DEVELOPMENT AND STATUS QUO OF JAPANESE SCIENCE AND TECHNOLOGY POLICIES[1)]

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The scientific and technological policies of modern capitalism were founded mainly in the monopoly-capitalist stage of its world history, in the late 19th century. More exactly, there are such capitalist countries as Germany, Russia and Japan, pursued closely behind the most advanced country, England, which was already in the monopoly-capitalist stage. They needed especially strong policies for science and technology, even as they began their early capitalist developmemt[2)]. If we roughly survey the historical development of modern Japanese industries as well as science and technology since the 1870s, we could see that the brilliant achievements of Japanese industries were almost always a result of close cooperative relations between big firms and the government. Even from the very beginning, some extremely ugly and antidemocratic aspects of the government/business ties were already evident.

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2) Takayoshi Inoue, Kagaku Gijutsu Seisaku, in: Kunioki Katô and others (ed.), *Shizen Kagaku Gairon*, Aoki Shoten, 1980. It would be easier to understand historically the necessity for the strong industrial policies promoted by the goverment of the "persuing countries", if we use the term "generation" proposed by Yong-ho Kim, calling England the 1st generation of capitalism, France and Germany the 2nd, Russia and Japan the 3rd and the East-Asian NICs the 4th (Kim, Y., *Higashi Ajia Kôgyôka to Sekai Shihonshugi*, Tokyo 1988).

[1] Foundations of Science and Technology Policy of Japan —historical background before the 2nd World War—

In Japan, government-managed raw silk factories were founded in 1870s, just after the Meiji Restoration. The purpose was to promoting the most important export industries by using foreign technologies. The policies included inviting foreign engineers, dispatching trainees abroad, importing foreign machines, employing female workers and financing by the government. Similar policies were followed in establishing cotton, railroads etc. by the 1890s. Thereafter, through privatization and diffusion of technologies and skills, capitalist production and accumulation could be on course, together with reforming and reorganizing other related industrial sectors[3].

One of the other important factors of scientific and technological policies was rapid military rearmament and war. To establish home production of arms, the Meiji government constructed various arsenals for canons, warships, rifles and bullets in the late-1870s. But apart from rifles, they needed also imported machines and materials and foreign engineers[4]. The government-managed Yahata Iron and Steel Manufacturing Co., which was constructed on the reparation money from Qing dynasty after the Sino-Japanese War (1894-1895) and started producing in 1901, was a great step toward the home production of materials of arms.

About a half of the reparations was appropriated directly for military expansion[5]. After the Russo-Japanese War during 1904-1905, military expansion and development of heavy industries went ahead hand in hand, The Law on Mobilization of War Industries established in 1918 was not only a model for the National General Mobilization Law in 1938 but also for a fundamental militarized direction of Japanese industy policies. The Japan Iron and Steel Corporation was established in 1933 as a joint enterprise both government and privately managed and played the leading role in government control of key industries[6]. Tanks and armoured cars, battleships, submarines, war-planes, high explosives etc. were producted by the heavy industries supported more or less with governmental finance and technical guidance.

Chemicals, electro-chemical, special steel, coal-tar, alkali, optic industries as well as other various industries, developing during and after the 1st World War, tied up in most of cases with military demand on the one hand, although new civilian demand, such as chemical manures, medicines, dystuffs, electric bulbs, radios and cameras, gave big markets to these industries as well, and with the aggressive policies against Asian countries on the other[7].

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3) Kanji Ishii, *Nihon Keizaishi*, Tokyo Univ. Press, 1976.
4) Kaichirô Ôishi (ed.), *Nihon Sangyôkakumei no Kenkyu*, 1, Tokyo Univ. Press, 1975.
5) Makoto Takahashi, *Meiji Zaiseishi Kenkyû*, Aoki Shoten, 1964.
6) Mitsuhaya Kajinishi and others (ed.), *Nihon Shihonshugi no Botsuraku*, 3, Tokyo Univ. Press, 1963.
7) Kaichirô Ôishi (ed.), *Nihon Teikokushugishi*, 1, Tokyo Univ. Press, 1985.

As for the pure sciences, such as physics, biololgy, medicine, chemistry, as well as some essential technologies, social siences and humanities such as philosophy, law, economics, sociology etc., were almost all introduced afresh from european countries as well. Higher education concentrated on studying european languages, learning from both foreign teachers and books, and sending students abroad. Since the 1890s, higher education sysem became almost independent of foreign teachers. Main universities and higher professional schools were established by the early 20th century[8]. But in the industrial fields, the main stream of science and technologies was, until the 1930s, as dependent on foreign teachers as ever. Moreover, the original idea of keeping academic freedom and autonomy on the one hand, and promoting practical sciences following the policies of the government on the other, coexisted isolated from each other[9]. The separation of pure science research and applied science originated in the Meiji period, because Japanese science and technology policies placed more value on the short-term application of technology for industry rather than establishing a close working relationship between them for long-range creative research and development. Meanwhile, a few excellent results of the natural sciences were published and internationally appreciated : botany, bacteriology, astronomy, nuclear physics, pharmacology, quantum mechanics etc., though they were individual contributions and not systematical. Professorships (Kôza-sei), formations of research and education in the imperial universities were based on authoritarianism and professors controled their fellow assistants by means of planning projects, of distributing budgets and subsidies, and of promoting fellows as they liked[10]. Above them, the Japan Imperial Academy, former established as Tôkyô Academy in 1879, the Learning and Study Advancement Society (1932) under the Ministry of Education and other institutions had a great power over the academic world, getting the cooperation of many of professors[11]. During the 2nd World War, the military authorities had command of academic world forcing military research and training and even abolishing all colleges and faculties except those of natural sciences and technologies in order to mobilize the students into the battlefield.

