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JAPAN REPORT

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POLITICAL AND SOCIOLOGICAL

TEXT OF 'TONG-A ILBO' INTERVIEW WITH NAKASONE

SK050239 Seoul TONG-A ILBO in Korean 1 Apr 83 p 4

["Full text" of special written interview with Japanese Prime Minister Yasuhiro Nakasone by TONG-A ILBO correspondent in Tokyo Chong Ku-chong on the 63d anniversary of the newspaper's founding--date not given]

[Text] [Question] In the wake of your visit to the ROK, the ROK-Japanese summit talks with President Chon Tu-hwan have served as momentum in opening a new ROK-Japanese era. For establishing new ROK-Japanese relations, what kind of concrete policy are you going to pursue towards the ROK?

[Answer] When I visited the ROK in January, actually the first time for a Japanese prime minister, an ROK military band played the Japanese national anthem and the Japanese national flag was hoisted in Seoul. I felt that this was indeed the opening of a new era between the ROK and Japan and I was deeply impressed by your country's deep affection. Although the ROK and Japan are separated from each other by a narrow strip of water, they have been sometimes called "close but faraway countries." It is my hope and mission to turn this into "close and the most friendly countries." What is important, above all, to this end is to broaden the scope of exchanges between the ROK and Japan, thus realizing exchanges on a citizens' level in the true sense of the meaning. For historical reasons, it may not be easy for the two countries to establish a firm and immovable relationship of mutual trust in a day. However, we, too, will make efforts to steadily deepen mutual understanding through exchanges in various sectors, such as youth, sports and culture, on the basis of self-examination and self-discipline and will make the relationship of trust stand firm. And, on the basis of such a long-term viewpoint, we should, I think, exert efforts to find the best solution also to issues pending between the ROK and Japanese governments, while taking into consideration the other side's position on every issue.

[Question] ROK-Japanese economic cooperation was settled by your visit to the ROK. Please tell us your opinion about the significance economic cooperation carries for the overall ROK-Japanese relationship and about how to push ahead with it in the future.

[Answer] The economic cooperation issue, which had been pending between the ROK and Japan for more than a year, was settled by the talks with

President Chon Tu-hwan. I am very pleased with this. I firmly believe that this issue was settled because, with mutual understanding of the need to consolidate the relations of good-neighborly friendship, the ROK and Japan dealt with the issue sincerely, with a spirit of mutual concession. Even if any problem occurs in ROK-Japanese relations in the future, I think, there will be no problem that we cannot resolve if we handle it with such a spirit. For future economic cooperation with the ROK, under Japan's basic policy for economic cooperation with foreign countries, I intend to give concrete shape to the cooperation in the form of project-by-project cooperation--projects which will contribute to socio-economic development, the stabilization of the people's livelihood and the promotion of welfare in the ROK--in water supply and drainage, hospitals and dams. And I expect that such economic cooperation can serve as a symbol of friendly ROK-Japanese relations on a citizens' level.

[Question] Japanese defense policy has been often discussed. What is your opinion?

[Answer] Under the peace constitution, with the Japanese-U.S. security treaty as a basis, it is Japan's basic defense policy not to become a military power threatening neighboring countries. This policy is carried out through the defense-only-policy (a passive defense strategy conforming to the spirit of the constitution that one will not exercise defense capabilities until attacked). It is also Japan's basic defense policy to maintain the minimum defense capabilities necessary for self-defense by following the three-non-nuclear-principles (which means not possessing, not producing and not introducing nuclear weapons). Japan is also making efforts to reach the levels in the "defense plan outline (completed in 1976)" as soon as possible. This level of defense capabilities is based on plans for Japan to be fully able to take a vigilant posture in peacetime as well as, if an armed attack is launched against it, for Japan, in principle, to be able to repel this unassisted--if the attack is a small-scale limited invasion--or, if it is difficult for Japan to repel the attack unassisted, for Japan to continue tenacious resistance, waiting for aid from the United States.

