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Research and Development Activity of Asahi Engineers before, during work at and after their Employments at Asahi Jinzokenshi and Asahi Kenshoku in 1920～1940s: (Part II) Analysis on the Publication Lists

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SYNOPSIS: An attempt was made to uncover and investigate, from meticulous analysis on the data base of scientific papers, reviews and patents constructed in the previous paper (This journal, vol. 17,(2002)), R & D achievements of 25 ex-Asahi chemist individuals, before and during work at and after resignation from Asahi. Total number of the publications amounted to 26, 60 and 154, corresponding to the above three periods. Average duration of the employment by other organizations before joining to Asahi was 3.7 years. Judging from previous job career and R & D achievements, 3 experienced graduate chemists, 3 mid-career technical college graduates and 13 new recruitments joined to Asahi in 1919～1927. Five individuals, all of them belonging to the categories of the established and mid-career engineers, published totally 12 papers, 7 reviews (Code no. 1) and 5 patents (Code no. 6) before joining to Asahi. Ex-Asahi engineers, who resigned from Asahi before full retirement (defined as Group I), stayed on average 6 years at Asahi. All Asahi engineers, who were once employed by Asahi, published 16 papers and 44 patents at Asahi. Close correlation was confirmed among them between the productivity of scientific research and that of technological development. Research activity of some major chemists was investigated in connection with their job positions. Role of Asahi chemists was demonstrated in the three cases to vary significantly, depending on the time of resignation from Asahi.

1 INTRODUCTION

In Part I of this series[1] the database of scientific and technical papers, general reviews, books and patents written or applied by 35 Asahi engineers before, during work at and after quit from Asahi Jinzokenshi (AJK) or Asahi Kenshoku (AKS) was constructed.

Their job career had been surveyed in detail in the previous paper[2].

In this article, an enterprise will be made, on the basis of the above list, to study

(1) classification of the Asahi-engineers, by professional level, judged from the total number of scientific papers for each individuals together with the job career before joining,

(2) total number of papers and patents for each individuals produced before, during work at and quit from Asahi,

(3) frequency distribution of the number of published documents for each individuals,

(4) classification of the publications with respect to subject (textile or non-textile), to estimate the portion of papers on artificial silk among the total papers,

(5) correlations between productivity of papers and that of patents for each individuals, and

(6) comparison of the work achievements, expressed by the publications, and the job positions for 4 key individuals.

In this article, Asahi chemists can be classified, for the sake of simplicity, into two groups:

Group I: Individuals who resigned from Asahi before full retirement and took other jobs.

Group II: Individuals who worked at Asahi until full retirement (i. e., life-employment).

In addition, the working stages will be defined as:

Stage A; before joining to Asahi

Stage B; during work at Asahi

Stage C; after quit from Asahi.

According to the above criterion, 17 individuals belong to Group I and 5 individuals to Group II and remaining 3 are unclear.

2 NAME OF ASAHI ENGINEERS

Following 25 individuals were chosen for further analysis.

Code no. 1 Koju Asahina

no. 2 Yoshio Kami

no. 3 Toshio Sugimoto

no. 4 Yutaka Yoneda

no. 6 Goichiro Uehata

no. 7 Ei-ichiro Tonomura

no. 8 Gennosuke Ando
no. 9 Masayuki Yamada
no. 10 Bukichi Tsujii
no. 12 Tokutaro Ogiwara
no. 13 Eitaro Takamatsu
no. 16 Norio Uei
no. 17 Toshio Ishino
no. 18 Shigegaki Hamada
no. 19 Shozo Tachikawa
no. 20 Mikio Nozaki
no. 21 Naohiko Matsunami
no. 24 Yoshiakira Tamura
no. 28 Hidejiro Fujii
no. 29 Ryo-ichi Aoki
no. 34 Yoshikichi Suyama
no. 35 Chujiro Kishimoto
no. 36 Doho Horiuchi
no. 37 Sho-ichi Nishimura
no. 38 Akira Ohtani

3 ANALYSIS

3.1 Total number of scientific and technical publications for each individuals

Table 1 summarizes number of scientific and technical publications, including Japanese patents, of Asahi engineers. They published totally 27 papers before work at Asahi (Stage A), 51 papers during employment (Stage B), and 151 papers after their quit (Stage C). Roughly speaking, the number was doubled with shift from stage A to stage B and tripled with shift from stage B to stage C, suggesting that Asahi engineers had, on average, successfully developed their job careers through most working careers.

At the moment of employment by Asahi two individuals (Code no. 1 & 8) were categorized as the established engineers (i. e., 'Master') or engineers at senior level, who had carried out for several years independent works, publishing not so few scientific papers in professional journals. At Asahi they took the position of chief engineer (Code no. 1) or managing director (plant manager) (Code no. 8) when they joined. Note that code no. 1 had not published any original paper on regenerated cellulose fibers through

Table 1 Number of scientific publications, including patents, of Asahi

engineers. Code no	Number of publications			
	before*a	during*b	after*c	total (life long)
1	10	0	9	19
2	2	0	41	43
3	0	1	[0]*d	1
4	0	0	5	5
6	8	1	[0]	9
7	0	0	1	1
8	0	4	0	4
9	0	2	0	2
10	0	2	[0]	2
12	1	3	6	10
13	1	0	0	1
16	0	1	0	1
17	0	3	62	65
18	0	3	[0]	3
19	0	11	6	17
20	0	0	2	2
21	4	10	15	29
24	0	2	0	2
28	0	0	2	2
29	1	0	1	2
34	0	0	1	1
35	0	2	0	2
36	0	3	[0]	3
37	0	3	0	3
total	**27**	**51**	**151**	**229**

*a: before joining to Asahi *b: during working at Asahi (average 7/person)
*c: after retirement from Asahi *d: no job transfer from Asahi until full retirement

whole his career, but issued many excellent reviews in that area (note that these 7 reviews consists a single large review.). At the same moment, 4 individuals (Code no.2, 12, 19 and 21) were categorized as experienced mid-career engineers (i.e., 'Journey man'), who experienced scientific or laboratory works under direction of their professors for a few years. For examples, code no. 21 had published 4 papers with professor Komatsu of Kyoto University on organic chemistry of Kakishibuol. Code no. 19 had been for some years an experimental assistant to a university professor, although no achievement was published. Thirteen individuals (Code no. 3, 4, 9, 10, 12, 16, 17, 18, 24, 28, 29, 34, and 35) were practically new graduates or equivalent, whose R & D experience was limited only to gradua-

tion researches (approximately, one year) and some of their results had been exceptionally published in the journals with their directors (For examples, (2.1), (2.2), (12.1), (29.1): Here, combination of numbers in parenthesis(i. j.)means jth publication article of code no i, as listed in ref.1)[1]). Therefore, they had just finished 'Apprenticeship' when they joined to Asahi ('Graduate recruitment').

