Railway); 1906, naval (Mitsubishi Shipbuilding); 1908, naval (Kawasaki Shipyard); 1909, naval (Navy).
- Asano Shipyard* University grads.: 1901, naval (Kawasaki Shipyard), technical division head; 1903, naval (Osaka Shōsen); 1903, civil (Navy); 1905, naval (Kawasaki Shipyard); 1906, military (Japan Steel Works); 1908, naval (Mitsubishi Shipbuilding).
Tech.-school grads.: 1899, mech. (Ishikari Colliery); 1901, mech. (Mitsubishi Shipbuilding, 2 people); 1906, naval (Mitsubishi Shipbuilding); 1907, naval (Kawasaki Shipyard); 1908, naval (Navy); 1908, naval (Mitsubishi Shipbuilding); 1910, mech. (Nippon Sharyo).
- Mitsui & Co. Shipbuilding* University grads.: 1896, civil (Hyogo Prefecture); 1908, naval (Kawasaki Shipyard); 1909, mech. (Kawasaki Shipyard); 1910, naval (Kawasaki Shipyard).

- Kasado Shipyard* University grad.: 1899, mech. (Kawasaki Shipyard), head of shipyard.
Tech.-school grads.: 1903, mech. (Kawasaki Shipyard); 1907, mech. (Kisha Seizō).
- Uchida Shipyard* University grads.: 1906, naval (Mitsubishi Shipbuilding), chief engineer; 1908, mech. (Mitsubishi Shipbuilding); 1910, naval (Mitsubishi Shipbuilding).
Tec.-school grads.: 1905, naval (Government-General of Korea); 1905, naval (Mitsubishi Shipbuilding); 1908, naval (Mitsubishi Shipbuilding).
- Toba Shipyard* University grad.: 1884, naval (Navy).
Tech.-school grads.: 1900, elec. (Ōkura-Gumi); 1905, naval (Ono Shipyard); 1908, mech. (Mitsubishi Shipbuilding).

As expected, the demand for upper-level and middle-level engineers for newly established shipyards was satisfied by means of transfers from the Mitsubishi and Kawasaki companies. To be noted is the fact that both the Mitsui & Co. and the Kasado shipyards drew all their engineers from Kawasaki, and Uchida Shipyard drew all of its from Mitsubishi. These are thought to have a connection with shake-ups of top engineers.

- Nippon Kōgaku* University grads.: 1899, chem. (Aichi Cement), manager; 1910, physics (Tokyo Gauge).
Tech.-school grad.: 1891, mech. (Navy).
This firm was established with capital support from Mitsubishi to industrialize optical instruments including lens developed by Ryūzō Fujii while he was employed in the Navy.
- Tokyo Gas & Electric* University grads.: 1902, mech. (Tokyo Gas), chief engineer; 1910, mech. (Dai Nippon Railway).
Tech.-school grads.: 1906, mech. (National Railway); 1906, mech. (Ōkura-Gumi); 1907, mech. (Nippon Electric); 1909, mech. (Mitsubishi Shipbuilding); 1910, mech. (National Railway).
- Kawakita Electric Enterprise* University grads.: 1902, elec. (Siemens), pres.; 1906, elec. (Kyūshū University); 1908, mech. (Nagasaki Spinning & Weaving); 1909, elec. and 1910, elec. (Siemens); 1909, elec. (Tottori Electric Light).

