

A Modern History of Technology in Japan (II): Synopsis of a Lecture from the Socio-economic Perspective

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Continued from the previous volume.¹

VIII. Technological Transformation in Occupied Japan.²

1. Socio-economic Changes under the Occupation

The political, economic, social and cultural changes that arise under the occupation are consequences of the interactions between the occupiers and the occupied. Various historical studies that were conducted since the public release of the Records of the General Headquarters of Supreme Commander for Allied Powers (GHQ/SCAP) show that there used to be intense conflicts between the occupation, i.e., the GHQ/SCAP, and the Japanese government and Japanese business circles.

The Occupation took priority over all other subjects in the investigation of Japan's remaining ability to fight a war due to the fear of Japan's concealed war potential. Then, General Douglas MacArthur, Supreme Commander for the Allied Powers, adopted a policy not to participate in the economic issues, except for the repeated reductions of the compensation.

However, once the Republican Party

won the US off-year election in 1946, the US government sought to make the occupied areas economically independent to ease the financial burden of the US taxpayers. They estimated that the occupied areas, which included Japan and some parts of Germany, would become economically independent by 1951-53 with 95-120 million dollars of US aid. They set up the financial measures for this purpose. These included the Government Appropriation for Relief in Occupied Areas Fund (GARIOA) programme in October of 1946 and the Economic Rehabilitation in Occupied Areas (EROA) plan in 1948. Within the GHQ/SCAP, the Economic and Scientific Section (ESS) drafted out the plans for Japan's economic independence. They issued a comprehensive plan, entitled "*Possibility of Balanced Japanese Economy* (Green Book)" in October 1947, which was followed by "*Programme for Self-Supporting Japanese Economy* (Blue Book)" in November of 1948. They persuaded the Japanese government to accept these plans. The Japanese government eventually agreed with the GHQ/SCAP on the main points and introduced their Nine-Point Economic Stabilisation Programme in December 1948.

After the Korean War broke out in June

1950, the ESS drafted the “*Industrial Expansion Programme*,” which intended to make Japan a logistics base for the US Military in Eastern Asia.

On the other hand, Japanese business circles were repulsed by the anti-trust and cartel policy of the Occupation, but they kept their concerns private for a long time. After the surrender, several Japanese firms often made profits from so-called “Hoarding of Materials” or “Sabotage (Slow-down) of Production” in a hyper-inflated market. In 1947, the social democratic government of Japan promoted some important industries, such as the coal industry and the chemical fertiliser industry, with generous financial support from the *Fukkô Kinyû Kôko* (Governmental Finance Corporation for Recovery: in short: *Fukkin*). They could also take advantage of “the Multiple Currency Exchanging Rates” that correspond to the international competitiveness of each industry.

A prominent American banker, Joseph Dodge, visited Japan as a financial advisor of the GHQ/SCAP and persuaded the Japanese government to do away with its artificial sustainment of the fragile Japanese economy that was precariously supported by *Fukkin* and “the Multiple Currency Exchanging Rates.” The Occupation intended to make Japan adopt the “normality” of capitalism. A series of policies, known as the “Dodge Line,” were then introduced. These policies, which were named after Joseph Dodge, were directed toward the normalisation of Japanese economy brought about large-scale shake-up of excessive manpower and non-efficient production facilities.

The Korean War commenced in June of 1950, while Japan was in the midst of the

economic depression that was caused by the “Dodge Line.” This resulted in the “Special Procurements Boom,” which was called “a welcome rain during the dry season” by then Prime Minister, Yoshida, Shigeru. Then, the “Strategic Agreement” between the Occupation (or the US government behind them) and the Japanese government and the business circles was finalised.

2. The Scientific and Technical Division of the Economic and Scientific Section, GHQ/SCAP: The Policies, Activities and Accomplishments.

In September of 1945, near the beginning of the Occupation, two American scientists, Dr. Karl T. Compton, the elder brother of Arthur Compton and the Chancellor of Massachusetts Institute of Technology at the time, and Edward Moreland, the then dean of MIT, reached Japan. At the instruction of the Supreme Commander for the Allied Powers, General Douglas MacArthur, they organised the Special Scientific Mission and carried out an overall investigation for almost two months on the wartime scientific efforts and the research activities of various Japanese scientific and technological facilities. Their investigation aimed to clarify Japan’s scientific potential for hostile action against the Allied Nations in accordance with the paragraphs of the “Joint Council of Staffs (JCS) 1380/15” (*JCS Serial 18*, November 3, 1945).

On September 7, 1945, another investigative group —headed by Major Robert R. Furman— who is well-known for his active role in the “*Alsos Mission*,” was organised as a substructure of the Atomic Bomb Mission, which was first commanded by Brigadier General Thomas F. Farrell and then by

Brigadier General J.B. Newman. Having investigated Japan's scientific efforts to develop atomic bombs, known as Operation "Ni" and Operation "F," and its geological and mineralogical surveillance for uranium ore in Korea and Northern Chinese districts that were formerly occupied by the Japanese Army, they submitted their final report that consisted of more than 30 of field reports and interview records to the U.S. Department of the Army and the Manhattan Engineering District on September 28, 1945.

The function of conducting such investigations was handed over to the Scientific and Technical Division (ST) of the ESS. In addition to "JCS 1380/15," "Directive No.3 (SCAPIN 47)" was introduced on the same day. A paragraph within the latter mandated that all Japanese scientific and technological institutions, including universities, were to submit their monthly activity reports to the GHQ/SCAP (ST was in charge). Hence, the ST's report entitled "Review of the Third Year of Occupation" stated, "The first year of occupation was characterised by a programme of constant surveillance and investigation into scientific research having particular war potential" [cited from a document titled, ESS/ST, "Review of Third Year of Occupation," p.1, in Literature ② at the end of this chapter]

However, as clarified in many earlier studies, the wartime research and development projects had a merely transient and mobile basis and lacked the requisite material means and funds. Therefore, the mobilisation systems of the scientific and technological talents and resources were disintegrated once the war ended. It had been made clear that Japan's scientific and technological potential were no longer any menace to the Allied Nations, until

"Directive No. 3," which prohibited research that could be possibly used by the military, was released. On May 25, 1946, the scientific and technological institutions' obligation to submit the monthly activity reports to the GHQ/SCAP was loosened and replaced by the obligation to submit semi-annual reports once every six months. Thus, the elimination of Japan's war potential in various fields of scientific and technological research was *de facto* accomplished almost without any interference from the Occupation. At that moment, the ST's policies were re-oriented to ensure a greater contribution of Japan's scientific and technological potential toward its economic rehabilitation. The draft for their report, "History of Non-Military Activities of Japan" stated the following.