During work at Asahi, code no. 2 and 4 developed career to a great extent although they had neither applied patents nor submitted papers. They had been at the heart of the technology transfer and development. In later period code no. 19 and 21 were very active in R & D at AKS. After quits code no. 2, 17 and 21 published 41, 62 and 15 papers, respectively. These individuals were the most productive in R & D. Code no. 17 became university professor. Code no. 21 stayed at industry. Code no. 8 resigned at the time of dissolution of partnership between Nippon Menka (Japan Cotton) and Nichitsu (Japan Nitrogen Fertilizer) capitals [1929]. The former was purchased by the latter and Asahi Kenshoku (AKS) became a subsidiary company of Nichitsu. As far as code no .8 was con-

Table 2 Time of submit of publications

Total number of publications	Stage A Code no. [Total]	Stage B Code no. [Total]	Stage C Code no. [Total]	whole stages Code no. [Total]
0	3,4,7,8,9,10, 16,17,18,19, 20,24,28,34-37 [17]	1,2,4,13,20 28,29,34 [8]	8,13,16,24, 35,37 [6]	– [0]
1	12,13,29 [3]	3,6,16 [3]		3,7,13,16,34 [5]
2	2 [1]	9,10,24,35 [4]		9,10,20,24, 28, 29 [6]
3		12,17,18,36,37 [5]		18,36,37 [3]
4	21 [1]	8 [1]		8 [1]
5			5 [1]	4 [1]
6			12, 19 [2]	– [0]
7				– [0]
8	6 [1]			– [0]
9			1 [1]	6 [1]
10	1 [1]	21 [1]		12 [1]
11~15		19 [1]	21 [1]	– [0]
16~20				1,19 [2]
21~25				– [0]
26~30				21 [1]
31~35				– [0]
36~40			2 [1]	– [0]
41~			17 [1]	17 [1]

cerned, it is not clear whether his service to Asahi contributed significantly to his career inventory or not.

3.2 Frequency distribution of the total number of publications per individuals

Based on the data in Table 1, the frequency distributions of the total number of publications of individual engineers at three stages are constructed (Table 2). Among 17 individuals who had not ever published any paper before joining to Asahi 12 individuals had published at least a paper during work at Asahi. After resignation from Asahi 6 individuals each (Code no. 1, 2, 12, 17, 19, and 21) published more than 6 papers (per person) including patents. Code no. 17 published 62 papers after transferred to Osaka

Table 3 Classification of original papers, patents, general papers and books

Code no.	Original papers		Patent		General papers		Books
	textile	non-textile	textile	non-textile	textile	non-textile	
1		3	8		8		
2	13	3	25*a				1
3			1				
4			5				
6		3	1	5			
7			1				
8		2	2				
9			2				
10			8*b				
12		8	2				
13	1						
16			1				
17		50		10		4	
18			3				
19	5		12				
20			3				
21	4	4	17	4			
24			3				
28			2				
29			2				
34			1				
35			2				
36			1	1			
37			3				
38			2				
Total	**23**	**73**	**107**	**20**	**8**	**4**	**1**

*a: JJP sho 12-4161 was rejected, *b: only (10.4) and (10.8) were recorded in CTCJL

(Imperial) University, where he presided over a large school.

3.3 Classification of publications with respect to the subject (textile or non-textile)

Table 3 collects the number of publications on the subject of textile and that of non-textile among scientific papers, general reviews and patents for each individuals. Seventy six (=$\{73/(73+23)\times100\}$) percent of whole publications of 25 individuals were on the subject of non-textiles. This value will reduce to about 50% if the data of code no. 17 is excluded. Textile papers had been written exclusively by three persons (Code no. 2, 19 and 21), who had been Otsu Plant Manager at different times. Among whole patents 84 (=$\{107/(107+20)\}\times100$)% were concerned with textiles and 92 (=$\{23/25\}\times100$)% of engineers (i. e., all ex-Asahimen except code no. 13 and 17) applied patents, suggesting that they were technology-minded individuals.

3.4 Correlations between R & D productivity

Fig. 1 shows the plots of the number of patents against the number of scientific papers, both produced by the given individual in his life-long job career. In the figure number denotes code no. There exists a strongly significant correlation between the productivity of scientific paper and that of patent. In other words, the person who produced a large number of scientific papers could invent also many patents. An exception is code no. 12 (physical chemist).

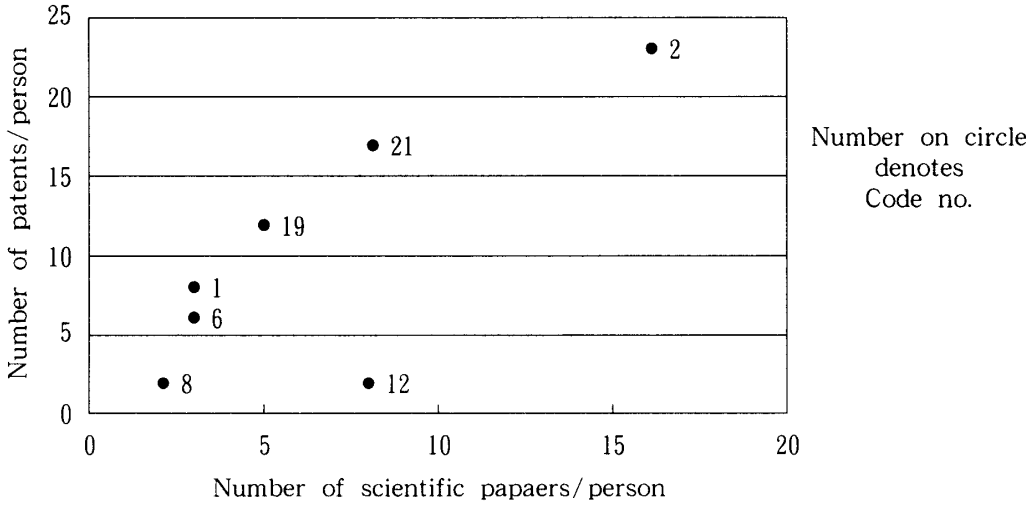

Figure 1 Correlation between the productivity of scientific papaers and that of patents