[Question] We understand that the issue of a blockade of the Korea straits has been discussed at the Japanese Diet recently.

[Answer] Japan will limit exercising its right to self-defense only to cases where Japan is dealing with armed attack. Even when Japan considers blocking the channel in the open sea in the western watercourse of the Tsushima Straits as absolutely necessary for Japan's self-defense, Japan is not considering blocking the channel without taking into consideration the views of South Korea, which is a coastal state and a friendly nation, because such an act may exert great influence on South Korea.

[Question] We would like to hear your opinions on the issue of cross-recognition of North and South Korea by the United States, Japan, Communist China and the USSR, as well as on the issue of the simultaneous entry of North and South Korea into the United Nations or unilateral entry by South Korea.

[Answer] I am greatly interested in the issue of easing tension on the Korean Peninsula. We broadly exchanged views on this with President Chon Tu-hwan when we held talks in Seoul. It is the consistent position of the Japanese Government to make all possible efforts to help ease tension on the Korean Peninsula. I think the North-South reunification question should be solved independently and voluntarily between the persons concerned [tangsaja] in the North and South Korea. Thus, I support the proposal made to the North by President Chon. I think the idea of cross-recognition would be worth reviewing if it does not affect the delicate relations between the North and South Korea and helps ease tension on the Korean Peninsula. The issue of cross-recognition has many aspects shich should be taken into account, such as simultaneous entry into the United Nations by North and South Korea and the North-South dialogue and relations. I think early realization of this goal will be difficult in view of the complex situation surrounding the Korean Peninsula. However, I feel this issue should be carefully reviewed by considering the intentions of the countries concerned.

If both the North and South regard it as a step in the course of achieving the peaceful reunification of the Korean Peninsula, the simultaneous entry into the United Nations by North and South Korea is good, in view of the fact that it would contribute to easing tension on the Korean Peninsula and would enhance the universality of the United Nations. If South Korea wants separate entry into the United Nations, regarding this as an interim step leading to reunification, I wish to basically support this as I think this would promote the universality of the United Nations.

[Question] The imbalance in trade between Korea and Japan since the two nations normalized their relations has emerged as a serious question to which Korea pays great attention. What is your opinion?

[Answer] A trade imbalance may take place to some extent in any nation under a free trade system. Japan goes into the red with some countries, just as Korea goes into the black with some countries. Since Korea and Japan are engaged in dynamic activities in the world's economy, I think the two nations should strive to attain balance from multilateral standpoints, rather than simply attempting to bring an equilibrium of trade between Korea and Japan. However, the Japanese side understands Korea's position which is that a sharp imbalance in trade between the two countries over a long time is not favorable for the sound development of trade between Korea and Japan. Thus, I think the two nations should make efforts to achieve balanced expansion. For this, the Japanese side made all possible efforts, such as lowering the custom duties and the application of preferential customs.

And, as far as Japanese preferential custom duties are concerned, the ROK is becoming the biggest beneficiary. In the future, too, we will exert efforts, as best as we can, in such a direction. If we look at the recent trend in the balance of payments in trade between the ROK and Japan, the ROK-Japanese trade imbalance, we can say, is being slowly improved in terms of volume, when compared with total trade volume. In other words, the ratio of the ROK's exports to and its imports from Japan in 1965 was 1 to 3.8; 1 to 1.9 in 1975; and 1 to 1.8 in 1981. Thus, it is becoming balanced. We expect that the two countries' trade relations will develop in line with this trend in the future, too.

[Question] Regarding the issue of Japanese textbooks, an issue which developed even into a diplomatic one between the ROK and Japan last year--rectification was promised in the Japanese Government's opinions and its education minister's views. Attention is being paid to how the promise will be reflected in the field of education in the new semester and in textbook authorization.