"At a relatively early period, it became clear that the democratisation of Japan would depend in large measure upon economic rehabilitation. Hence, at an early stage in the Occupation, emphasis shifted from the surveillance function to a policy of friendly guidance designed to increase the ability of Japanese scientists and technologists to contribute to the economic rehabilitation effort. The advice and guidance function of ESS in this area of operation therefore came to be of major importance at an early stage in the Occupation, and led to the formulation of a group of programs and projects, the implementation of which constitutes the major accomplishments of the Section in this field." [cited from a document titled, ESS/ST, Draft for "History of Non-Military Activities of Japan." p.6, in Literature ②].

What did they mean by the words, “economic rehabilitation?” Their annual report of 1948 stated, “The introduction of new scientific and technical techniques is now more essential to Japan than ever before for they must replace the cheaper labour available under the old feudalistic system. Substitutes must be developed for the lack of raw materials formerly available to Japan and efficiency must conserve her very limited natural resources.” [cited from a document titled, ESS/ST, “Review of Third Year ...” op.cit., p.9]. This implies that they attempted to make the Japanese economy acceptable to “the peaceful nations of the world,” which were probably comprised of the capitalist nations that the United States was leading. Thus, the economic lever for Japan’s imperialistic expansion — namely its cheaper labour and the lower productivity required for the cheaper export-commodities that resulted in its advantageous competitiveness — was eliminated. Under such a recognition the Division developed their policies in the second half of the Occupation. In opposition to “the old feudalistic system,” they sought to mobilise the scientific and technological potential of Japan to facilitate its industrial recovery through their efforts, as described in the following section of this chapter. The activities of the ST can be classified into five fields: 1) industrial standardisation, 2) industrial property rights, 3) industrial research, 4) improvement of quality control, and 5) renewal of scientific organisations.

Industrial standardisation: In the second year of the Occupation, the ESS/ST made the Ministry of Commerce and Industry rearrange and unify the complicated industrial standard systems and re-establish contact with the Comité International des Poids et Mesures (Sèvres,

France) to facilitate Japan’s return to the world market. The ST aimed at devising “plans for the Japanese to stimulate standardization for domestic progress and further acceptance of their products in foreign market.” [cited from a document titled, Summery ESS/ST Activities for “Report on Political and Economic Conditions in Japan,” 24 Sept. 1947, in Literature ②]

In July of 1948, the *Export Commodities Control Law* was promulgated, which was expected to provide the foundation for establishing the system that ensured the quality of exported goods. While the restriction on international trade by the Japanese was gradually eased from March, 1946, and the export of Japanese goods increased, the ESS feared that numerous “cheap” and “poor quality” commodities might flow into the foreign markets, particularly the Asian markets.

Simultaneously, domestic efforts such as the organisation of more than one hundred quality-control associations and the standardisation of technical terminology in Japanese language were also undertaken. However, the ST complained of inefficiency in the organisation of work related to quality control despite the involvement of around 200,000 people in such work. In those days, the Japanese Engineering Standards and the Emergency Japanese Engineering Standards coexisted disharmoniously. Both of them were *de facto* determined by large manufacturers without consideration of the requirements of medium and small manufacturers or consumers. Such rules were to be replaced with “democratised” and rationalised ones. The *Industrial Standardisation Law* that the ST longed for finally passed the Diet in

1949 and came into effect on August 1. It was accompanied by the amendment of the *Export Commodities Control Law* in December. The control of the competent Ministry was reinforced. Thus, the Japan Industrial Standards (JIS) were established. The standards were to be determined by a board that was comprised of representatives from the government, large manufacturers and small manufacturers. The new standardisation system had a fair and strict statistical quality inspection system, which was the first in Japan's modern history. Although the ST favourably received the establishment of the JIS, they were disappointed by the negative attitudes of the Japanese authorities, who almost gave up on conducting quality inspection for the export commodities to some Asian countries.

“Japanese government officers have strongly advocated writing high minimum standards under the *Export Commodities Control Law* and authorizing the competent Minister to waive the standards for export of commodities to Asiatic countries or elsewhere where the reputation of high quality of Japanese goods is not considered important.” [cited from, ESS/ST Draft for ... op. cit., p.16, in Literature ②]

They were also aware of the possible recession of democratisation. They stated “the possibility is recognised that in Japan the eventual result might be a tendency to use the standards as a mean of control of small manufacturers.” [ibid., p.16]

Industrial property rights: Issues related to patents and trademarks are essentially legal issues. Therefore, the Legal Section (LS) and

the Office of Civil Property Custodian (CPC) of the GHQ/SCAP took charge of those issues. Although the ST was limited to an advisory role with respect to the technical aspects of the matter, they came to be deeply involved in them, because the ESS was perturbed by the unfair competition prevalent within the Japanese market, which infringed foreign industrial property rights. Until the amendment of the *Unfair Competition Preventive Law*, which came into effect on May 1, 1950, the ST made a great effort to organise the legal regulations on industrial rights and to educate the Japanese about the significance of industrial property rights.

In the second year of the Occupation, the ST began to reorganise the Japanese patent system. At first, they made the Japanese government prepare a law that aimed to properly price the patent fee and abolish the concealed patents used by the military. In the following year, the ST made advances in the rearrangement of the classification system for patents in accordance with their end uses and the amendment of the *Patent Law*. In addition, they undertook the role of educating the concerned Japanese parties regarding industrial rights during that year.

Despite their best efforts, infringements of industrial property rights by the Japanese occurred so frequently that even during the final stage of the Occupation, the ST had to highlight the possibility that “infringements of foreign design, patents, trademarks, etc., may continue” even after the Peace Treaty. It appears that the reestablishment of the link between Japan's patent system and those of foreign countries was delayed for this reason. As of January 1950, only the United States and the United Kingdom responded positively

to the proposal to re-establish the linkage in industrial property rights from the Japanese side. Not only for the re-establishment of such international linkage, but also for the promotion of investment from abroad to Japan, the problem of the industrial property right protects was of crucial significance.

“It is quite likely that some time to come Japan will be energetically interested in securing introduction of foreign capital to stimulate the rate of development. One of the prime factors considered by a foreign investor is the protection afforded him in Japan for his industrial property rights. He wants to know what protection he will have for patents, designs, and trademarks. The answer to this question hinges on the type of administration afforded to the new laws enacted at the instigation of the Occupation.” [cited from, ESS/ST Draft for ... op. cit., p.16, in Literature ②]

Industrial research: In early days of the Occupation, the ST made a great effort to protect private industrial research laboratories from the negative impact of the dissolution of *Zaibatsu* (large-scale monopolistic industrial and financial combines). Moreover, such laboratories at the brink of collapse due to the damage caused to them by the war and their lack of financial support. The ST appealed other sections of the GHQ/SCAP to provide them with support. In 1949, the ST conducted an overall investigation on Japanese laboratories “in an effort to determine which laboratories were (or were capable of) contributing effectively to the economic rehabilitation of Japan” [1949 Annual Historical Report. 20 Jan. 1950, pp.23-25: in Literature ②]. Based on this investigation, the

ST suggested eliminating certain inefficient research laboratories.