3.5 Research activity of some individuals

An attempt was made for some major engineers to establish one-to-one correspondence of scientific and technological publication and the professional occupation where the publication (or strictly, the study) was undertaken. For analysis, following five individuals were chosen: Code no. 1, 2, 16, 19 and 21.

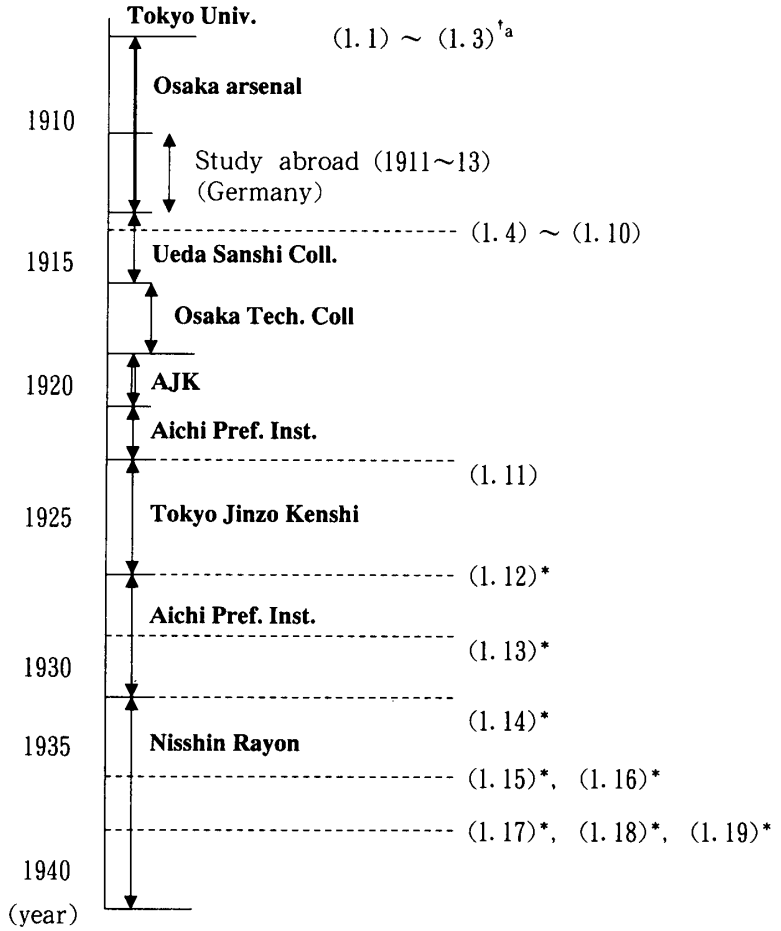

Figure 2 Research activity and job position (Code no. 1) (* : denotes patent)
†a : Combination of numbers in parenthesis (i.j) means jth article of code no i (in this case, i=1) as listed in ref. 1.

Fig. 2 shows the research activity and the job position of code no. 1. K. Asahina published his graduation study on glass [(1.1)~(1.3)[1]] in 1906. During the employment at Osaka Arsenal (a government factory) [1906~1913], he did not publish any paper there. Abroad study in Germany [1911~1913], to where he was dispatched by the arsenal, enabled him to write the long and systematic reviews [(1.4)~(1.10)[1]] [1914]. After resignation from AJK, he wrote a review lecture on the present and future aspect of artificial silk industry (1.11)[1] [1923]. At Aichi Pref. Institute he studied dyeing technology (1.12), (1.13)[1] [1928~1930]. Also he applied the first patent on artificial silk (1.14) [1933]. After