Criticism of and resistance against authoritarianism, appeared in the social sciences and philosophy, and to some extent in the natural sciences, but those who openly resisted were cruelly oppressed, resulting in death or silence.

Mainly Marxists, even liberals were arrested if they criticized military or imperial control of science and human rights. Most researchers and technologist joined various munitions for the research and development project voluntarily, or otherwise, mobilized for the military industries and the battlefield[12].

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8) Tôru Hiroshige, *Kagaku no Shakaishi*, Chûô-Kôron Sha, 1973.

9) T. Hiroshige, *Ibid*. But Hiroshige denies both the existence and even possibility of the academic freedom in general because of the "institutionalization of science" .

10) Nihon Kagakusha Kaigi (JSA)(ed.), *Gendai Shakai to Kagakusha*, Ôtuki Shoten, 1980.

11) T. Hiroshige, *Ibid*.

12) Chikatsugu Iwasaki, Marxistische Philosophie in Japan, in : S. Bonisch u. a. (hrsg.), *Marxistische Dialektik in Japan*, Dietz Vlg., Berlin, 1987.

Concerning the compulsory elementary education system since 1872, although the percentage of school attendance was lower than 100% until the early 20th century, it served to attain a high level of essential knowledge and skills as well as to pave the way for ideological control of the people instead of establishing independent and creative personalities[13].

Introducing these science and technology policies from abroad more or less succeeded except in agriculture, which, because of tight landownership and semi-feudal tenancy system, was unsuitable for european large scale farming methods and technologies and so returned to traditional methods.

[2] Science and Technology Policies Contributing to the Rapid Growth of Japanese Economy —after the 2nd World War—

In the midst of the ruins of the 2nd World War, Japanese scientists and technologists were for the first time conscious of the importance of peace and freedom. They realized their own responsibility for the military use of science and technologies and for the lack of courage to criticize militarism as well as "Tennôism". Authoritarianism of the academic world isolated from the people had to be examined radically. The Japan Imperial Academy as well as another academic institutions were closed and the Japan Academy started afresh in 1949[14]. It consisted of the members who were directly voted by scientists and technologists. On the other hand, the abrogation of the Law for Maintenance of the Public Peace (Chian-Iji-Hô), which had oppressed not only political leftists but also many conscientious scientists and teachers, made possible the renaissance of autonomous scientists movements. The Association of Democratic Scientists was established in 1946[15]. Philosophy, economics, law, history, arts and natural sciences were included. It seemed to have opened up new democratic perspectives in science and technology.

But, under the cold war strategies of the United States, the policies of their occupying force in Japan changed from democratizing Japanese politics and economy to reorganizing military and industrial power based on the restored former conservative authorities. Purged capitalist and ultra-right authoritarianists responsible for war-crimes recovered their positions while communists and radical leaders of labour movement were again purged of their posts. Framed up accidents in 1949, organized by secret agents of the occupying force of United States accusing the communists unjustly, for example the murder of the then Governer of Japan National Railroad, Shimoyama, and the intentional derailment of a passenger train, made the red-purge very smooth. These manipulations

13) Teruhisa Horio, Kokumin no Gakushûken, in: *Gendai to Shiso*, No. 11, 1973.
14) T. Hiroshige, *Ibid.*
15) Nihon Kagakusha Kaigi (JSA) (ed.), *Ibid.*

are typical events in reactionary reconstruction and development of Japanese economy and politics[16].

Japan's dependence on policies dictated by the U.S. cold war strategies under the Japan-U.S. Mutual Security Treaty (Anpo-Jôyaku) was one of the other factors. Rearmament policies together with the expansion of American military bases in Japan prevented the development of Japanese society in the direction of peace and democracy.

In 1950s, when Japan had almost finished its economic reconstruction after the 2nd World War under the favour of American-Korean War, the Ministry of International Trade and Industry (MITI), reorganized from the Ministry of Commerce and Industry, pointed the principle of Japanese economic development. It was to establish economic independence, by preventing imports except urgent needs, by promoting exports and by establishing tehnological foundation of industries[17]. It resembled, in a sense, the mercantile policies which were also characteristic in thr pre-war time, although they were taking place only within the framework of dependency in the post-war period.