The ST also attempted to establish an entirely new organisation that integrated the research and testing laboratories within the Ministry of Commerce and Industry, so that they might have enough authority to stand up to those of the Ministry of Education. This plan was realised through the establishment of the Agency of Industrial Science and Technology in 1948. Their basic recognition was as follows.

“... this ministry [the Ministry of Education — the writer] was charged with responsibility for administering an overly large part of the national government’s programme of support of research, resulting in a continuing over-emphasis on fundamental research in national research programme. In another ministry (the fore-runner of the present Ministry of International Trade and Industry — MITI) there was a totally inadequate degree of coordination between the various research and testing laboratories associated with the Ministry, indicating a need for an administrative revision of considerable magnitude.” [cited from, ESS/ST Draft for ... op. cit., p.5, in Literature ②]

In 1949, the ST drafted a plan, entitled “*The Importation of Technology Programme*,” which was sought to facilitate the provision of both of visible and invisible technical assistance to Japan by taking advantage of the SCAP Commercial Account Funds to supplement the insufficient foreign currency reserve of Japan. This programme facilitated the following: 1) foreign technological assistance and/or patent acquisitions by the Japanese, 2) the usage of foreign industrial property rights

by the Japanese, 3) organisation of visits to the United States by Japanese scientists and engineers, 4) the import of scientific equipment and instruments, 5) the import of industrial equipment, 6) the import of the scientific and technological literature, 7) payment of the affiliation fee to the international scientific organisations on behalf of the Japanese government or its domestic scientific societies. However, according to the ST, the achievements of these plans were estimated to be insufficient due to the indifference of the Japanese businesses toward the application of advanced technology in the industrial production.

Nevertheless, the scientific magazines and literature that were supplied by the US and the imported scientific equipment and instruments contributed significantly to the post-war development of Japanese science, which transformed in various ways through its encounter with the American style of scientific research. In this regard, the GHQ/SCAP established the Interchange of Persons Board in July of 1949, which the Deputy Director of the ST, Dr. Bowen C. Dees, attended on behalf of the ST. This board was assigned to carry out *GARIOA Project 452: National Leader Programme* and was allotted a budget of 450,000 dollars. It was designed to facilitate the generation of pro-American groups in various field of Japanese social life through organising visits to the United States for the Japanese. The programme included a number of missions concerned with scientific and technological areas.

Improvement of quality control: It must be noted that several special staff sections of the GHQ/SCAP or AFPAC (US Army Forces Pacific) developed their own efforts to improve the management of operations.

The Headquarters of Far Eastern Air Forces (FEAF) developed the *Indigenous Persons Training Programme* for Japanese workers to make their operations smooth and elaborate. The Civil Communication Section (CCS) of the GHQ/SCAP organised a series of lectures on management training for Japanese private manufacturers and those working on the construction of the electrical communication equipment and lines. These lectures were called *CCS Kôza*. The Labour Division of the ESS introduced a training programme, entitled *Training within Industry for Supervisor* (TWI), for the reinforcement of appropriate discipline.

On March 10, 1950, L. Q. Moss, who belonged to the Adult Education Branch in the Education Division of the Civil Information and Education Section (CIE) of the GHQ/SCAP, called representatives from various sections that were concerned the improvement of the industrial management to a meeting. At this meeting, a coordinating board was organised. The next meeting was held on March 17, 1950. The meeting was officially named the Conference on a Programme for Improvement of Industrial Management in Japan and was assigned to systematise various efforts and trials in the GHQ/SCAP and make the Japanese comprehend the importance of rational management. The ST was in charge of inviting American specialists in the field of management. They sent a letter to F. Schneider from the American Management Association and dispatched Deputy Director Dees to the United States in June to look for suitable individuals. The Engineering Education Mission that was proposed by Dees finally visited Japan in the summer of 1951. A combined meeting of the Conference, which was attended by numerous Japanese

representatives, was held on June 15—immediately before the outbreak of the Korean War.

Renewal of scientific organisations: During the first stage of the Occupation, the ST had to discharge scientists from the mobilisation for military research and development by restricting research for military use and dissolving the *Gakujutsu-Kenkyū Kaigi* (National Research Council: Also known as *Gakken*), which played the central (but unsuccessful) role in directing scientific activities toward militaristic endeavours. They ordered to radically change the Japan Society for the Promotion of Science (JSPS) —the main body for the scientific mobilisation— to render it into a scholarship organisation that would have relatively little influence on such matters. During the war the JSPS had financially supported the application of scientific findings to expansionist plans, which included subjects such as military research, the development of raw materials in the areas occupied by Japanese Imperial Army and so on. On the other hand, the ST encouraged Japanese scientists to establish a new organisation, which was later called the Japan Science Council (JSC). The council was a democratically elected body of scientists that was suitable for the international linkage with various scientific organisation of the world and had a high level of authority as an advisory body to governmental agencies. The ST simultaneously sought to establish a governmental body for administrative action. Thus, the Scientific and Technical Administrative Commission (STAC) was formed and attached to the Cabinet as a coordinating agency. However, the STAC achieved limited success.

The ST was able to be in direct contact

with the Japanese scientists in this field. Many Japanese scientists were impressed by the ST's commitment to the renewal of the nation's scientific organisations. Dr. Harry C. Kelly, another Deputy Director of the ST, was particularly appreciated. He was later called even “a benefactor of Japanese science.” There was, however, a difference in perspective between the ST and the Japanese scientists who participated in the renewal movement. As early as the JSC's establishment in 1948, the ST stated that “scientists who have worked at removing the feudalistic elements in national scientific organisations still do not fully appreciate exigency of this transition” (the transfer of the Occupation policies to the priority of the economic rehabilitation — the author) [cited from, ESS/ST, “Review of Third Year...” op. cit., p.9, in Literature ②].

Literature)

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IX. The High Economic Growth

1. Overview of “Japan’s Miracle”³

The annual growth rate of Japan’s Gross National Product exceeded 10% twelve times between 1955 and 1973, whereas those of other Western Bloc nations never exceeded 10%, except for Western Germany achieving it once. Japan’s GNP fell in below 5% only twice, although the United States experienced the same 10 times, the United Kingdom experienced it 17 times and in Western Germany was witnessed such a slump 7 times. Japan’s GNP increased 4.6 times over that period, whereas that of Western Germany’s increased 2.3 times, the United States’ GNP increased 1.7 times and that of the United Kingdom increased 1.5 times. [Hereafter to the end of this section, the numerical indices are cited mainly from the literature ① at the end of this chapter.]

The international context: The extreme sophistication of armament due to the Cold War and the Vietnamese War made the US

economy so militarised that its citizens’ demand for everyday mass-produced industrial products, such as textile goods, home electric appliances and automobiles had to be met with imported goods. [See, Literature ① and ② at the end of this chapter] Japanese industrial products rushed into the consumer markets of the United States, particularly in the second half of 1960s. In addition, the fixed exchange rate of currency —which was long maintained at the rate of one dollar for 360 Japanese Yen despite the US’ constant fiscal deficit and its chronic currency crises due to its immense expenditure on defence and overseas aid— worked in Japan’s favour.