- Tech.-school grads.: 1901, elec. (Siemens); 1909, civil (prefectural office); 1910, elec. (Iwaki Colliery).
- Tōzai Manufacturing* University grads.: 1904, elec. (Inawashiro Hydro-Electric); 1909, elec. (Akashi Electric Light); 1910, elec. (National Railway), exec. dir.
Tech.-school grads.: 1909, mech. (Takada Co.); 1910, mech. (Navy).
- Yuasa Battery* University grad.: 1895, chem. (Kyoto University), dir.
Tech.-school grads.: 1906, mech. (Navy); 1910, elec. (Kisha Seizō).
- Tōyō Electric* University grads.: 1883, elec. (National Railway); 1904, elec. (Keihan Elec. Railway).
Tech.-school grads.: 1889, mech. (Kyūshū Railway); 1894, mech. (National Railway).
- Yasukawa Elec. Machinery* University grad.: 1912, elec. (Hitachi), pres.
- Ujikawa Electric* University grads.: 1902, civil (Fujita-Gumi); 1902, civil (National Railway); 1903, elec. (Kanazawa Electricity & Gas), chief engineer; 1907, civil (Tokyo City).
Tech.-school grads.: 1905, elec. (Shimotsuke Electric Power); 1906, elec. (commercial business); 1909, elec. (National Railway); 1910, civil (Ujikawa Electric).
- Inawashiro Hydro-Electric* University grads.: 1895, mech. (National Railway); 1904, civil (Ujikawa Electric).
Tech.-school grads.: 1907, elec. (Nagoya Electric Power); 1908, civil (Ministry of Home Affairs).
- Nippon Electric Power* University grads.: 1902, civil (Fukui Prefecture); 1909, elec. (Tokyo City).
Tech.-school grad.: 1906, elec. (Inawashiro Hydro-Electric).
- Kinugawa Hydro-Electric* University grads.: 1902, elec. (Meiji Electric); 1903, elec. (Nagoya Electric Light); 1906, elec. (Minō-Arima Railway); 1908, civil (Government General of Korea).
- Nippon Electric Power* University grads.: 1902, civil (Kyoto City); 1907, elec. (Ōita Hydro-Electric); 1909, civil (Kobe City).

As might be expected, these new hydroelectric power enterprises were made possible by shake-ups of electrical engineers from existing electric power companies and civil engineers from government authorities.

- Denki Kagaku* University grads.: 1898, elec. (Nippon Chisso), exec. dir.; 1898, mech. (Kwantung Government-General); 1910, chem. (the Mint).
Tech.-school grads.: 1899, ceramics (Army Gunpowder Arsenal); 1900, applied eng. (Mitsui Mining).
- Mitsui Mining* University grads.: 1895, chem. (Mitsui Mining);
- Miike Dye-Stuff* 1910, chem. (Cassela).
Tech.-school grad.: 1907, dyeing (prefectural office)
- Japan Dye-Stuff* University grads.: 1896, chem. (Osaka Gas), chief engineer; 1909, chem. (Hokkaido Gas); 1910, chem. (Yokohama Gas).
Tech.-school grads.: 1897, chem. (Yonezawa Higher Technical School); 1905, dyeing (commercial business); 1909, chem. (technical school).

Because the development of synthetic dyes by Japan Dye-Stuff and Mitsui Mining was based on a completely different process from the inorganic-chemistry industry as carried on by existing enterprises, there was no movement of engineers from these enterprises, and the two firms relied mainly on a large number of newly graduated engineers, the core of whom were a small number of men experienced with coal-tar derivatives.

- Nippon Glycerine* Tech.-school grads.: 1886, chem. (Osaka Technical Testing); 1893, mech. (Osaka Higher Technical School); 1900, chem. (Japan Candle); 1901, chem. (Customs); 1904, mech. (Teikoku Fish Oil).

The above data are limited to transfers to new enterprises of engineers who had spent ten years or more after graduation accumulating experience in another firm. In addition to these engineers, these new enterprises had hired large numbers of engineers who had graduated from universities or higher technical schools less than ten years before. Among these were included some with experience in other firms, though of a shorter duration. The on-the-spot technology needed for the construction and operation of manufacturing plants had been transferred from existing establishments through the mediation of such people as these.

5. THE START OF INTRA-ENTERPRISE RESEARCH AND THE HIRING OF SCIENCE FACULTY GRADUATES

Basic sources have confirmed that, in 1920, a considerably large number of people from the physics and chemistry departments of university science faculties were being hired by enterprises. Nearly all of them were rising scientists who had graduated in the 1910s; not a few had “research laboratory” clearly entered after their names as the places they were attached to. This was a new phenomenon, something not seen in the general trends of engineer employment in private enterprise during the Meiji period.

True, even in the Meiji years it was common for geology department graduates to enter mining companies, but this is because they had been hired as specialist engineers needed for mining companies’ prospecting operations. If we leave these geologists out of the question, then, we find that the majority of those who majored in physics or chemistry had found employment in schools or government offices during the Meiji years. Those who were the exception and entered private enterprises were, it seems, hired as substitutes for engineering graduates when there was a shortage of the latter, and, once hired, they were treated the same as engineering graduates and put to work within the plants.