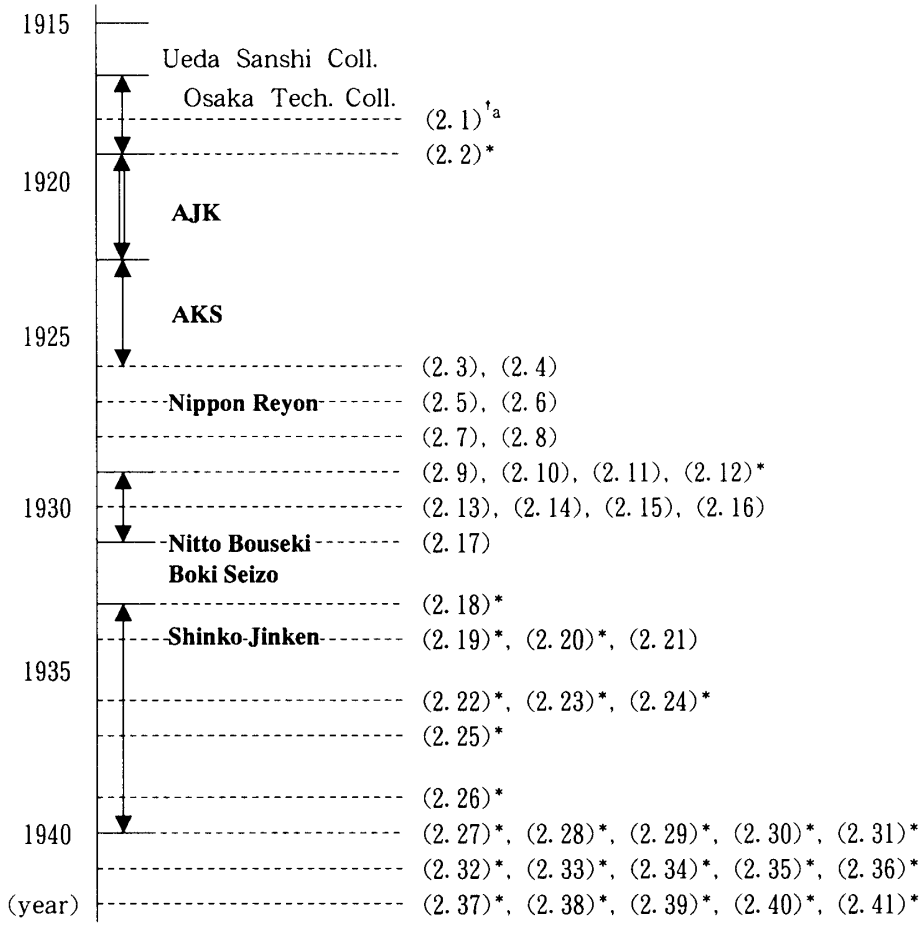

Figure 3 Research activity and job position (Code no. 2) (* : patent)
†a : Combination of numbers in parenthesis (i.j) means jth article of code no i (in this case, i=2) as listed in ref. 1.

joining to Nisshin Rayon in 1935~1936, he was licensed 5 patents, all on artificial silk (1.15)~(1.19)[1] [1937~1939] (assignee, Nisshin Rayon). Through his career [~1942] he had no scientific papers on artificial silk.

Fig. 3 shows the research activity and the job position of code no. 2. Y. Kami had completed his college graduation study under the guidance of Sojiro Kawase, publishing their results; (2.1)[1] [1918], and (2.2)[1] [1919]. At AJK and AKS he had not published, because the establishment of bench scale to pilot scale production technology (AJK) and installment of German-made machines as well as quick learning of Vereinigte Glanzstoff Fabriken (VGF) technology for full scale rayon production were his (and T. Sugimoto (Code no. 3)'s) urgent major target. After resignation from Asahi he published as a technical adviser to Nihon Rayon 4 scientific papers (2.3), (2.4). (2.5), (2.7)[1] [1926~1928] in scholarly journals. In the second half of Nihon Rayon period he studied abroad, keeping the position at the company and after the trip he published in 1928 an excellent, 'state-of-

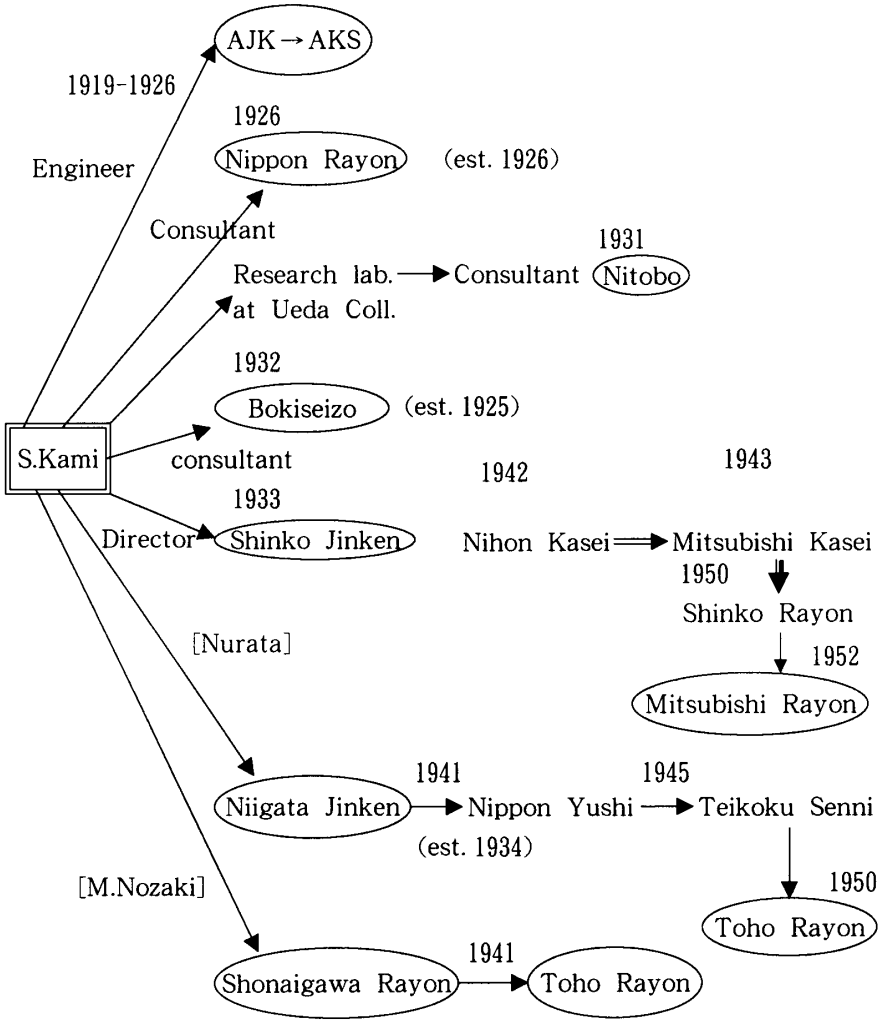

Fig. 4 Technical guidance of S. Kami to new comers (constructed using ref. 3).
[ ] ; his coworkers

arts' book on regenerated cellulose industry, one of the best introductory books of artificial silk industry. Even now the book provides valuable sources for historians: (2.6)[1]. He presided a small private (unofficial) laboratory for study of artificial silk at Ueda Textile College with utilization of apparatus owned by the college [1928~1932]. There he was very active in basic research, hoping new official appointment to the faculty position and published 7 papers [(2.8)~(2.16)[1]]. However his hope was not realized. He guided young students of Ueda, consulting about rayon technology to new comers such as Nittobou [1931] and Bokiseizo [1932]. In 1934~1936, he applied 6 patents [(2.19)~(2.22), (2.24), (2.25)[1]]. After joining to Shinko Jinken he invented 17 patents [(2.25)[1937]~(2.41)[1942]][1] (one of them was rejected). He had strong and longstanding connection, even after taking the position of directorship at Shinko Jinken, with Bokiseizo. He went also into consulting with numerous companies keeping the position at Sinko Jinken. Fig. 4