As a result of Japan’s surrender in World War II, it lost its colonies and the spheres of influence from which it had previously gained natural resources and industrial raw materials. During the post-war period, Japan came to rely upon the United States and its allies to obtain natural resources and raw materials, such as petroleum from American and British oil companies and iron ore from Australia. On the other hand, in some industries, such a change in the import trade made it necessary and possible to build new giant plants without incurring any cost for scrapping older facilities and equipment. In many cases, the Japanese iron and steel manufacturers lacked blast furnaces in their home land during the pre-war period, because they depended upon the northern part of China and India for the supply of pig iron and on the United States for that of scrap iron. Additionally, pre-war Japan’s largest (albeit outdated) chemical plant was located in colonial Korea.

The domestic factors: With respect to the basic structure of Japan’s Gross National Expenditure (GNE) (Table 1), the expansion of

Table 1: Real Gross National Expenditure of Japan, 1955-1973

*unit = 1 milliard yen.

Year	Individual Consumption	Government Purchases	Formation of Fixed Capital in Private Sector	(housing)	(equipment)	Formation of Fixed Capital in Public Sector	Income from Overseas and Export	Gross National Expenditure
1955	10,496 (62.1%)	2,853 (16.8%)	1,799 (10.6%)	562 (3.3%)	1,237 (7.3%)	926 (5.5%)	1,099 (6.5%)	16,901 (100%)
1960	15,261 (60.1%)	3,227 (12.7%)	4,477 (17.6%)	1,103 (4.3%)	3,374 (13.3%)	1,670 (6.6%)	2,023 (8.0%)	25,406 (100%)
1965	23,448 (57.4%)	4,548 (11.1%)	8,105 (19.8%)	2,464 (6.0%)	5,641 (13.8%)	3,497 (8.6%)	4,012 (9.8%)	40,880 (100%)
1970	36,259 (51.3%)	5,796 (8.2%)	16,956 (26.8%)	4,761 (6.7%)	14,195 (20.1%)	5,811 (8.2%)	8,272 (11.7%)	70,635 (100%)
1973	45,920 (50.5%)	7,166 (7.9%)	25,147 (27.7%)	6,714 (7.4%)	18,434 (20.3%)	8,766 (9.6%)	11,136 (12.3%)	90,851 (100%)

Source: The Economic Planning Agency, *The Annual Report of National Income*, 1975

the fixed capital formation in the private sector exceeded that of the personal consumption expenditure and the government purchases by a great degree. From 1955 to 1973, the ratio of the personal consumption expenditure in GNE decreased by 11.6%, dropping from 62.1% to 50.5%. In the United States, this parameter was constantly more than 70%. Additionally, Japan's ratio of fixed capital formation increased by 12.8% (from 10.6% to 27.7%). Thus, personal consumption and welfare was sacrificed for the sake of capital accumulation.

The currency and credits were excessively supplied by the budgetary public investment, the ex-budgetary financial investment and loan, the credits of the Bank of Japan and public debts. The high-rate investment often exceeded the real capital accumulation by the private enterprises. The low level of public welfare, especially the insufficient pension, forced the Japanese people to save their money as individual savings. A large part of such saved money flowed into the government through the post-office saving system as the "the Second Budget," which was officially known as the Governmental Financial Investment Plans. It was utilised for the governmental projects for developing industrial and urban infrastructure.

Owing to the lack of a job priority system, a qualification system or a job grading system, an employee could be reshuffled within firms. Such an employment system facilitated technological

innovations. To acquire cheap, half-fabricated goods and parts, the large manufacturers could take advantage of the hierarchical structure that consisted of various subcontractors, which often were the medium and small manufacturers that had lost a large amount of the former military procurement. As a result, the labour productivity in Japan increased by 284.4% from 1960 to 1970. In contrast, the rate of increase in labour productivity in the United States, the United Kingdom, West Germany, France and Italy during this period was 134.8%, 134.0%, 178.3%, 182.4%, and 188.9%, respectively.

Science and Technology Policies: The policies related to science and technology that were designed to achieve high economic growth consisted mainly of the taxation-induced system for the promotion of importation of technology from abroad and specialist education. These included the Exemption of the Imported Tariff on Imported Machineries (1951), the Reduction of Withholding Tax Rate on the Rental Fees for the Important Foreign Technologies (1953), the Special Deduction on Overseas Technology Trading and so on. Such a series of taxation policies stimulated the technological development mainly thanks to the imported technologies. These policies simultaneously strengthened Japan's technological dependence upon the United States and other Western countries (see, Table 2). As for the specialist

Table 2: Foreign Technology Trade, 1960-1968

*unit = 1 million U.S. dollar

Year	Japan			U.S.A.			United Kingdom			France			West Germany		
	A (earning)	B (payment)	A/B	A (earning)	B (payment)	A/B	A (earning)	B (payment)	A/B	A (earning)	B (payment)	A/B	A (earning)	B (payment)	A/B
1960	2.3	94.9	0.02	650	67	9.70	*	*	*	48.1	90.8	0.53	38.8	127.5	0.31
1961	2.8	111.9	0.03	711	80	8.90	*	*	*	55.7	105.0	0.53	42.5	154.5	0.27
1962	6.8	113.9	0.06	837	100	8.37	*	*	*	54.8	120.2	0.46	46.5	157.8	0.29
1963	9.1	136.6	0.07	927	111	8.35	*	*	*	138.6	188.7	0.73	54.0	159.3	0.34
1964	14.2	155.7	0.09	1,057	127	8.34	125.2	115.1	1.07	144.0	191.0	0.76	66.3	174.5	0.38
1965	17.0	167.0	0.10	1,316	134	9.29	133.8	128.5	1.04	168.0	213.0	0.79	79.8	195.2	0.41
1966	19.0	192.0	0.10	1,380	140	9.86	160.1	132.4	1.21	180.0	243.0	0.74	77.0	201.0	0.38
1967	27.0	239.0	0.11	1,567	171	9.16	175.5	164.6	1.07	195.0	230.0	0.85	95.0	222.0	0.43
1968	34.0	314.0	*	1,805	194	9.30	*	*	*	*	*	*	105.0	249.8	0.42

Source: The Agency of Science and Technology, *The White Paper on Science and Technology in 1969*.

education, the government planned to train 170,000 students in scientific and engineering specialties for ten years from 1960 to 1970 (10-year Plan for the Promotion of Science and Technology in 1960). This plan facilitated the establishment of faculties of engineering within universities throughout Japan. The Japanese engineers in those days devoted themselves to making partial improvements or reducing production costs by using the imported technology.[See, Literature ③]

The basic feature of technological development:
Toda, Shintarô: The overall technological development during Japan's economic boom was characterised in one phrase by the outstanding economist, Toda, Shintarô.[See, Literature ⑧] He

characterised it as “(Production) on a large scale, in succession and with high speed.”