In the field of science and technology policies, catching-up strategies with the latest foreign technologies and productivity, which have become even further advanced than those of Japan during the war time, were put forward especially through introduction of foreign techniques as well as capital. To those purposes, for example, foreign machine tools contributing to improve the qualities of Japanese products were imported with 50% subsidies of their prices; trial manufactures modelling after the imported tools were promoted also with 50% subsidies of their costs for realizing their home production; tax cuts as well as exemptions under the name of "special depreciation" for more than 150 of designated sorts of the tools and machines contributed not only to improve the levels rapidly but also to ensure the extra-surplus-values or surplus-profits to the big businesses. Coal mining, electric, iron-and-steel, textile and a few other industrial fields made succeededly great strides thanks to governmental patronage. The Japan Development Bank, one of the national banks, also played a great roll in financing big businesses of these fields directly. It is noticeable that many laws for protecting and developing big key industries were made under the name of "provisional laws", because they were obviously in contravension of the Anti-Monopoly-Law, hence the name meant they were "provisionally" effective within only several years. In fact, most of their limitations were repeatedly prolonged[18].

In 1956 Science and Technology Agency were founded for promoting mainly large scale projects of technological development. The National Aerospace Laboratory, the Laboratory for Metalic Materials Technologies, the General Laboratory for Radiotherapeutics belonged to the Agency and it also administered the Japan Atomic Energy Rsearch Institute and several others.

Petroleum and petro-chemical industries and their related industrial fields, such as

16) Rekishigaku Kenkyûkai (ed.), *Nihon Dôjidaishi* 2, Aoki Shoten, 1990.

17) *Ibid.*

18) Rekishigaku Kenkyûkai (ed.), *Nihon Dôjidaishi* 3, Aoki Shoten, 1990.

synthetic fiber, rubber and other plastics, undertook the leading role in so-called "rapid-growth period" in the 1960s. Also the essential technologies and know-how were imported under the similar privileged support with finance and taxation. Moreover the policies of constructing "new industrial cities" or "industrial combination areas" drew enormous sums from financial funds of local administrations to profit the monopoly-capitals[19].

Automobiles, home electric and electronic wares, such as washers, refrigerators and televisions spread hand in hand with conservatism in daily lives.

Universities and colleges were rapidly expanded or newly founded in order to ensure the required mass of backbone engineers. Mass producing higher education system devastated its level and quality as well as humanistic atmosphere of the campus[20].

In the early 1970s, the industrial and tecnology policies were forced to change because of international trends toward liberalization of trade, taxation and capital firstly, and because of resistance from mass movements against environmental pollution, monopoly-capitalist exploitation. Also there were serious economic crises called "Dollar Crisis" and "Oil Crises". The rapid growth of Japanese economy ceased and the way to break through the crisis was eagerly sought[21].

Microelectronics technologies were one of powerful means. They were successfully introduced into almost all of the industrial fields with the full of cooperation between big firms and government. This government business cooperation greatly helped to promote Japanese industries to the position "No.1". The catchword of science and technology policies was "the establishment of the state on the base of technologies"[22]. It means that, after having achieved the catching-up strategies, Japan as a country with few resources should contribute to international society by means of brain resources. Research and development of computers, aerospace, bio-technologies, information and communication, city-development, atomic energy, oceans, new-type devices, industrial robots, laser, fine-ceramics etc. were included in the objects of the policy. Especially it is emphasized that privileged financial aid to promising but risky fields of research and development, mobilization of public institutes and universities to this purose and training of selected technological élite should be far more reinforced than ever[23].

In the early 1980s, an important reaction in Japanese science and technology policies occurred: The Law was changed so that the Japan Academy lost its autonomy through changing election system of its members from direct vote by scientists to recomendations by academic bodies and Prime Minister's appointment. The Academy weakened its influence over policies, so that military strategies of scientific and technological coopera-

19) Keizo Hayasaka, Nihon Sekiyu-Kagaku Kôgyô no Seisei to Tenkai 1-3, In: *Artes Liberales*, No. 20-22, 1977-1978.

20) Nihon Kagakusha Kaigi (JSA) (ed.), *Ibid.*

21) Rekishigaku Kenkyûkai(ed.), *Nihon Dôjidaishi* 5, Aoki Shoten, 1991.

22) (NIRA)'s Report, *Changes in International Circumstance and Japan's Coping with It*, 1977.

23) Akira Sasabe, "Gijutsu Rikkoku Ron" to sono Kikensei, in: Masakatsu Yamazaki and others, *Kagakushi*, Aoki Shoten, 1987.

tion between U.S. and Japan began to be openly promoted. There was a sort of cooperative mobilization of big firms, government and universities.

The Conference of Science and Technology, an advisory organ for the Prime Minister, answered to the inquiry and indicated the perspective in 1984. It included firstly the necessity of a clearer division of the research and development works concerning science and technology : direct development by private firms, more risky high-technologies by government and fundamental research by colleges ; secondly the achievment of harmony between technology and human life ; and finally the consideration of its international character. In the back-ground, however, is the same governmental support to big firms, the same neglect of human rights and the same disregard for the environment for the sake of high profitability as ever.

In the mid-1980s, after a short-term depression caused by the rise of Yen rate, the so-called "bubble economy", the enthusiastic economic prosperity with little real development, promoted rapid investment and innovation amidst more and more intensified international competition. It was very characteristic that the priority of research and development was remarkably increased especially in high-tech industrial fields.