[Answer] The descriptions in Japanese history textbooks evoked criticism from neighboring countries in Asia, including the ROK. In this connection, the Japanese Government, on 26 August last year, issued the opinion that "the government will take responsibility for making corrections by giving full ear to such criticism" and the government has conveyed this to the ROK Government. On the basis of this opinion, in November last year, the Education Ministry took measures to revise the yardstick for authorizing textbooks and to thoroughly see to it that the spirit in the ROK-Japanese joint communique in 1965 is also respected also in school education. We are also determined to fulfill the contents of the aforementioned opinion under the present cabinet. Presently, the Education Ministry is working towards this end. As I said when I visited the ROK in January, regrettably, it is true that there has been an unfortunate history between the ROK and Japan. And it is necessary for the Japanese people to take this seriously, to examine and admonish themselves. I think that this understanding should be the basis for establishing relations between the ROK and Japan as good neighbors and that it is our responsibility to pass this on to the younger generation, which will take charge of next generation. The textbook issue last year was a precious lesson for me because it reminded us afresh how important it is for the ROK and Japanese peoples to make efforts to understand each other's culture and history. And, I think that the issue has served as momentum for the two countries' peoples to widen such understanding. With this lesson as a driving force, I am going to exert efforts so that unshakable ROK-Japanese relations, backed up by the two countries' people's relationship of mutual understanding and trust, can be established in the future, too.

[Question] We want to hear your opinion on Japan-North Korea exchanges.

[Answer] While paying attention to the development of the North-South relations on the Korean Peninsula, Japan has maintained a certain level of exchanges with North Korea up to now only in such sectors as economy, culture and sports, thoroughly on a non-governmental level. However, from the long range viewpoint of easing tension on the Korean Peninsula and realizing a durable peace we will fully take into consideration the subtle equilibrium between the South and North. At the same time, we will regard as of the greatest importance the position of the ROK, a friendly nation.

[Question] How would you develop civil and cultural exchanges between the ROK and Japan from now on?

[Answer] The ROK and Japan are the closest neighbors historically and culturally as well, and there are ample grounds, I think, for closer relations, with better mutual understanding, than presently exist. The exhibition of 5,000 years of Korean art held in Japan 7 years ago impressed the Japanese people because of the refined beauty of the Korean culture and all that it has in common with Japanese culture. To deepen mutual understanding between the peoples of the ROK and Japan, exchanges among youths are considered to be among the most important. Towards the end of the 70's, the high schools in western Japan began to go on school excursions to Korea in rapidly increasing numbers, and I hear the number of such high schools by 1983 will reach some 7,000 students from some 50 schools. This is a very encouraging development. There has been an increasing awareness in the two nations of the importance of such cultural and youth exchanges between the ROK and Japan. Taking an example of the government level approach, among students studying in Japan at the invitation of the Japanese Government at government expense, students from the ROK predominate. There have also been moves recently, at the nongovernment level both in the ROK and Japan, to set up a fund for cultural exchanges between the two countries. This is a most welcome development. I think active and broad exchanges between the countries in many areas and various strata should be pushed ahead with both at the government and nongovernment levels. For this purpose, the government ought to do all that it can do and render assistance to nongovernmental enterprises.

[Question] The prime minister has disclosed that the increase in Japanese defense capability is "the minimum effort for the purpose of defending one's own country with one's own hands." Surrounding countries, including the Southeast Asian countries, are raising their voices expressing concern over Japan defense buildup. We would like to hear your opinion on Japan's defense capability buildup.

[Answer] The security policy of Japan consists of three major principles, namely, (1) development of active peace diplomacy inclusive of economic cooperation; (2) smooth and effective operation of the U.S.-Japan security system; (3) systematization of an efficient and qualitative defense capability. Above all, as for the systematization of Japan's defense capability, it is our principle that Japan will, under the peace constitution, adhere to the defense-only policy, will not become a military giant and will not be a threat to the surrounding countries. We want to have Japan, which is located in Asia, maintain a correlation among the above-mentioned policies of diplomacy, defense and economic cooperation and comprehensively push ahead with them, thereby contributing to peace and stability in Asia. We want to improve even more the mutual understanding and friendly relations with countries in Asia, endeavoring to broaden the scope of peace and friendship to all areas of Asia. I believe that the nations in Southeast Asia will have basic understanding of such a Japanese security and defense policy.