By building large-scale apparatuses, “economy of scale” (also known as “scale merit”) was pursued throughout. The capital investment was concentrated in the heavy industries (Table 3), where the entrepreneurs could take maximum advantage of “scale merit.” According to Toda's economic calculation, scaling up may facilitate the saving of land, buildings, warehouses, and fuel. For example, increase in crude steel production from 2,500,000 tons annually to 5,000,000 tons leads to a 5-10% reduction of investment and reduces the cost by 20-25% per unit. Toda indicated that intensive expansion is more

Table 3: Structure of Investment in Industrial Equipment in Postwar Japan.

*unit =1 milliard yen.

Industries / age	1956-1961	1962-1965	1966-1970
Electricity	1,450 (25.5%)	1,333 (22.7%)	2,603 (18.3%)
Coal	130 (2.3%)	131 (2.2%)	220 (1.5%)
Iron & Steel	902 (15.8%)	738 (12.6%)	2,243 (15.8%)
Petroleum	320 (5.6%)	370 (6.3%)	1,075 (7.6%)
Machinery	926 (16.2%)	1,144 (19.5%)	2,942 (20.7%)
(Electrical Machines)	367 (6.4%)	341 (5.8%)	791 (5.6%)
(Automobiles)	262 (4.6%)	482 (8.2%)	1,358 (9.5%)
Chemical Industry	691 (12.1%)	870 (14.8%)	2,053 (14.4%)
(Chemical Fertilizers)	120 (2.1%)	84 (1.4%)	193 (1.4%)
(Plastics)	65 (1.1%)	92 (1.6%)	194 (1.4%)
(Petrochemicals)	183 (3.3%)	320 (5.5%)	860 (6.2%)
Fiber & Textile	413 (7.2%)	383 (6.5%)	632 (4.4%)
(Synthetic Fiber)	137 (2.4%)	210 (3.6%)	304 (2.1%)
Paper & Pulp	216 (3.8%)	173 (2.9%)	396 (2.8%)
Ceramics	204 (3.6%)	256 (4.4%)	448 (3.1%)
(Cement)	133 (2.3%)	168 (2.9%)	246 (1.7%)
Total	5,710 (100.0%)	5,870 (100.0%)	14,237 (100.0%)

Source: The Economic Planning Agency, *Survey on Economy, in various years*.

significant. If the production capacity of steel making equipment (a converter) was enlarged from 50,000 tons to 300,000 tons annually (six times), then the investment on the equipment would also increase, however, from 2,200 million yen to 5,400 million. (less than three times) The ratio of labour expenses in the production cost would be reduced from 4.60% to 1.04%.

Automation (Detroit-Type) enabled the speeding up of mechanical processes. Thanks to the introduction of transfer machines and transfer presses, various processes of fabrication and plasticity processing were effectively realised. In particular, the introduction of new methods of plasticity processing significantly contributed to the rapid growth of the labour productivity. Although the wing clogs of a fighter plane were made using 272 metal sheets with 3,200 rivets, they could now be constructed with only one stroke of the 35,000 ton press machine, which also reduced the weight of the object by 50 kg. Such automation was widely introduced in the machinery industries, which include the automobile industries and the home electric appliance industries.

The newly built large-scale industrial complex, known as *Kombinat*, secured ceaseless production. The construction of the “Coastal Integrated Iron and Steel Works” in particular were extremely advantageous in economising the transportation costs of raw material, fuel and steel products. “Oil Refinement and Petrochemical Complexes,” which were first built during the late 1950s, facilitated the production of a great number of cars and industrial fuels and a great variety of chemical products.

2. The Tremendous Development of the Apparatus Industries

The rapid growth of some apparatus industries was the most remarkable feature of the High Economic Growth. Therefore, we examine the developments of iron and steel making [based mainly on Literature ⑩] and petrochemical industry [based mainly on Literature ⑪] here.

The coastal integrated iron and steel works:

In light of India gaining independence, the communists’ triumph in the Chinese civil war and other changes in the Asian political landscape, post-war Japan could no longer rely on other Asian nations for the supply of cheap pig iron and iron ore. The Japanese iron and steel makers had to cover the shortage of pig iron supply by building several new blast furnaces. In the 1960s, many large-scale integrated iron and steel works, which combined large blast furnaces and steelmaking, were built in various Japanese coastal areas to minimise transportation costs. These included *Nagoya Works* of *Fuji Iron and Steel Company* (constructed in 1960), *Sakai Works* (1961), and *Kimitsu Works* (1962) of *Yahata Iron and Steel Company* (Later, *Yahata* and *Fuji* were merged into *Shin-Nihon Iron and Steel Co. Ltd.*), *Mizushima Works* of *Kawasaki Iron and Steel Co.* (1961), *Kakogawa Works* of *Kôbe Iron and Steel Co.* (1964), *Fukuyama Works* of *Nihon Kôkan Co.* (presently known as JFE) (1965), *Kashima Works* of *Sumitomo Metal Industries Ltd.* (1968), *Ôita Works* of *Shin-Nihon Iron and Steel Co. Ltd.* (1971), and others. At these plants, many gigantic blast furnaces that had an inner volume greater than 1,000m³ were built one after another. For example, whereas the first blast furnace of *Fukuyama Works* already had an inner volume of 2,323m³, its newest furnace had a volume of 4,664m³.

The internal volume of the fourth furnace at *Mizushima* reached $5,005\text{m}^3$. The iron and steel makers adopted a high top pressure operation and a heavy oil supplement to utilise heat advantageously. The latter method worsened the air pollution due to the sulphur oxide being emitted from the blast furnace. Sulphur oxide was not been supposed to be emitted from a blast furnace, which naturally requires sulphur-free fuel.



Fig.29, A view of a coastal integrated iron and steel works (*Fukuyama Works*)

Source: Pamphlet of *Nihon Kōkan Co. Ltd.*, *NKK Fukuyama Setetsujo* (*NKK Fukuyama Iron and Steel Works*). 1990.