I would like to show you growth of some indices relating to Japanese science and technology policies during 1980-1990[24] :

* Sum of expenditures for research and development increased during 10 years about 50% ;
* Rate of expenditures for research and development to GNP : from under 2% → to the level of near 3%, of which 69.7% were used by private firms, 18% by colleges and 12.3% by governmental and public institutes ; 74% of those for private were used by big firms with capital of over 10 billion Yen which were only 0.2% of total firms ;
* About 1/3 of the expenditures by private firms were used in the electro-machinery field including electronics ; the biggest user in 1960 was chemical industry ;
* Number of researchers increased from 360,000 → to 560,000.
* Number of researchers per 10,000 of working population became over 80 in 1990

Masakatsu Yamazaki, a reseacher of the history of science, pointed out special characters and problems about recent activities of research and development in Japan as follows :

* The activities concerned mainly private enterprises, very few depending on governmental support ;
* It suggests in some sense the facts that self-financing were very easy in the "bubble era" in order to expand laboratories and that quick and incessant development forestalling other firms became more vital for getting extra-surplus and for surviving the international competition ;
* The subjects for research were designed mainly for directly practical applications and developments, while fundamental researches were very poor and back-warded (handicapped) ;

24) Masakatsu Yamazaki, "Hai-Teku Jidai" no Seisan, Rôdô, Gijutsu Kagaku, in : *Rôdôundô* No. 312, 1991.

* The proportion of military technology was relatively small before, although increasing gradually, and that was one of the important reasons for the rapid growth of Japanese economy based on civilian industries; but recently cooperation between Japan and the United States in military technologies was tightened and therefore regulations of reseach and development by the United States would be reinforced.
* Plans for establishing cooperation between military-industry-bureaucracy and universities for research and development would also be strengthened[25].

Toshio Satô, an economist, characterizes the high-technology strategy of Japanese monopoly capitals as follows:

1. Research and development of high-technologies for the sake of special surplus-value, under the conditions of dependent economy on the U.S.;
2. High technologies as the means of expoiting and oppressing the working people;
3. Increase of unemployment and various forms of unstable employment;
4. Urging (driving) researchers and engineers into cut-throat competition between monopoly capitals[26].

As to so-called "big sciences", better to say "big technologies", such as nuclear energy, space, it should be said that United States' initiatives are especially stronger than those in other fields, that inevitable financial support by government can easily be connected with anti-democratic or anti-humanistic character as I shall mention in the 2nd part of my another lecture about Toshiba's case.

The space station project named "FREEDOM" by 4 countries (US, EU, Japan and Russia), International Tokamak Experimental Reactor (ITER) also by 4 countries, Human Genome Project by U.S., Japan and many other countries, Superconductive Super Collider (SSC) by U.S. are only some examples. These examples show the degree of socialization of science and technologies and suggest strongly the necessity for their democratic control.

"Karôshi"[27] or death from over-work and mental stress, as another example, became one of the most world-wide common Japanese words since the late 1970s, symbolizing the "Japanese disease"[28]. The 12 hour work day is again being introduced as a "flexible" working system under the newly "improved" Labour Standards Law.

The Japan Scientists Association (JSA), founded in 1965 succeeding the Association of Democratic Scientists, has come out against the collaboration between government and big business and for the protection of academic freedom, autonomy, democracy and free speech, and though not yet so influential, has investigated social problems: for example, an

25) M. Yamazaki, *Ibid.*

26) Toshio Satô, Nihon Dokusen Shihon no Hai-Teku Senryaku to Chikuseki Yôshiki no Henka, in: *Rôdôundô* No. 312, 1991.

27) Takeshi Inaki and others, *Karôshi tono Tatakai*, Shin Nihon Shuppansha, 1989.

28) See note 45).

investigation commission into "defoliants" as well as other problems from the Vietnam War, research and protest concerning environmental pollution by big firms, constructing atomic power stations etc. The autonomy and social responsibility of scientists has been one of the most important tasks of the movement[29].

I am afraid that this rough survey of the historical development of modern Japanese science and technology should leave you with a feeling of frustration.

But I would be very glad if you could understand that the brilliant achievements of Japanese science and technology as well as the close cooperative relations between firms and the government, however attractive at first glance, have none the less some extremely ugly and anti-democratic aspects, and that Japan stands now on the crossroads of the future. That is to say, whether Japan can become peaceful, green, safe and sustainable for human life, or whether it will continue to persue profit for a ruling minority in a perverted use of high-technology. The final result of this path of development could be the destruction of Japanese society.

[3] One of the Most Typical Examples —microelectronics industry and Japanese government—

In surveying Japanese sciennce and technology through and after the 2nd World War, one of the most important characteristics of Japanese industry was thoroughgoing support and aid by the government. Especially after the 2nd World War, it has rather been strengthened by the Ministry of International Trade and Industry (MITI) and the Science and Technology Agency (STA). Another one is its dependency on American basic conception of new technologies. The micro-electronics industriy is no exception.

Here, I would like to give you a rough sketch of Japanese microelectronics industry as a typical example of those industries which show the essential characteristics of Japanese state-monopoly capitalism.

1. From Transistor to IC

The starting point of innovation in the field of "semi-conductor" after the 2nd World War was, as you know, the invention of transistors in the United States.