[Question] What will Japan's role in Asia be?

[Answer] The peace and prosperity of Asia is essential to world peace and security. It is one of the major tasks of Japanese diplomacy for Japan as an Asian nation, to continue playing an active role for peace and prosperity in this region together with the friendly nations in Asia, including the ROK, China, ASEAN and Southwest Asian countries. Based on such a basic concept, Japan is engaged in active diplomatic efforts to (1) establish stable ROK-Japan relations (we agreed in the meeting with President Chon to develop relations between the two countries on a broad national basis); (2) carry on with cooperation with China, under the concept that China's current modernization line and open foreign policy are beneficial to Japan and other Western nations; (3) strengthen cooperation with ASEAN nations that are growing to be important stabilizing forces in Southeast Asia; (4) realize comprehensive political settlement of Cambodian question as well as cooperation in the Indochinese refugee problem. I think it contributes greatly to peace and security in this region for Japan to consider systematization of its defense capability under the peace constitution and within the scope of the defense-only principle and for it to maintain close U.S.-Japan relations under the security treaty with the United States, thus keeping Japan a stable force in Asia. I also think it greatly contributes to peace and security in Asia for Japan to help strengthen the economic and social bases of friendly Asian nations through economic cooperation. (For this, approximately 70 percent of Japan's bilateral government development aid is set aside for Asia.) We intend to make efforts to enhance mutual understanding and friendly cooperative relations with these nations.

[Question] How do you view the move to reduce oil prices?

[Answer] The rapid and drastic reduction of oil prices that some people worried about has been avoided by the agreement at the extraordinary general meeting of the Organization of Petroleum Exporting Countries [OPEC] in London. In the long-range view of more than 1 year, I expect that the business upturn in consuming countries caused by the reduction of the purchase price of oil will exceed the deflation effect in the oil producing countries and will have a good effect on the world economy as a whole. It has also been noted that with the recent consultations, which were held for unprecedentedly long hours, as momentum, major non-OPEC oil producing countries have shown that they understand, to varying degrees, that they have a common interest with the OPEC nations in preventing the collapse of prices. Meanwhile, because the future of the oil situation contains various unstable factors, it is necessary also for the consuming countries to move carefully. At the same time, it seems that it will be the task for the consuming nations to review how to make intense contacts with the oil producing countries in the future so as to seek the stabilization of the oil market.

[Question] Concerning the future international economy, what do you think will be Japan's role?

[Answer] Despite the protracted economic recession in the wake of the second oil crisis, the world economy shows indications of improvement, such as the slowing inflationary trend, the fall in interest rates and the move in the United States to rebuild its economy. However, with an abnormally high unemployment rate as a background, the European nations are still resorting to strong protectionism. With the reduction of income from exports and their serious accumulated debts as a background, the developing countries, too, are introducing protectionist measures in the form of counterpurchasing, which links imports to exports.

In addition to the recession in the world economy and because of sluggish trading of primary products, including oil, world trade is decreasing. In this connection, it is anticipated that the recent fall in the oil prices will serve to stimulate the entire world economy over the mid- and long-range term if the fall continues at its current rate. But, a trend in oil prices does not justify a forecast. Under these circumstances, it is important for every country to cooperate with each other and maintain the free trade system, thus seeking a wholesome development of the world economy.