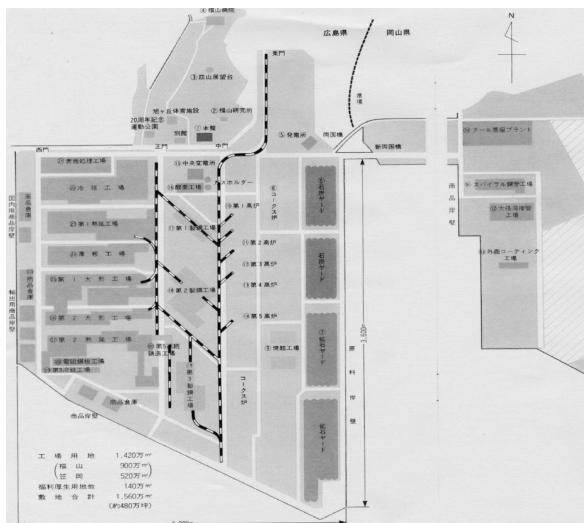


Fig.30, A plan of a coastal integrated iron and steel works (*Fukuyama Works*)

Source: Pamphlet of *Nihon Kōkan Co. Ltd.*, *NKK Fukuyama Seitsujo* (*NKK Fukuyama Iron and Steel Works*). 1990

What is the most remarkable in the development of iron and steel making technology in post-war Japan is the rapid replacement of the method of steel making, which transitioned from using open hearth furnaces to using Linz-Donawitz (LD) steel converters. While steel made in open-hearth furnaces accounted for almost 80% of the total output in Japan in 1955, steel made in the LD converters accounted for approximately 90% of the total output in 1980. LD steel converters were developed in the early 1950s and offered high productivity by using pure oxygen for the oxidation of (or removal of carbon from) pig iron in a crucible shaped like a pear. LD converters produced high quality steel that did not contain impurities such as phosphorus and nitrogen. Although open-hearth furnaces—which were invented in the second half of the nineteenth century and functioned as improved and scaled-up reverberators—provided a qualitatively wide range of steel and treated with a variety in quality of pig iron as material, they were more time-consuming to operate in comparison to LD converters.

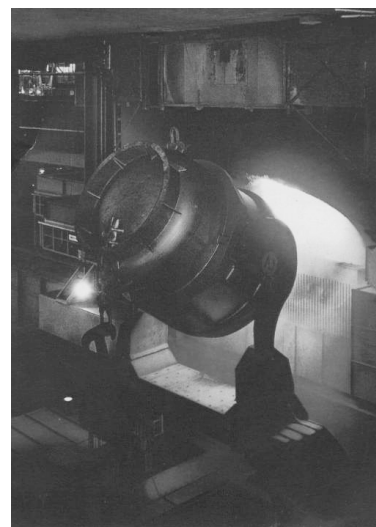


Fig.31, LD Converter.

Source: Pamphlet of *Nihon Kōkan Co. Ltd.*, *NKK Fukuyama Seitsujo* (*NKK Fukuyama Iron and Steel Works*). 1990

In addition to such rapid constructions of the huge blast furnaces and many LD converters, the Japanese iron and steel makers adopted new technology such as continuous casting that was developed in the Soviet Union during the 1950s, which was a method of directly rolling molten steel. Continuous casting radically economised the fuel and time needed for blooming and reheating.

The locations of the coastal integrated iron and steel works were somewhat grotesque. Many of them were built in the areas surrounding the *Seto* Inland Sea, which also had a high population density. The iron and steel works there generated air pollution and other public hazards, which included the *Mizushima Asthma*, the hot wasted water controversy in *Kakogawa*, *Sakai* air pollution controversy and others.

Oil refinement and petrochemical complexes (*Kombinats*): The Fluid Catalytic Cracking (FCC) process for effectively refining petroleum oil was developed in the United States during World War II as one of the wartime scientific and technological efforts. It drastically increased productivity in oil refinement by efficiently circulating, repeatedly restoring and reusing the catalyst. The excessive supply of naphtha accompanied with the usage of this process made the scientists and engineers eager to invent new effective ways to use naphtha within the chemical industry. Eventually a series of the scientific efforts to replace the starting material for polymer-chemical goods from acetylene to ethylene, which is easily obtained from naphtha, led to a radical change in the chemical industry. During 1950s, the oxychlorination process was invented to make vinyl chloride from ethylene. K. Ziegler discovered (and G. Natta improved) the special

catalyst that contributed to the massive supply of polyethylene in the early 1950s. In 1959, Standard Oil of Ohio invented the Sohio process to make acrylonitrile from propylene and two German chemical companies, Höchst Co. and Wacker Co., jointly developed the Höchst-Wacker process to make acetaldehyde from ethylene. Thus, almost all polymer-chemical goods, which were previously derived through the organic synthesis of carbon compounds, could now be obtained from naphtha—one of the by-products of oil refinement.



Fig.32. A view of an oil refinement and petrochemical complex (*Yokka-ichi*).

Source: Internet Source (<https://sspec1days.exblog.jp/18409697/>).

Introducing the FCC process and those petrochemical processes into Japan, the formerly *Zaibatsu*-affiliated chemical companies required the government to dispose its former Army and Naval fuel arsenals, which could serve as the bases for their new industries—the oil refinement and petrochemical industry. In 1955, after much hesitation, the government accepted their request under the condition that they limit the variety of their products so as not to compete with the existing chemical companies that utilised carbide-acetylene organic synthesis until 1961.

The formerly *Zaibatsu*-affiliated chemical companies rushed into successively

constructing large-scale industrial complexes that combined petroleum oil refinement and petrochemical processes. These complexes were called *Kombinats*, which is a term derived from a Russian word. They were often built at the sites that formerly hosted the Army and Naval fuel arsenals. *Nippon* Petrochemical Industry Co. Ltd. constructed an oil-refinement and petrochemical industrial complex in *Kawasaki* city, *Mitsubishi* Petrochemical Co. Ltd. did the same at the site of the former Second Naval Fuel Arsenal in *Yokka-ichi*, *Mitsui* Petrochemical Co. Ltd. did so at the site of the former *Iwakuni* Army Fuel Arsenal and *Sumitomo* Chemical Industry Co. Ltd. built such a complex in *Nihama*. The industrial complexes in *Iwakuni* and *Nihama* began their operations as early as 1958. The surprisingly rapid and grotesque growth of the oil-refinement and petrochemical complexes without sufficient environmental protection measures resulted in causation of severe diseases (asthma and others), especially among the *Yokka-ichi* inhabitants, due to exposure to polluting emissions. In addition, the local residents were also affected by other issues, such as the noise pollution generated by these complexes.

The companies that continued to utilise old, non-petrochemical processes faced significant challenges due to the disadvantageous competition with the rapidly growing petrochemical industry. One such old company that was cornered by flourishing of the petrochemical industry, *Shin-Nihon Chisso Hiryo* (nitrogenous fertiliser) Co. Ltd. (later known as *Chisso* Co. Ltd.), tried to overcome these challenges by adopting petrochemical processes on the basis of its own funds, which were to be accumulated through the radical increase of its output of acetic acid derivatives.

This reckless increase in production brought about the most tragic public health issue in the modern history of Japan—*Minamata Disease*. It was caused due to mercury poisoning that occurred due to the excessive emissions of mercury from the mercury catalyst that was used for synthesis of acetaldehyde. The victims of this disease often suffered from paralysis of limbs, speech disorders, hearing disability, a narrowed field of vision and other symptoms. Since 1953, which was when the first patient was identified, the responsibility (guilt) of *Chisso* Co. Ltd. was not clarified until the judgement that was delivered in the district court in 1973.⁴ Therefore, the disease was widespread. Although only 1,343 patients were confirmed by the government as victims of the disease as of 1982, it is often estimated that it had 10,000 patients and that 200,000 people suffered from it in any aspects.