Makoto Kikuchi, a former researching member of the Electro-technical Laboratory of MITI and later director of Sony Research Center, wrote on "transistor shock" and "catching up" story of Japanese electronic technologies with the latest American ones[30]. MITI's Laboratory staffs began testing immediately after having read the news of the discovery of transistor in 1948. They simply "replicated" (imitated) the process of the

29) Nihon Kagakusha Kaigi (JSA) (ed.), *Ibid.*

30) Makoto Kikuchi, *Japanese Electronics*, The Simul Press Inc., Tokyo, 1983.

American discovery. The so-called "zone levelling technique", which is one of the most important processes for obtaining material of a super-high purity, was also learned from some articles in foreign scientific journals.

Transistor-radios were sold in Japan by Tôkyô Communication Manufacturing Co. (Tôtsûkô, later Sony Corporation) for the first time in 1954, and after 5 years its production in Japan overcame that of America. But the fundamental technological conceptions of transistor were dependent on the patent licensed from Western Electric Co. (WE) as well as other contracts for technical aid with RCA or other American firms[31]. It should be said that one of the backgrounds of Tôtsûkô's success was it applied the new technologiy to consumer products. The constitutional prohibition of armaments did not allow any other choice at that time. Monochrome television sets were also developed using another imported technique of silicon transistors which was far cheaper than techniques using germanium. I would like to emphasize, that the government's approval for importing techniques was very important because of the scarcity of foreign currency and the importance of imports for the Japanese economy. Thus government control functioned as a control and often as a privileged aid to big firms.[32]

It also functioned as a barrior against foreign firms. For instance, when Japan IBM Co., a daughter company of the International Buisiness Machines Co. (IBM), applied in 1956 for permission to produce computers under contract with the parent company, the Japanese government rejected it until 1960 based on the Law on Foreign Capital, which strictly limited both production and remittance of royalties abroad by a foreign company with contribution of over 50% of foreign capital. Of course, It was one of the most important means of protecting home industries before the liberalization of trade, exchange and capital after 1960[33].

Meanwhile, the concerning computer and electronics industries, the "Provisional Act for Promoting Electronic Industry" was enacted in 1957. But why was it called "provisional"? The purpose was to get around the restrictions on big business cooperative activities under the Anti-Monopoly Law. In fact, the Law allowed open cooperation of big businesses for developing, producing and selling under the powerful control, guidance and financial support of the government.

A dramatic turning point was initiated by MITI: IBM-Japan (International Business Machines Corporation) had been founded already in the late 1940s. In 1956, IBM-Japan applied to the Japanese government for the technical tie-up with IBM-WTC, so that it could send to the IBM-USA royalties and fees for know-how, but it was not allowed to because of the restriction on the extention of foreign capital into Japan based on the Exchange Control Law.

In 1960, MITI finally made an agreement with IBM to allow the tie-up in exchange for

31) *Ibid.*

32) Rekishigaku Kenkyûkai (ed.), *Nihon Dôjidaishi* 3.

33) Nihon Denshi Sangyô Shinkôkai (JEIDA), *Denshi Sangyô Shinkô 30 Nen,* 1988.

IBM's making a contract with Japanese big firms allowing them to use the essential computer patent. It was MITI's great help to the big firms through a sort of diplomatic manoeuvers and negotiation. As a result, 15 Japanese firms made contracts with IBM and, adding contracts with other American firms to obtain licenses and know-how for the producing of computer parts[34].

The Japan Electronic Computer Co., Ltd. (JECC), was also one of the typical fruits of state policy for the electronics industry. Of course I know it was an economic policiy rather than a science and technology policy, but I would like to stress that this was essential factor for the scientific and technological development for Japanese electronics industry and science and technology policies ; policies which of cource had for the most part on economic purpose.

In the first stage, the Japanese government intended to establish a national enterprise financed by itself. The government wanted to introduce a rental-system for computers, the production and development of home-made computers and the training of programmers and planners. But, because of various problems and strong opposition, it started as a private corporation financed by big electronics firms for rental management only, supported with special low-rate financing from the Japan Development Bank, one of the state-banks for concentrating state finance in the most important industries. It facilitated both buying large scale computers by users and production with finance from the JECC[35].

The first extension of the expiry date of the "Provisional" Act was enacted between 1964 and 1971. Coincidently, IBM announced a new family of machines called "System /360", which were sensationally named the 3rd generation. To cope with this situation, MITI, under the Law on the Union of Mining and Manufacturing Industry for the Research of Technology, started to organize a large scale project, and as the first one was Project for the "Association of Developing Computer Technology", with more than tens of billion Yen of governmental subsidies[36].

Now, let us take the example of Integrated Circuits (IC). Already in 1959, IC had been invented again in America with registered patents by J.S. Kilby, R.W. Noyce, know-how for metal oxide semiconductors (MOS) transistors etc. It became possible to produce then in Japan for the first time in 1968 after obtaining a licence for the basic patents of IC technology which had been developed by the American firms, Western Electric Co. (WE), Fairchild Semiconductor (FC) and Texas Instruments (TI). Above all, a contract to use the main patent for ICs with the Texas Instruments (TI), was finally concluded in 1968. A conditional permission was also given for establishing a daughter company in Japan under

34) Nihon Ai-Bi-Emu, *Nihon Ai-Bi-Emu 50 Nenshi*, 1988.
35) Nihon Denshi Sangyô Shinkôkai, *Ibid.*
36) *Ibid.*

a joint account with Sony, after 4 years of deliberate delay by MITI. Needless to say, the delaying tactics were also for the sake of protecting as well as developing the home industry.