With a view toward making a contribution that befits its status in the international society, Japan has sought economic growth, based on its domestic markets, by positively pushing ahead with the industrial cooperation and technological cooperation with every foreign country. At the same time, Japan has decided to put into force a series of measures for opening its markets, including the reduction of customs duties and the improvement of the procedures of import inspection. These were started the year before last. We are going to seek the understanding of other foreign countries, too, for such efforts exerted by Japan, and we expect that they will cooperate with us to maintain and solidify the free trade system.

[Question] How is Japan coping with the disarmament issue?

[Answer] Presently, the peace and stability of the international society are guaranteed by the balance of power among the countries. In order to place the international society on a more stable foundation from a long range viewpoint, it is important to make efforts to maintain the balance of power; and it is also important to make efforts to pursue a real disarmament, with the nuclear disarmament as a basis, to secure the world's peace and security at a lower possible level of armaments. Japan, which has been the only victim of nuclear bombs and which is not becoming a military power and is maintaining the three nonnuclear principles under the peace constitution, has long made efforts to pursue disarmament, with nuclear disarmament as a basis, as an important mainstay for peace diplomacy at the United Nations Disarmament Commission and other forums. In order to make progress in disarmament, it is important to take realizable and effective measures of inspection and verification one by one based on the reality in international society. To put it concretely, we regard the supreme task in connection with nuclear reduction the total ban of nuclear tests, the maintenance and consolidation of a system of banning nuclear proliferation and the ban of chemical weapons in the nonnuclear disarmament field. At the same time, we are urging the United States and the Soviet Union to accelerate negotiations for disarmament.

[Question] We understand that President Chon Tu-hwan will visit Japan at the earliest possible date. We want to hear your opinion about the summit exchanges between the ROK and Japan.

[Answer] When I visited the ROK in January, I invited President Chon Tu-hwan to be a state guest in Japan. President Chon accepted this with pleasure. A detailed schedule for his visit to Japan will be set up through diplomatic consultations in the future. The Japanese people, including myself, will wholeheartedly welcome President Chon. The ROK is our closest neighboring country both in terms of geography and of culture. Japan has learned much through exchanges with the ROK. However, substantial summit-level exchanges have not been realized since the war [World War II]. This is unnatural. Right after I took office as prime minister, I made a phone call to President Chon and chose the ROK for my first foreign-country visit. In a sense, this was because I wanted to improve the unnatural relations between the ROK and Japan as soon as possible. I thought that the ROK and Japan should maintain a relationship in which the two countries' chief executives would always exchange mutual visits and meet each other. I expect that President Chon's visit to Japan, as well as my visit to the ROK, will serve as a departure towards such a new ROK-Japanese relationship. I am sincerely looking forward to President Chon's visit to Japan.

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SCIENCE AND TECHNOLOGY

NEC'S INDUSTRIAL STRATEGIES TO EXPAND COMPUTER, COMMUNICATIONS SECTORS

Tokyo ZAIKAI TEMBO in Japanese Feb 83 pp 56-65

[Text] "Sekimoto's NEC" Continues Double-Digit Growth

For the past few years, Nippon Electric Company's aggressive management has moved it well ahead of the crowd, even in semiconductors, computers and other electronics fields which have done well generally. This shows that the "attack" management style of President Tadahiro Sekimoto is well suited to the times. It is certain that the mood at NEC has changed completely since Seikmoto took office.

Given the conservative, refined style of the Sumitomo group, any lack of polish has been eliminated. At the same time, the colorful brightness, unbounded cheerfulness, sociability and energetic action of Sekimoto's style has been worked into a new NEC style. Other companies may take the view that NEC is a little too buoyant, but that buoyancy is certainly an important motive factor behind NEC's rapid growth. In NEC's more than 80 years, there has been no one with as much effect on the company's style as Sekimoto. He is both an individualist and full of confidence in his management.

In the field of semiconductors, the mainstay of production, NEC is second behind the world leader, Texas Instruments. It holds the top international position as an integrated manufacturer of electronic equipment, with telecommunications and computers included. The "NEC" brand is one of a small number that is recognized throughout the world.