3. The Tremendous Development of the Large-scale Mechanical Assembly Industries

The rapid growth of some machine-building industries also shapes the fundamental feature of the High Economic Growth. Therefore, we trace the development of the ship-building industry [based mainly on Literature ⑭] and the automobile manufacture [based mainly on Literature ⑮] here.

The ship-building industry: During the Japanese-Chinese War and Pacific War, naval ship-building was prioritised over civilian ship-building. Therefore, once the war was over, many civilian ships were already decrepit. In addition, the air raids that were conducted by the US avoided the shipbuilding yards because of their strategic plan for the post-war occupation. Thanks to them, ship-building became the heavy industry that was recovered earlier than any other heavy industry. In terms

of launch volume, Japanese ship-building was the best in the world as early as in 1952.

The new technologies for ship-building were drawn from the United States. The welding process completely replaced riveting. The process reduced the weight of ships and shortened the time needed for ship-building. The block construction method effectively turned a hull construction into a quick assembly process, wherein blocks that were previously prepared in the factories were made into a ship at the yard.

Most remarkably, many mammoth tankers were built in post-war Japan. This supported the large-scale conversion of industrial fuel from coal to petroleum oil. In 1962, a giant tanker called *Hitachi-maru* was launched. It had a displacement of 130,000 tons. In 1966,

the *Idemitsu-maru*, which was the largest tanker in the world at the time due to its displacement of 210,000 tons, was launched.

To build such mammoth tankers and other large ships, several ship-building companies constructed huge new shipyards. *Ishikawa-jima Harima Heavy Industry Co. Ltd.* constructed a shipyard in *Yokohama*, *Hitachi Ship-building Co. Ltd.* did so in *Sakai*, *Kawasaki Heavy Industry Co. Ltd.* constructed one in *Sakaide*, *Mitsui Ship-building Co. Ltd.* did the same in *Chiba*, *Nihon Kōkan* (Steel Pipe Co. Ltd. Now known as *Universal Zōsen Ship-building Co.*) constructed a shipyard in *Tsu*, *Mitsubishi Heavy Industry* made one in *Kōyagi* and *Sumitomo Heavy Machine-building Co. Ltd.* did so in *Oihama*.

The automobile industry: The rapid



Fig.33, Minamata diseased.

Source: Minamata Forum, *Minamata Ten* (Pamphlet of Minamata Exhibition). 1999. p.36.

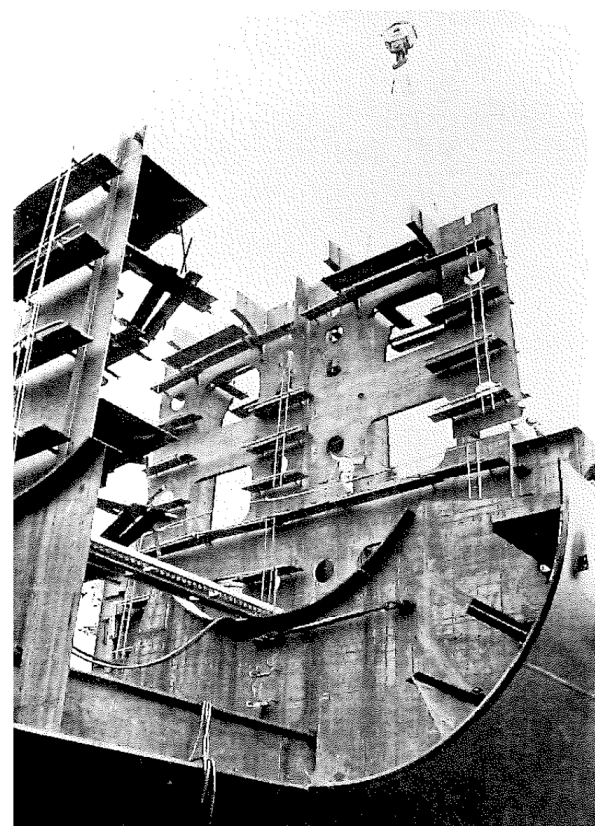


Fig.34, Block construction method.

Source: *Nippon no Gijutsu 100nen* (A Century of Japanese Technology) Vol.3: Zōsen, Tetsudō (Ship-building and Railroad). Chikuma Pub., 1987. p.71.



Fig.35, Idemitsu-maru.

Source: *ibid.*, p.81.

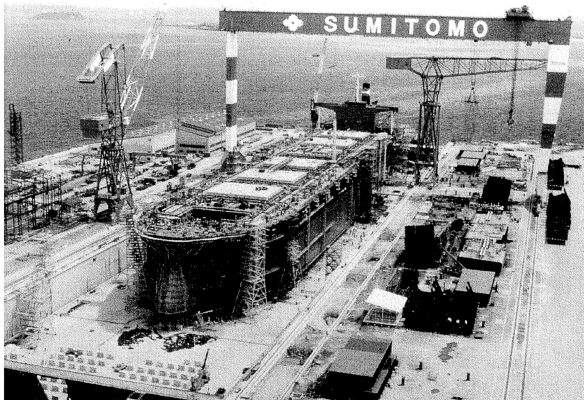


Fig.36, A giant shipyard with a goliath crane (in Oihama)

Source: *ibid.*, p.77.

development of the oil refinement industry resulted in the abundant supply of cheap gasoline. To create the corresponding demand for petroleum oil, the government settled on a series of policies to construct new highways and other motorways as the fundamental infrastructure for the so-called “Motorisation” (through the [First] National Comprehensive Development Plan from 1962 to 1969, followed by the New National Comprehensive Development Plan from 1969 to 1977). In 1963, a section of the *Meishin* Highway between *Rittô* Interchange and *Amagasaki* Interchange was opened as the first highway in Japan. This “Motorisation Drive” eventually brought about the overall conversion of fuel from coal to petroleum oil and the closure of many coal mines throughout Japan. A great labour

dispute that occurred during the shutdown of *Mitsui-Miike* coal mine was severely fought from 1959 to 1960.

Supported by such governmental policies, many mechanical manufacturers that were previously engaged in the military armament industry entered into the young and promising industry of automobile assembly. For example, *Tôyô Kôgyô* (Industry) Co. Ltd., which earlier manufactured Type 38 rifles —the major infantry equipment of Japanese Imperial Army— and other mechanical products, turned into *Mazda* Motor Corporation which is presently one of the major automobile manufacturers in Japan. *Nakajima Hikôki* (aircraft) Co. Ltd., which used to manufacture *Zero Fighters*, became *Fuji* Industry Co. Ltd. It was followingly divided into *Fuji* Heavy Industry Co. Ltd. (now known as *Subaru* Corporation) and *Prince* Automobile, which was later absorbed into *Nissan* Automobile.