Meanwhile, MITI began testing ICs in its Institute in 1960, immediately after the discovering of ICs. Japan Electric Co. (NEC) followed in close cooperation with Japan Telephone and Telegram Corporation (NTT), then a public corporation. From 1965, about 400 million Yen were given as a subsidy to the research groups of big electronic firms for research and development to manufacture ICs. The subsidies continued until 1971 amounting to 10 billion Yen. In addition, over 6 billion Yen of financing by the Japan Development Bank, one of the national banks, was given to the big IC makers between 1965 and 1974[37].

In the mid-1960s, while developing ultra-highly efficient computers, it became increasingly necessary to develop so-called "soft ware" separately from the "hard ware". When IBM announced "unbundling principles" between hard and soft ware in 1970, the "Act of the Society for Promoting the Processing of Information" was enacted. The foundation of Information-processing Promotion Association (IPA)'s policy was to give subsidies and to finance the soft ware and information industries. In MITI, the section of information-processing promotion was set up.

However, the market for computer and its soft ware was then almost a monopoly of IBM and some other venture buisinesses, and the situation only began to change as the "down-sizing" (miniturization) of computers accelerated in the 1980s.

The "Provisional Act for Promoting Specific Electronics and Machinery Industries" was enacted in 1971. This was virtually the second extension of the former "Provisional" Act.

At the same time, the appearance of micro-computers on a very small chip named "i-4004" in 1971, which Intel Co. developed for the first time, created tremendous opportunities for its technical applications. It was really epoch-making not only in the electronics industries but also in almost all industrial fields. Japanese big electronic firms developed some original micro-processors, but being defeated in the rate-war, they resigned themselves to be its "second sourcers" under the licence of Intel Co. On the other hand, in the industrial field of memory-ICs, for instance Dynamic Random Access Memory (DRAM), the big electronic firms planned comprehensive development of technologies for them with the full support of the government[38].

2. LSI, VLSI and Indusrtial Robots

Since 1972, Japanese computer manufacturing firms were organized into 3 groups (Fujitsû-Hitachi, NEC-Toshiba, and Oki-Mitsubishi) and promoted until 1976 to develop new

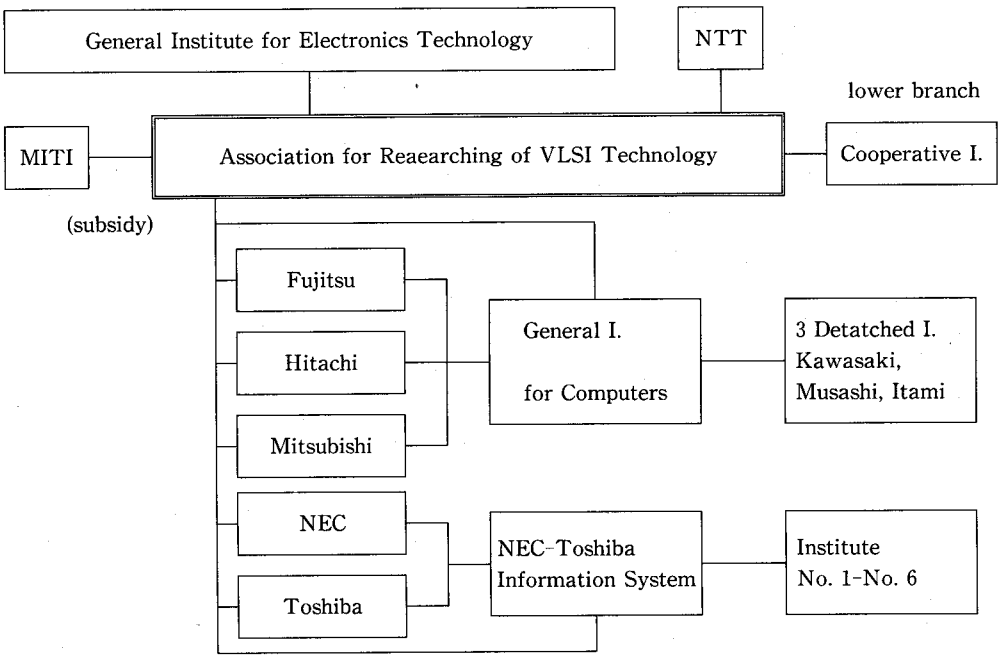
37) Shigeru Nakayama and others (ed.), *Gendai Nihon Kagaku Gijutsu no Shakaishi,* Vol. 4, Gakuyô-Shobô, 1995. .

38) Nihon Denshi Sangyô Shinkôkai (ed.), *Maikon Sutôri*, Seibundô Shinkôsha, 1987.

types of computer with subsidy of 50% of costs provided by MITI.

This was one of the challenges to IBM's 370-series and the so-called "Future System". The complete liberalization of computers and related fields which would begin 1975, also had an influence on MITI's policy.