Sekimoto's aggressive management is clearly illustrated by investment in the semiconductor division. Even in earlier years, NEC repeatedly went beyond its rival companies in terms of facilities investment. As a result, it is now in the position of reinforcing its base, but the plan to invest 48 billion yen in 1983 (up 11.6 percent from 1982) has undergone a considerable upward revision to 52 billion yen, well ahead of the 48 billion yen of second place Hitachi Ltd and the 32 billion yen of third place Toshiba Corp.

At present, NEC's semiconductor production bases are Kyushu Nippon Denki, Yamagata Nippon Denki, Nippon Denki Sagamihara Works and the Shin Nippon Denki Ozu plant. The company has also decided to build a VLSI and LSI plant in

Nakatsu, Oita and to establish Oita Nippon Denki. Investment will total about 6 billion yen; monthly production will begin at 2 million units and ultimately increase to 6 million units. Operation is to begin in 1985; construction of an advanced semiconductor plant with an area between 6,000 and 10,000 square meters has begun.

Sekimoto plans to build on the semiconductor sector by means of decisive facilities investment in the fields of computers and peripheral and terminal equipment as well.

This management style is fully reflected in the performance record. Let us examine NEC's sales totals for the past few years.

To look first at overall sales, there has been strong growth from 717.8 billion yen in 1979 (up 17.0 percent from the previous year) to 892.8 billion yen in 1980 (up 24.1 percent), and past the trillion yen mark to 1.054 trillion yen in 1981 (up 18.1 percent). The sales target for 1982 was set at 1.24 trillion yen, and a slight upward adjustment of this target is anticipated.

Looking at individual divisions, we see that for the past 3 years, sales growth in the computer and other electronic equipment division has averaged a high 19.3 percent per year. In 1981, sales in this division came to 284.7 billion yen. With personal computer sales added on, the total comes to 332.5 billion yen, ahead of Hitachi and third behind Fujitsu and Japan IBM. In 1982, sales in this division, without personal computers, is expected to be 339 billion yen (up 19.1 percent).

The electronic devices division has also done well. Growth over the past 3 years has been a surprisingly high 30.3 percent average. The sales total for 1981 was 262.9 billion yen. NEC was the sales leader, of course, well ahead of other companies like Hitachi, Toshiba and Fujitsu.

The 3-year average growth rate for telecommunications equipment has been 13.6 percent, lower than that for semiconductors. But this is still double-digit growth, a rate which would be envied by such industries as nonferrous metals, textiles and steel. It can be said that the worldwide demand for telecommunications equipment has finally entered a period of stable growth.

In 1981, sales came to 413.4 billion yen, which is still ahead of sales in computers and other divisions. As of 1981, NEC's share of the market for telecommunications equipment was 33.0 percent (up 0.2 percent), still far ahead of second place Fujitsu's 10.0 percent (125.8 billion yen, down 1.5 percent from 1980) and third place Oki Denki's 5.6 percent (70.3 billion yen, down 0.3 percent). In 1982, sales are expected to be 463 billion yen (up 12 percent). Planning in this division is ambitious.

The home electronics division has done well in the past 3 years, with growth averaging 28.4 percent. In 1981, sales came to 93.1 billion yen, and 1982 sales are expected to be 95 billion yen (up 2.1 percent).

Total sales can also be considered in terms of demand in the private, government and export sectors. Private demand in 1981 was 497.6 billion yen (up 17.4 percent), 47.2 percent of the total. Government sales amounted to 210.7 billion yen (up 6.4 percent) and 20.0 percent of the total; exports amounted to 345.7 billion yen (27.6 percent), 32.8 percent of the total. It is anticipated that in 1982 private demand will be 608.0 billion yen (up 22.2 percent), 49.1 percent of the total. Government sales will be 215.0 billion yen (up 2.0 percent), 17.3 percent of the total, and exports will be 517.0 billion yen (20.6 percent), 33.6 percent of the total.