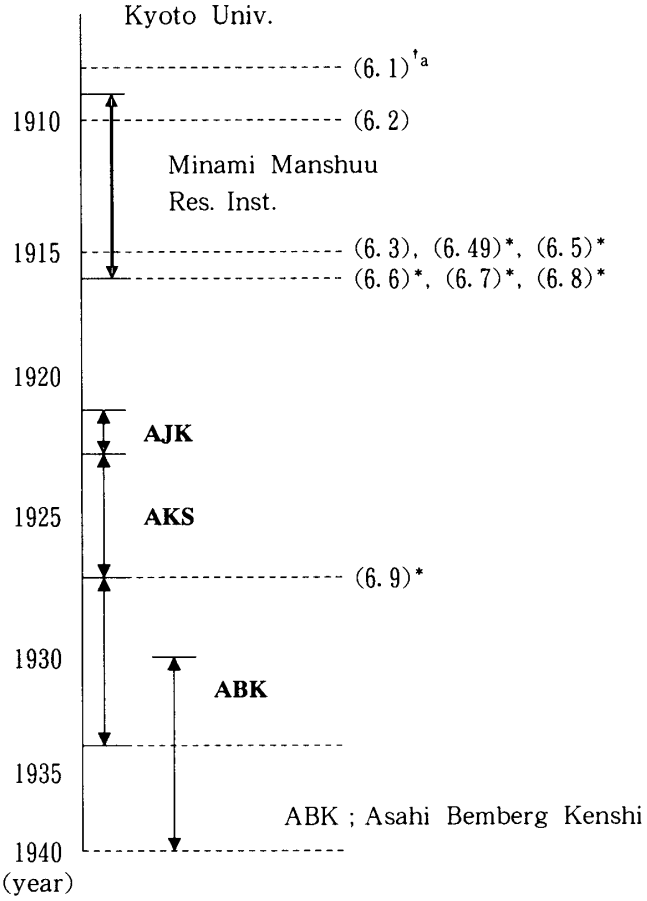

Figure 5 Research activity and job position (Code no. 6) (* : patent)
†a : Combination of numbers in parenthesis (i.j) means jth article of code no i (in this case, i=6) as listed in ref. 1.

illustrates the technical relations of Kami to viscose rayon manufacturer.

Fig. 5 shows the research activity and the job position of code no.6. G. Uehata studied synthesis of indigo as graduation dissertation (6.1)[1] [1908] and joined, after graduation, to South Manshu Research Institute (he worked there at least during about 1909~1916), where he published 2 scientific papers (6.2) [1910], (6.3) [1915][1] and 5 patents (6.4)~(6.8)[1] [1915~1916] until 1916. When Uehata tried to study abroad he was deeply inspired by Matazo Kita, who was then the president of Nihon Menka Ltd. and had stayed at Paris in 1918~1919 as a delegate of the Versailles Peace Conference after world war I, the bright future aspect of artificial silk industry. Note that Kita was a friend of Uehata's father and G. Uehata was son of rich capitalist. Before establishment of AKS he did purchase these rights in Emil Bronnert's patents on viscose rayon in 1920 (Japanese Patent No. 61,264, 62,839, 62,840, 63,603, and 66,919) (these assignee became AJK afterwards). He joined to AJK in 1921 as managing director. After its dissolution he was also appointed managing director of AKS (1922). He spent his core career as managing

director, or similar positions for almost 20 years until his death (1940) and was also one of the biggest share holders of Asahi. He had not carried out at Asahi R & D himself, but played an important role in activating and up-grading R & D capability of Asahi by

(1) recruiting the university graduates, especially from faculty of science,

(2) head-hunting the experimental assistants (graduates of technical colleges) from Kyoto University, who became R & D managers after that (code no. 19 and 21),

(3) encouraging R & D in the company (circulation within the plant of latest editions of overseas journals for specialists: dispatching young scientists to the university for training (code no. 17): communication of unveiled technical information obtained in his frequent Europe trips.

Fig. 6 shows the research activity and the job position of code no. 19. S. Tachikawa started his career first as an experiment assistant to professor I. Fukushima of Kyoto