Some automobile manufacturers like *Nissan*, *Hino* Diesel Co. and *Isuzu* launched their business through knocked-down production contracts with foreign companies. *Nissan* created the Austin A40 as early as 1953 in this manner. On the other hand, *Toyota* pursued its own independent development. Its effort led to the creation of the Toyota Crown RS in 1955.

Japanese automobile manufacturers introduced progressive technology that was derived from the United States. In 1953, *Toyota*



Fig.37, Toyota Crown RS.

Source: Internet Source (<https://221616.com/car-topics/20080214-a49055/>)

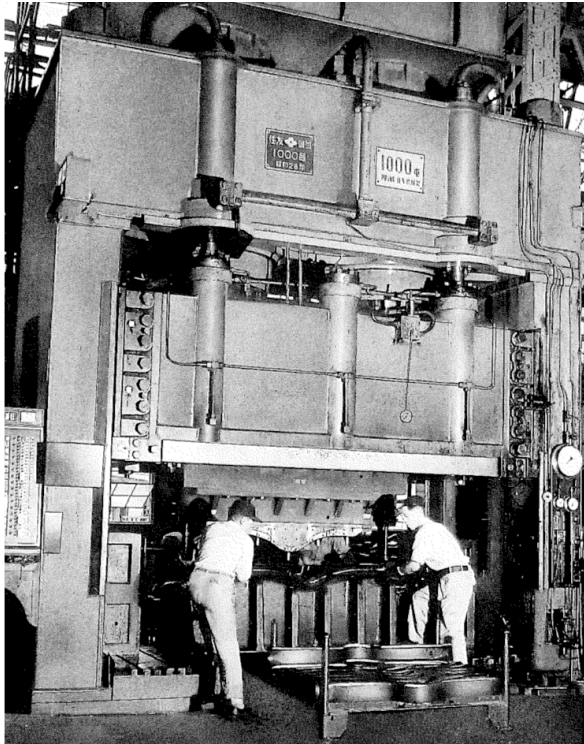


Fig.38, 1,000ton press machine that was introduced at the Toyota Factory.

Source: *Nippon no Gijutsu 100nen (A Century of Japanese Technology)* Vol.3: Kôkûki, Jidôsha (Aircraft and Automobile). Chikuma Pub., 1987. p.119.

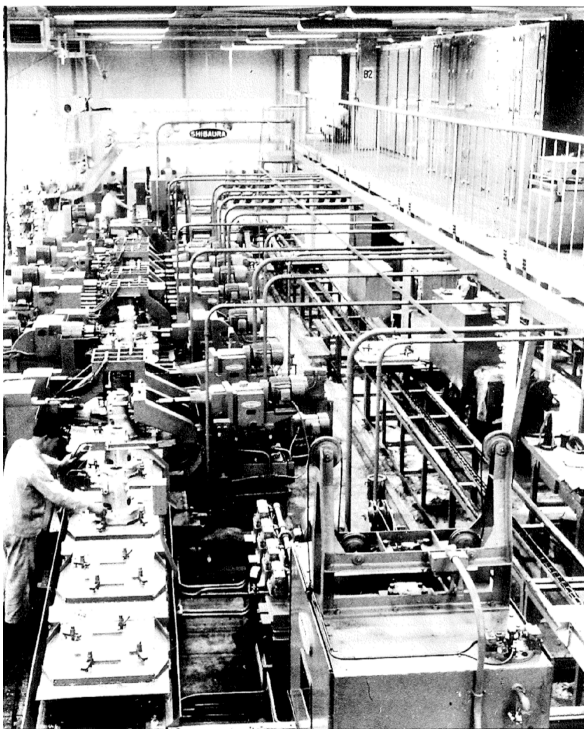


Fig.39, A transfer machine that was introduced at the Nissan Yokohama Factory.

Source: *Nippon no Gijutsu 100nen (A Century of Japanese Technology)* Vol.3: Kôkûki, Jidôsha (Aircraft and Automobile). Chikuma Pub., 1987. p.116.

introduced fifteen 1,000 ton press machines. Nissan installed transfer machines at its Yokohama Factory. This factory is said to be the first (Detroit-type) automation factory in Japan.

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X. The Consequences of the High Economic Growth.

However, building giant plants required a long “pregnancy period” of capital. In addition,

the reduction in the operation of large-scale apparatuses occasionally leads to catastrophic profit rates. Therefore, the maintenance of full or quasi-full operation became the “supreme proposition” for the entrepreneurs. As a result, Japanese people suffered due to the chronic inflation and the potential excessive supply, which eventually resulted in the economic crisis of 1974-75.

The large-scale industrial investment was often accompanied by “saving” the anti-pollution equipment and the safety facilities. Thus, the Japanese also suffered significantly due to environmental pollution. The most serious case was perhaps the air pollution generated by a huge oil refinement and petrochemical complex in *Yokka-ichi* city.

The rapid development of oil refinement in postwar Japan increased the utilisation of petroleum oil. The government undertook a policy called “Motorisation Drive,” which supported the increased consumption of petroleum oil by constructing highways and motor ways and encouraged thermal power generation using heavy oil as fuel, which led to the closure of coal mines. The rapid increase of the use of heavy oil further facilitated environmental pollution.

Notes,

1. Ichikawa, Hiroshi, “A Modern History of Technology in Japan (I): Synopsis of a Lecture from the Socio-economic Perspective.” Bulletin of the Graduate School of Integrated Arts and Sciences, Hiroshima University, III, *Bunmei Kagaku Kenkyû (Studies in Cultural Sciences)*. Vol.14 (2019), pp.25-47.
2. This section is a revised and summarised version of the author’s former work: Ichikawa, Hiroshi,

“Technological Transformation of Occupied Japan; The Implications of the Policies and Activities of the Scientific and Technical Division of the Economic and Scientific Section of GHQ/SCAP”. The History of Science Society of Japan, *Historia Scientiarum*, Vol.5-2, Dec. 1995, p.p.183~197.

3. This part is a revised and summarised version of the author's former work: Ichikawa, Hiroshi, “A Problem in Contemporary History of Technological Development in Japan: Reconsidering “Japan's Miracle” in 1960s.” Hiroshima University, The Graduate School of Integrated Arts and Sciences, *Shakai-Bunka Ronshû (Hiroshima Papers on Society and Culture)*, Vol.9, 2006, March, 1-10.
4. Some engineers of *Chisso* Co. Ltd. changed co-catalyst from manganese dioxide to ferro-sulphate without reporting to authority, which consequently resulted in an unexpected chemical reaction in the equipment. That process was clarified only in 2001 : Nishimura, Hajime and Okamoto, Tatsuaki, *Minamata-byô no Kagaku (Science on Minamata-Disease)*. Nihon Hyôron-sha, 2001.

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