It was especially an urgent task to develop their core components—very large scale ICs (VLSI)—successfully. Therefore, MITI took the initiative in organizing a new National Project named the "Association for Researching VLSI Technology" in 1976. I will show you the organization in the following figure[39]:



The Project was organized by MITI, together with the General Institute for Electronics Technology, the Nihon Telephone and Telegram Public Corporation (NTT) and 5 big private firms, Fujitsû, Hitachi, Mitsubishi, NEC and Toshiba. General Institute and the Institute of NTT offered their latest results of research.

Total expenditure was 72 billion (72,000,000,000) Yen, of which 30 billion Yen was a subsidy. It aimed to create minute processing technologies for making Very Large Scale Integrated Circuits (VLSI). To this end, it was necessary to make equipment which could set more than a million bits of minute transistor lines of circuitcy on 4 or 5 millimetres square of silicon plate with 0.1 to 1 micron-wide etching. Formerly, the method of Photo Lithography was dominant, but it could be used only for 2 micron-wide etching.

The Association housed 6 institutes in the new building of NEC's Central Laboratory. The first Institute, run by Hitachi, succeeded in developing the method of Electronic Beam Lithography useful for more minute etching. Some precision and optical machinery firms

39) Nihon Denshi Sangyô Shinkôkai, *Denshi Sangyô Shinkô 30 Nen.*

as well as daughter ("Keiretsu") machinery companies of the member firms contributed to the success. The other Institutes researched and developed various related materials and instruments. In 1977, 64 kilo bits (64,000) on 4 millimetre square chip was produced as a test product.

A bit is a binary unit which can hold a unit of information. Therefore 64 KB chip can memorize 64,000 units of memory. On the first appearanc of the IC chip for memory, its capacity was only 4 or 5 units of transistor. 1 KB chip for memory (RAM) appeared in 1971. In 1974 its capacity of memory was 4KB. After the success of producing the 64KB memory chip, the degree of integration developed at an extremely raapid pace : 256KB IC (RAM) appeared in 1984 ; 1 mega bits (1MB) RAM in 1985. In 1986 the Japnese share of producing semiconductors in the world market passed that of the USA.

In the same year, the economic conflict on semicnductor between Japan and USA began when the American Semiconductor Industry's Association (SIA) accused the Japanese semiconductor industry of its closed market system in 1986. In fact, it was a sort of revenge for or counter-attack on Japan's outstanding success in semiconductor technology and its large share in the world market. The SIA charged that the Japanese government's close relation and financial aid was unfair. It should be noticed that MITI played a great role also in this case to protect Japanese electronics industry[40]. None the less the growth of IC production did not cease for several years. In 1990 the share of Japan became over 50%. 4MB IC began to be mass-produced and both 16MB and 64MB ICs were also on the way to the market. It was said that even 1 or more giga bits (GB, 1,000,000,000 = billion) chips could be developed. But, thereafter, the share as well as the production decreased sharply because of the serious depression after the so-called "bubble prosperity".

On the other hand, Japanese computer industry was favoured by the so-called "down-sizing" (miniturizing) tendency since the late-1970s. In Japan, personal computers were first produced by NEC in 1979, 2 years after its appearance in the USA (by Apple Co.) using improved micro-processor on Intel Co.'s patent, USA.

But in the early 1990s the Japanese computer industry went the same way as the semi-conductor. Since the end of 1992, following the sharply increased exchange rate of the Yen, computer manufacturing firms in both the U.S. and South-East Asian countries have raided the Japanese home martket and have broken the stable monopoly enjoyed by NEC and other Japanese computer firms.

One of the typical examples of applying micro-processors to radically improve the means of production can be found in industrial robot technology. The original concept started with the application for a patent on an industrial robot in 1954 made by an American engineer, G.C. Devol. The fitst practical use of robot was made by an American

40) Kenji Kawano, Handôtai o Meguru Keizai Masatsu, In : Sadayuki Satô (ed.), *Nichi-Bei Keizai Masatsu no Kôzu,* Yûhikaku, 1987.

company, Unimation, in 1962 and Japan imported the technology from this company in 1968. Some MITI institutes organized several large scale projects and have promoted the R&D of industrial robots since 1970. Each of these programs was accompanied by subsidy of more than 20 billion Yen and carried out under the participation of manufacturing associations like those seen above in the case of VLSIs and others[41]. Thus, in 1980, when "the first year of the Robot-Era" was declared, production of full automatic industrial robots in Japan amounted to only 4,500 units. In 1990, it had increased to more than 75,000. The number of robots in operation at the end of 1989 in Japan was 219,700 and their share in the world amounted to 56.5%[42]. It was indeed a brilliantly successful application of technology owing to both the rapid spread of micro-computers and their effectiveness in precise machine-tool manufacturing, but it should be remembered that the robotization of Japanese industry is the wonderful result of the employers' desire to cut labour costs and the nonresistance of the "company" trade unions to any "rationalization policies", one of which have become an ever more prominent characteristic of "the crisis management" manoeuvers since the late 1970s[43]. Although the amount of production during the 1980s almost doubled, the number of the employed manufacturing workers increased only slightly, accompanied by the "phenomenon" of an extaordinary increase in the number of "part-time" or short-time workers, whose ratio to the total number of employees increased from 8.7% in 1976 to 15.2% in 1990, especially that of the female employees from 16.4% to 27.9%[44].