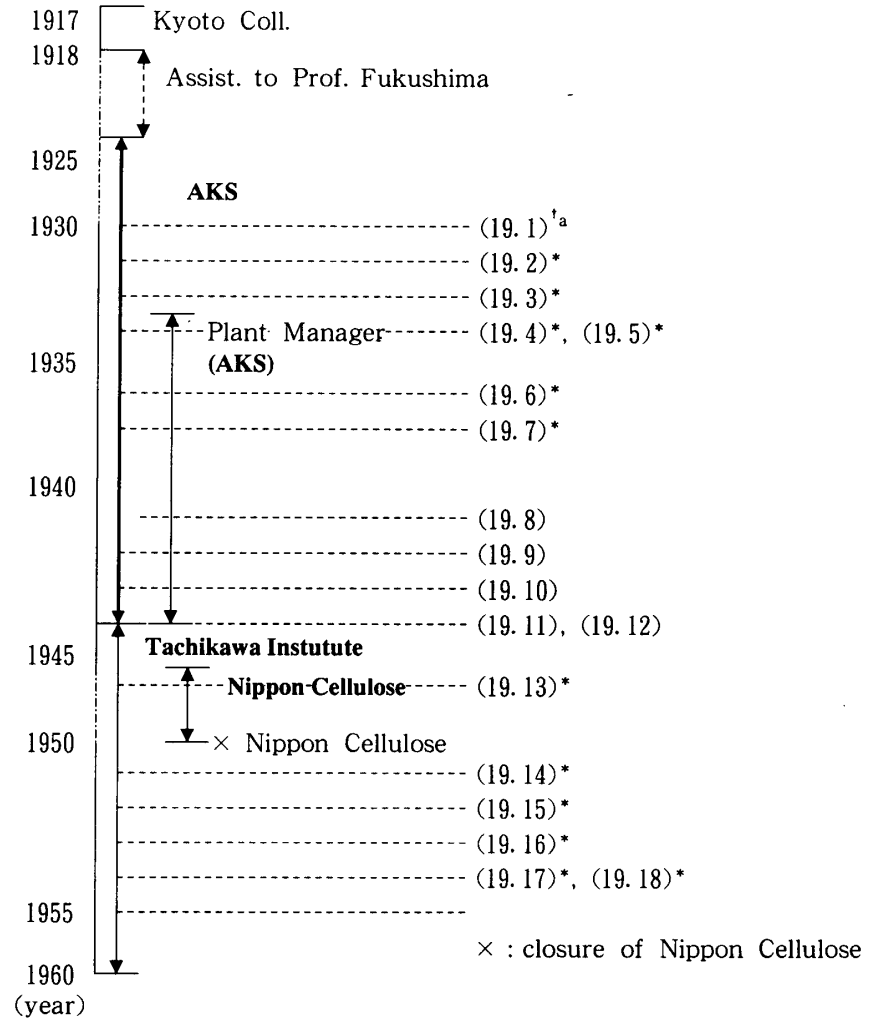

Figure 6 Research activity and job position (Code no. 19) (* : patent)
†a : Combination of numbers in parenthesis (i.j) means jth article of code no i (in this case, i = 19) as listed in ref. 1.

University, where he stayed for some years, although he had not published any paper, different from code no. 21. He applied 6 patents when he was at section and plant manager status (19.1)～(19.7)[1] [1930～1938]. During 1941～1944 he wrote 5 papers (19.8)～(19.12)[1], which formed the doctorate thesis to Tokyo (not Kyoto) University afterwards. He quitted the board member of Asahi at the time of closure of Otsu Plant [1943]. But he kept some position (consultant or adviser?) at Nihon Chisso (of which Asahi was subsidiary) in 1944 (see, (19.11) and (19.12)[1]). He founded Tachikawa Institute with his colleagues in about 1945 and got permission of usage of ex Kanebo-Hofu plant, which had been sold to Army Arsenal in 1944, and Tachikawa Institute established Hofu plant of Nippon Cellulose Kogyo (NCK) (established on Aug. 13th, 1947; capitals 100×10^6 yen (1948); capacity 21.350 Ton/day) for production of high tenacity rayon in 1947. Tachikawa and his coworkers established at Asahi's Otsu plant a world-widely recognized technology for production of high tenacity viscose rayon staple fiber. They practiced at Otsu plant until 1943 and then at Hofu plant of NCK in 1946～1950. Therefore, they had undoubtedly sound technical experience. After amalgamation of Hofu Plant of NCK with Kanebo, Tachikawa Institute seemed to change its strategy; from manufacturer to licensor of the technology of high tenacity viscose rayon staple fiber (Tora Momen^{TM}) (Tiger Cotton). Tachikawa obtained 5 patents (19.14)～(19.18)[1] [1951～1959]. In particular, (19.14) and (19.15) are the patents ruling on polynosic fibers, the most powerful blockbusters.

Tachikawa described his invention in U. S. Patent 2,732,279, applied for 1951 and granted in 1956, that[5]

(a) elimination of aging of alkali cellulose,

(b) dissolution of cellulose xanthate into water, in stead of dilute alkali to prepare cellulose xanthate solution,

(c) elimination of ripening of the cellulose xanthate solution,

(b) spinning bath consisting of acid of very low acid concentration and little or sometimes non salt.

This patent seems equivalent to (19.14)[1], which yielded a new class of viscose rayon (polynosic fibers), which has the following features: Higher strength, lower elongation at break, much higher ratio of wet strength to dry strength, less swelling in water. Moncrieff introduced Tachikawa's work in more detail, sparing 9 pages in his well-known book[5].

Tachikawa's patent was licensed to Europe and Asia: Fabelta (Belgium), Societe Chimiotex (Switzerland), Comptoir des Textiles Artificiel (France).