NEC's basic management strategy can be seen from these changes in the makeup of sales. There will be active expansion of the private demand and export sectors, primarily in computer and semiconductor sales, accompanied by an escape from dependence on sales to the Nippon Telegraph and Telephone Public Corporation (NTT) and other government agencies. This is the course Sekimoto has worked out for "Sekimoto's NEC."

"Attack" Management Goes beyond Dependence on NTT

The "relationship" between NEC and NTT is extremely close. NEC came into being in July 1899, as a joint venture with Western Electric Corp of the United States. Western Electric put up 54 percent of the capital, 200,000 yen. After various subsequent developments including ties between ISE, a subsidiary of ITT (International Telephone and Telegraph), and the old Sumitomo conglomerate, the name was changed to Sumitomo Communications Industry in 1943, at which time the company produced military communications equipment.

The loss of the war provided the occasion to change the company's name back to Nippon Electric Corp, and NEC began its advance into the field of telecommunications. At that time, in August 1952, NTT was created to promote telegraph and telephone operations as a matter of national policy. President Takeshi Kajii of Sumitomo Communications Industry was appointed NTT's first president. That was the beginning of the intimate relationship between NEC and NTT, and NEC grew along with NTT. At the time NEC depended on NTT for 50 percent of its sales; this "honeymoon" was of great importance to NEC.

As mentioned earlier, the relative importance of government sales within the overall sales picture has decreased. The reason for this is the sharp rise in computer and semiconductor sales; the sales growth has been much steeper than government budget growth, so the government's share is smaller in relative terms. Figures on the makeup of sales change, but it is correct to say that NEC is weaning itself from the government and from NTT.

An examination of the ranking of NTT's supply sources shows that in 1990 [as published; presumably should be 1980] NEC was in first place at 127.4 billion yen (20.1 percent of the total), overwhelming second place Fujitsu's 84.4 billion yen (13.3 percent), third place Oki Denki's 50.4 billion yen (8.0 percent) and fourth place Hitachi's 41.4 billion yen (6.5 percent). Both the amount and the share were up from NEC's 105.9 billion yen (19.3 percent) of 1979. These figures do not indicate that NEC is deliberately moving away from NTT.

So why is it said that NEC is pulling away? The biggest reason is Sekimoto's management stance.

NTT is without doubt a huge market for makers of telecommunications equipment, and it has been able to assure a certain level of sales. As long as a company is a member of the NTT family, NTT will guarantee sales at a fixed level.

NEC has grown steadily with the "patronage" of NTT. This is evident from the aspect of technical development, too.

As technical innovations in electronics have made computers and semiconductors available at low prices, these electronic products have generated an explosive demand. Where past management was passive and depended on demand in the government sector, primarily from NTT, there is now an active management style built on continually advancing electronic technology.

Active management centered on semiconductors was, of course, developed in the time of past President Tadao Tanaka, too. But NTT was always kept in mind. NTT was a refuge to which NEC could retreat whenever it became necessary. This attitude was not unreasonable, in view of the 30-year honemoon with NTT.

Sekimoto characteristically broke off the honeymoon. That is, by cutting off the path of retreat, he focused entirely on the road ahead. Facilities investment in semiconductors in a classic illustration of setting a course of active management.

The "protect" style of management is ill-suited to a period of continual technical innovation in electronics. Sekimoto has not taken the path of "protect" management. It is "attack" management that has given extra strength to managers. In that sense, it is certain that Chairman Koji Kobayaski had a keen eye in entrusting management to Sekimoto.

According to the Japan Recruiting Center's 1982 survey ranking popularity of companies as employers, NEC was ranked first in the science and engineering division. Hitachi, the perennial favorite, had slipped. NEC had been out of the running in the liberal arts division, ranking 147th in 1979 and 97th in 1980. Then it jumped to 14th in 1981 and entered the top 10 as number 8 in 1982.