[4] Perspectives ?

The superiority of Japanese semiconductor industry and some other related industrial fields became a past myth. Now, in 1995, some new directions are eagerly pursued by the big businesses around the world. The so-called "multi-media industry" includes not only computers, semiconductors, software and related micro-electronics fields, but also telephones, televisions, communication satelites, and many other fields and the development of the new industry needs increasingly close cooperation as well as enormous financial funds. The situation would strengthen the connection and cooperation between big businesses and governments across the border.

But, on the other hand, the dangers would also be increasingly enlarged : centralization of technologies, finance, profit and power etc. to the rich minority élite of the world. As a result, increasing dangers can be expected : waste of resourcees, environmental pollution on and in space, violation of human rights, and alienation of humanity etc.

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41) MITI, *Ôgata Purojekuto 20 Nen no Ayumi,* Tsûshôsangyô Chôsakai, 1987 ; Kôji Kubokawa, *Mekatoronikusu Gyôkai*, kyôikusha, 1990.

42) Tadahiro Mitsuhashi, *Sentan Gijutsu to Nihon Keizai,* Iwanami Shoten, 1992.

43) Rekishigaku Kenkyûkai (ed.), *Nihon Dôjidaishi* 5.

44) Sômuchô, *Rôdôryoku Chôsa*, 1991.

I emphasize also that these tendencies do not exclude competition at all. Japanese industry as well as technology are said to be rapidly losing their competitive power. It is obvious that the "multi-media industry" are initiated and conquered by American big business.

An intellectual from Thailand recently wrote about the "Japanese disease" syndrome[45], which is of course a parody of the "English disease" since the late 1940s. It could be said also on this point that Japan was a typical "pursuing capitalist country". We can easily find many other public statements about today's situation and the future of Japanese science and technology as well: "Losing their superiority", "their crisis", "the soft-ware crisis", "lack of vision i.e. creative long-term strategy", etc.[46], which are all comments by an American consultant of electronics and a professor; also the "deadlock of imitative technologies comes up against a wall", "lack of originality" by Japanese journalists[47]. It would be inevitable for the Japanese electronics industry to be resigned to their fate as an inferior collaborator of the U. S..

Finally, I would like to enumerate just the negative aspects of the too rapid growth of Japanese industry and high-technology under state-monopoly capitalism that have had serious consequences for Japanese society, especially:

1. farmers: by introducing policies of "free trade of agricultural products", which have threatened the very existence of Japanese agriculture, by mobilizing the ruined farmers as cheap labour for industry, by tearing apart their families, by underpopulating and destroying their communities, by driving them into debt slavery as a result of forcing them to buy more industrial products for agricultural production than they can afford on farming income;

2. middle-sized and small businesses: by destroying traditional industries through the shift from natural materials such as cotton, silk, wood to synthetical materials such as petro-chemical products, through changes in the means as well as the mode of production; by subordinating small companies to big firms as special suppliers of materials and parts while forcing them to accept extraordinarily low pricees;

3. workers: by intensifying instead of lightening working conditions, through weakening trade unions and changing them into "company" unions; by replacing regular employees with cheaper part-time workers under worse conditions;

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45) Prasert Chittiwatanapong, Once mere fiction, 'Oshin' is now History, in: *Japan times,* May 15, 1995.

46) William F. Finan/Jeffrey Fray, *Japan's Crisis in Electronics*: Failure of the Vision, (Japanese translation) Nihon-Keizai Press, 1994.

47) NHK Shuzai Han, *Gijutsu Rikkoku Nihon no Genjitsu*, NHK-Press, 1983.

4. the aged and the weak : by sharply cutting governmental subsidies for social security, in order to make amends for the enormous expenditure to promote rapid industrial growth ; by again imposing on them the burden of medical insurance ;

5. underdeveloped countries : by the exploitation of natural resorces in their countries, destroying their environment ; by exporting capital for obtaining cheap labour, land, resorces and tax consessions as well as in order to avoid criticism against industrial pollution ;

Thus, the big firms have been able to maintain their high profit only by victimizing almost all the other social strata.

Our rough survey on the situation and policies of Japanese science and technology indicates to us the urgent necessity of radical change in both policies and peoples' conciousness.

Japan Scientists' Association (JSA), for example, emphasized, in its recent document, that the democratic regulation of scientific and technology policies, the social responsibility of scientists to use all results of scientific and technological research only for peace and welfare of the people, are the most important tasks for scientists[48].

One of their most urgent problems should also be to found an interdisciplinary field of the science of science[49] in Japan, analysing the comprehensive aspects of the contemporary condition of society and the relationship between science, technology and society thus pointing the way for the most rational and humane application of science and technology for the benefit of the general mass of humanity and our fellow-creatures.

48) Nihon Kagakusha Kaigi (JSA), *Dai 30 Kai Teiki-Taikai Gian*, 1995.

49) Keizo Hayasaka, Shakaishugi Shokoku ni okeru Kagakuron Kenkyû no Tenkai to Genjô, *Artes Liberales*, No. 37, 1985.