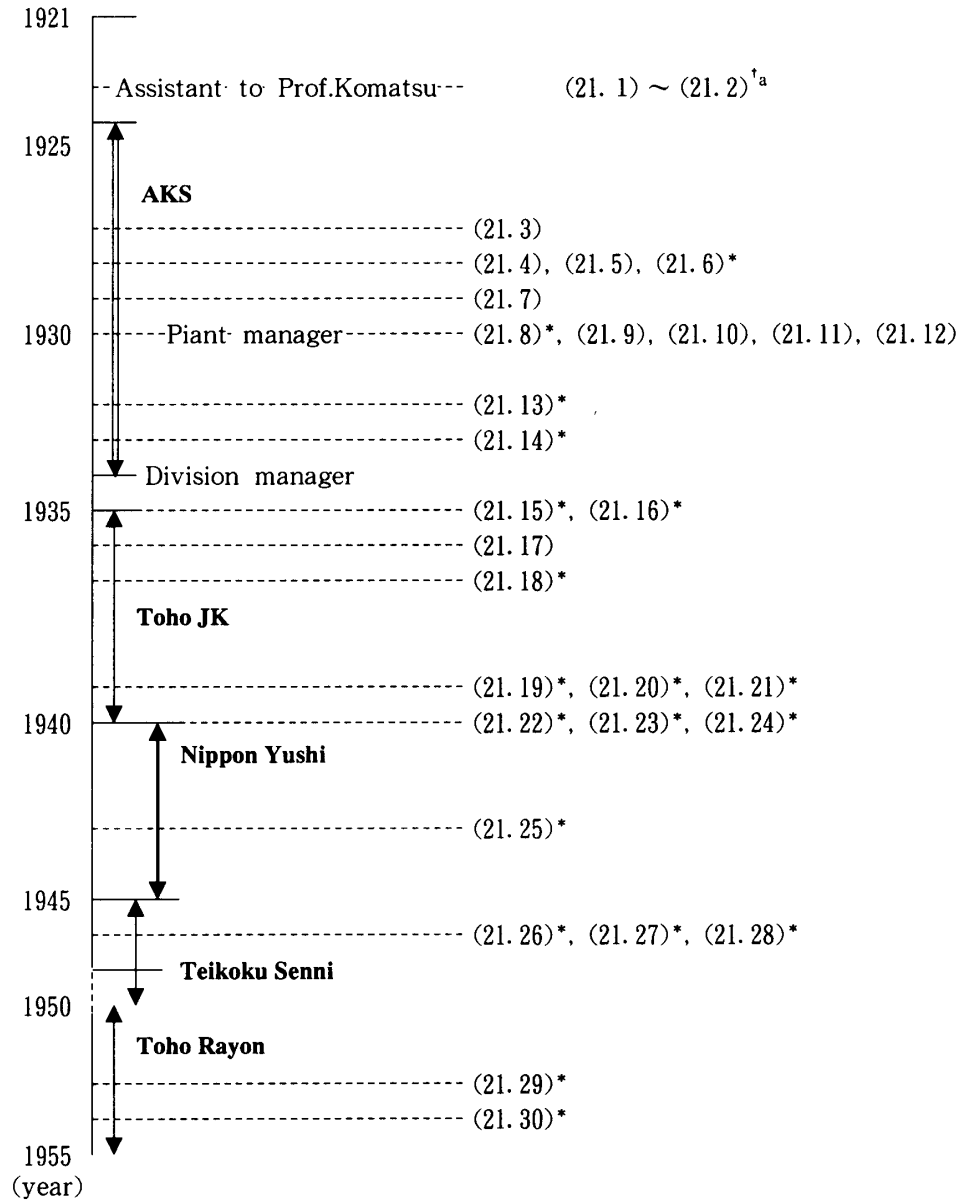

Figure 7 Research activity and job (Code no. 21), (* : patent)
†a : Combination of numbers in parenthesis (i.j) means jth article of code noi (in this case, i = 21) as listed in ref. 1.

Advance of manufacturing technology of viscose rayon fibers by Asahi will be studied elsewhere[5].

Fig. 7 shows the research activity and the job position of code no. 21. N. Matsunami was a most unusual person, who succeeded in constantly keeping high level of R & D activity through his career. He published 8 scientific papers at fist half of Asahi period; (21.3) ~ (21.5), (21.7), (21.9) ~ (21.12)[1] [1927~1929]. Since 1930 his attention was principally concentrated to the technological development (21.13) ~ (21.16)[1]. For short, while after resignation [1934] from Asahi (the reason why of his resignation was suggested in Table

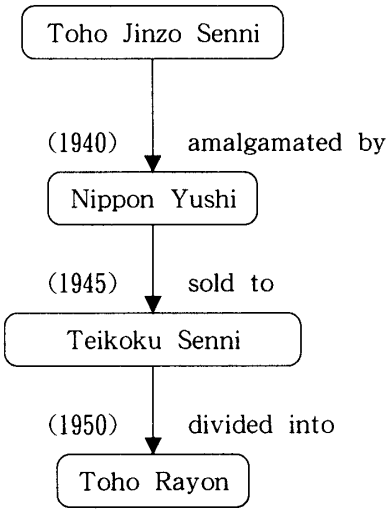

Figure 8 Metamorphosis of Toho Jinzo Senni

10 of the previous paper[1]), he continued to reside at the same address (Otsu) until new plant of Toho Jinzo Senni, to which he was head-hunted in 1934, was completed in the end of 1935. In this transit time he applied 2 personal patents; (21.15)[1] [1935], (21.16)[1] [1936]. He stayed almost 20 years at Tokushima until his full retirement, although Toho Jinzo Senni changed its name by amalgamation, sale or division (Fig. 8). He held 22 patents in total, among which two were rejected.

4 SUMMARY OF SURVEY

The summary of the analysis is tabulated in Table 4.

Average duration between the time of employment by Asahi and that of graduation (i. e., average period of Stage A) was 3.4 (=67/20) years. Among 20 individuals 7 had job before joining to Asahi: 3 experienced chemists (Code no. 1, 6 and 8) and 3 mid-career chemists (Code no. 2, 19, 21). The former group consists of all university graduates and the latter is college graduates who received some research training. Remaining 13 individuals (Code no. 3, 4, 9, 10, 12, 16, 17, 18, 24, 28, 29, 34, 35) plus probably 5 persons (Code no. 16, 20, 36~38)) were new recruitments: Code no. 9~12 can be regarded as 'new' undergraduates chemistry major.

Before joining to Asahi (Stage A) 6 individuals published totally 14 papers, 7 reviews and 5 patents and remaining 19 individuals had no publication: On average, 0.64 (=14/25) paper/person, 0.32 (=7/25) review/person, and 0.23 (=5/25) patent/person. Total 0.64+0.32+0.23=1.19 publication/person.

Duration of employment at Asahi of ex-Asahi engineers (Group I at Stage B) is estimated, on average, to be 5.95 years. All Asahi engineers (Group I+Group II=25)

Table 4 Summary of the survey

	Stge A					Stage B				Stage C			
	①	②			③	④	②			②			⑤
Code no.		P	R	Pt			P	R	Pt	P	R	Pt	
1	13	3	7	0	◎	2	0	0	0	0	1	8	
2	3	2	0	0	○	7	0	0	0	14	1	26	
3	0	0	0	0	△	(27)	0	0	1	—	—	—	
4	0	0	0	0	△	1	0	0	0	0	0	5(3)	
6	14	3	0	5	◎	(19)	0	0	1	—	—	—	
7		0	0	0		1	0	0	0	0	0	1	
8	20	0	0	0	○	3	2	0	2	0	0	0	
9	1	0	0	0	△	11	0	0	2	—	—	—	
10	1	0	0	0	△	(21)	0	0	8	—	—	—	
12	2	0	0	0	△	11	2	0	2	6	0	0	UP,DR
13	3	1	0	0		20	0	0	0	0	0	0	
16	0	0	0	0	△		0	0	1	0	0	0	
17	0	0	0	0	△	3	3	0	0	51	0	11	UP,DR ◎
18	0	0	0	0	△	(22)	0	0	3	—	—	—	
19	6	0	0	0	○	20	5	0	7	0	0	6	DR ○
20		0	0	0		2	0	0	0	1	0	3	
21	>3	4	0	0	○	9	4	0	7	0	0	15(13)	DR ○
24	1	0	0	0	△	13	0	0	2	—	—	—	
28	0	0	0	0	△	9	0	0	0	0	0	2	
29	0	1	0	0	△	8	0	0	0	0	0	1	
34	0	0	0	0	△	6	0	0	0	0	0	1	
35	0	0	0	0	△	16	0	0	2	0	0	0	
36		0	0	0			0	0	2	0	0	0	UP
37		0	0	0			0	0	3	—	—	—	
38		0	0	0			0	0	1	0	0	1	
Total	**67**	**14**	**7**	**5**		**142**	**16**	**0**	**44**	**72**	**2**	**80**	