From the end of the Meiji period, however, and into the first few years of Taishō, private enterprises were also able, finally, to set up separate sections for experimental research. Typical examples of this were the research laboratories of South Manchurian Railway and Shibaura Engineering Works (in 1915), Tokyo Electric (1918), Mitsubishi Mining (1917), Asahi Glass (1918), Furukawa’s Ōi Laboratory (1918), and Marumiya’s Mitsuwa Chemical Laboratory. To inaugurate these experimental research facilities, key personnel were chosen from among engineering department graduates already within the enterprise, but it is thought that, at the same time, enterprises also found

it necessary to hire graduates of physics and chemistry departments of science faculties who had training in the most recent basic-science research.

It is also thought that, in cases of industrialization of dyestuffs, storage batteries, optical instruments, and so on, products based on progress in basic science that had never before been made in Japan, developmental research formed the core of operations at first, and in such cases the difference in training between science faculty graduates and engineering faculty graduates was considered negligible.

To the extent that I could confirm things with data, the situation with regard to the registration of physics and chemistry graduates in various enterprises as of 1920 is as follows, with the year the person graduated; when it was possible to confirm that the person was attached to a research department, this fact is added in parentheses with the word "res."

South Manchurian Railway: 1909, chem. (res.); 1919, phys. (res.).

Mitsubishi Mining: 1915, phys. (res.); 1916, chem. (res.).

Furukawa Gōmei: 1908, chem.; 1918, chem. (res.); 1919, chem.

Asano Gōshi: 1907, chem.

Sumitomo Copper Rolling: 1918, chem.

Sumitomo Cast Steel: 1911, physics; 1917, phys.

Sumitomo Electric Wire: 1907, phys.

Yokohama Electric Wire: 1919, chem.

Japan Steel Corporation: 1916, phys.

Mitsubishi Shipbuilding: 1895, phys.; 1917, phys. (res.); 1917, chem. (res.); 1918, phys. (res.).

Kawasaki Shipyard: 1920, phys. (res.); 1920, phys.

Shibaura Engineering Works: 1917, chem.; 1918, phys. (res.).

Tokyo Electric (Matsuda Laboratory):

1895, phys. (head of lab.); 1898, phys.; 1910, chem.; 1913, phys. (2 people); 1914, phys.; 1915, phys. (3 people); 1915, chem.; 1916, phys.; 1920, phys.

Tokyo Electric Bulb: 1917, phys.

Tokyo Battery: 1918, chem. (2 people).

Shimadzu Works: 1915, chem.

Ikegai Iron Works: 1912, phys.

Nippon Kōgaku: 1910, phys. (2 people); 1919, phys.

Denki Kagaku:1909, chem.
Mitsui Mining Miike Dye-Stuff: 1911, chem.; 1913, chem.
Japan Dye-Stuff:1917, chem.; 1919, chem.
Nippon Glycerine:1919, chem.
Takasago Perfumes:1918, chem. (res.)
Ōji Paper Mill:1917, chem.
Nippon Chemical Paper Pulp:1907, chem.; 1919, chem.
Aji-no-moto:1912, chem.
Tokyo Electric Light:1916, phys. (res.).

There are twenty-seven companies in the above list, and in the majority of cases only one or two science faculty graduates. Tokyo Electric's Matsuda Laboratory has the very conspicuously large number of twelve, followed by Mitsubishi Shipbuilding with four.

The operations in the research facilities in private enterprise at this time still concentrated heavily on raw-material testing and developmental research; they had not reached the stage of carrying out basic research. Hence the initial hirings of science faculty graduates in the early Taishō period only indicated the budding of research and development in private industry, yet they are considered to be important groundwork for later improvement in industrial technical levels.

CONCLUSION

The period of expansion in the heavy and chemical industries before and just after World War I is an important turning point in the business history from early Meiji right up to the present time. Through an examination of the distribution at this time of engineers among the various enterprises, it was possible to discover several special features of this period.

The period that was to follow witnessed the recession that came after World War I, and firms like Mogi Gōmei and Suzuki Shōten, which we have seen in this study to have had a rapid increase in the number of engineers hired, went bankrupt, and the plans of Tōyō Iron Mfg and Mitsubishi Iron Mfg also went away. Shipbuilding also rushed headlong into recession. Because

business conditions were destined to enter a period of this nature, the places of employment of the engineers included among the figures given in this study would also, no doubt, undergo changes, each in their own way. This, however, forms the topic of the next article.