① : Duration between graduation and employment at Asahi (year)
② : Number of publications, P; Scientific papers, R; Reviews and books, Pt; Japanese patent, ( ); Number of patents registered
③ : Classification of engineers levels: ◎; 'Grown-up' (or master), ○; 'mid-' (Journeyman), △; Apprentice, no mark; less clear
④ : Duration of employment at Asahi (year) ( ): remained at Asahi until full retirement (Group II)
⑤ : Career development, UP; university professor, DR; doctor

published 16 scientific papers (0.64 (=16/25) paper/person), no review (0 review/person) and 44 patents (1.76 (=44/25) patent/person). If discussion is limited to Asahi-men whose job transfer was made before their full retirement (Group I; 17 individuals), R & D productivity is: 0.76 paper/person, and 1.48 patents/person (for Group I). Similar data on Group II at Stage B are collected in Table 5. Group II seems more science-oriented

Table 5 R& D achievements of Asahi engineers at Stage B and C

R & D Achievements	Group I*a (17 individuals)		Group II * b (4 individuals)
	Sage B (Av. 5. 95 years)	Stage C	Stage B (Av. 20 yeas)
No.of scientific papers(per person)	0.76	4.23(1.31) *c	0
No. of patents (per person)	1.48	4.71(4.31) *c	3.25(1.25) *d

*a: individuals who resigned from Asahi before full retirement and took other job
*b: individuals who worked at Asahi until full retirement.
*c: case where code no.17 is excluded.
*d: case where code no.10 is excluded.

than Group I. Note that 14 papers among total 16, published at Stage B, were written by only 4 individuals (Code no. 12, 17, 19, 21); 2 university graduates(Code no. 12, 17) became university professors and other 2 college graduates (Code no. 19, 21), who were categorized as mid-career men, were plant managers. The productivity of patents seems insignificant between Group I and Group II when working at Asahi (Stage B). After quit from Asahi (i. e., at Stage C), Group II people published 4.23 paper/person (if code no. 17 is excluded as an exception, 1.31 paper/person) and applied 4.71 patent/person (if code no. 17 is excluded, 4.31 patent/person) (Table 5). These values should be compared with those of Group II at Stage B (see also Table 5). Group I at Stage C is more productive than Group II at Stage B. Group I individuals developed their career remarkably in Stage B → Stage C, indicating that job transfer was usually successful.

5 CONCLUSION

It became clear that even before world war II Japanese engineers chose intellectual challenge of working at the cutting edges of the most advanced technology such as the viscose rayon industry. They tended willingly to stay~although not necessarily with the same employer. This fact seems a fundamental difference from contemporary 'job transfer' in general due to restructuring of private companies.

Capability in R & D is not simply predetermined by final academic career. Three ex-Asahi key persons, who gave intensive impact to the industry in question are college graduates who received some research training for several years at university or college. R & D achievements depend greatly on the personal capability including leadership.

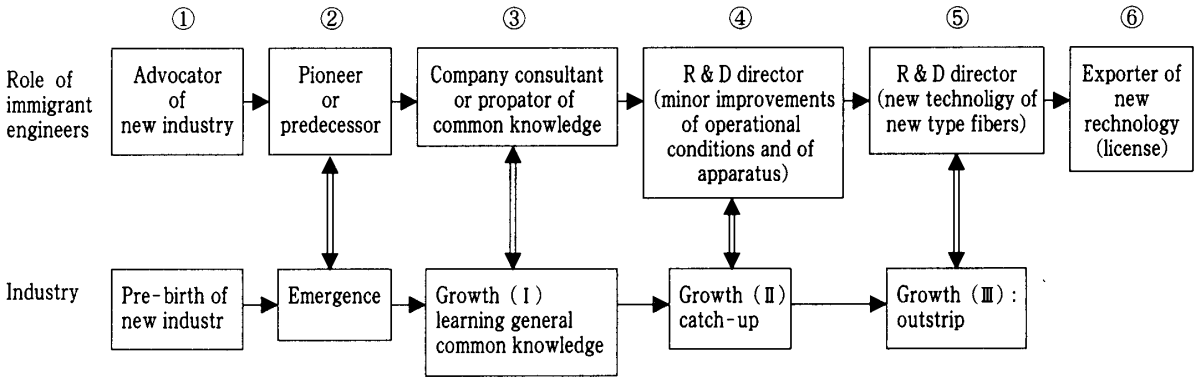

Figure 9 Change in expected role of ex-Asahi Chemists in other regenerated cellulose companies, to which they transferred, and its qualitative one-to-one correspondence to the stage of the industry concerned (i.e., coarse sense, life cycle)

The regenerated cellulose industry was, as described elsewhere, one of the most advanced industries originated in Europe in late 19th century and transplanted to Japan in 1920s~1940s. Capability, required for migration engineers, varied depending on the stage of development of the industry (Fig. 9). Hence, the role of Asahi men mainly as R & D directors seems to be characterized with the time when they departed from Asahi (in

Table 6 Role of ex-Asahi engineers in regenerated cellulose industry in Japan

(Code no.) Name	Year(AD) of resignation	Advocator	Pioneer	Consultant	R&D director (minor Improvement)	Exporter of (new tech- nology) license
(no. 1) K. Asahina	1920	◎	——— ○	—— ····· ——	○	
		7 reviews	Osaka TC AJK		8 patents	
(no. 2) Y. Kami	1926		○———	◎———	○	
AJK 14 papers 26 patents AKS (Fig.4)						
(no.21) N. Matsuura		◎				
					22 patents	
(no. 19) S. Tachikawa	1943				◎	◎
					5 papers 13 patents USP 2,732,279	

◎ : Main role

other words, the extent of development). Table 6 illustrates this idea. Note that ranking of the individuals shown in the table is very tentative and, of course, needs further detailed prudent examination of their technical achievements, which is beyond the scope of this article.

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