"People make the company." NEC's long-range plan for the next century is Sekimoto's management principle that it is necessary to g ther superior talent. In order to gather superior talent, he has begun advertising to enhance the corporate image. This effort has been effective to a certain extent, but the biggest factor is that NEC under Sekimoto has been accepted by young people as a modern, or, as they say, a "now" company.

There is probably no need to mention telecommunications equipment again. The "NEC" brand means the best of telecommunications technology, and is a guarantee of quality.

Crossbar switchboard installations are found in North America, Thailand, New Zealand, Iran--about 30 countries throughout the world; the total number of subscribers may have reached 3 million circuits. In 1963, silicon epitaxial transistors and silicon varactor elements were tested in high-performance microwave telecommunications devices with strong resistance to environmental hazards and NEC became the first to succeed in the point-to-point 4 GHz 120 channel formula. Using miniature "I" type devices, it succeeded in point-to-point use of 960 channel equipment in the 2 GHz to 7 GHz range. NEC already ships microwave telecommunications equipment to over 60 countries; it is no exaggeration to say it dominates the world in this field. NEC is without doubt the world's supreme manufacturer of communications equipment.

Continued "Humiliation" in the Computer Sector

Viewed in that way, it would appear that NEC has developed steadily, but that is not the case. There have been mistakes in the development of strategy for the computer division. That is why NEC has suffered a period of "humiliation" as number four among computer manufacturers. That may have been Kobayashi's only mistake.

The Ministry of International Trade and Industry has taken the view that Japan's future lies in control of electronics technology. As early as June 1957, MITI enacted a "law on temporary measures for promotion of the electronics industry" with the purpose of fostering production of electronics within Japan. That was keen perception. To compete with IBM, which held a 60 percent share of world computer markets, MITI quickly formulated policies to protect and foster domestic technology. That decision is what gives Japan the advantage over Britain, West Germany, France and other countries of Europe that bear the burden of IBM.

Japan's economic recovery after the war is called a "miracle." The domestic computer industry has been carefully fostered. In November 1958, NEC and Tohoku University developed the SENAC (NEAC 1102), and the following year Hitachi announced its HITAC 301.

Then in 1965, the spread of domestic computers gained momentum with the announcement of NEC's NEAC 2200 series in June, followed by Fujitsu's FACOM 230 series and Hitachi's HITAC 8000 series.

On the other hand, the countries of Europe and the United States were concerned about Japan's economic recovery, and pressed for liberalization of capital and imports. The United States took a particularly firm stand on liberalization, since world leader IBM was in a slump.

Finally deciding there was no alternatives to beginning liberalization of capital and imports, in 1971 MITI had the Diet pass a "law on temporary measures for promotion of certain electronics industries and certain machine industries." It also arranged for organization of six domestic computer companies (Fujitsu, NEC, Hitachi, Toshiba, Mitsubishi Electric and Oki Denki) into three groups to create a structure capable of competing with IBM.

Kobayashi became president of NEC in November 1964. It can be said without flattery that Kobayashi is one of the superior managers representing the period.

On becoming president, Kobayashi began working out, one by one, new strategies for the company. Microwave telecommunication equipment is one example. The computer field is another. NEC's microwave telecommunication equipment achieved world domination.

What happened with computers? The NEAC 2200 series did well, and there was a fierce fight with Fujitsu for first place among domestic computers. If NEC had continued to put its effort into the computer sector, it might well hold the top spot now instead of Fujitsu.

Instead, NEC changed course on computers. The change was a result of Kobayashi's reading of the giant IBM.

In the mid-1960's, NTT began development of data communications under its fourth 5-year plan. As part of that work, it decided to build its own DIPS computer, and requested the cooperation of Fujitsu, Hitachi and NEC.

Fujitsu, Hitachi and NEC had sharply divided views on the development of DIPS.

Fujitsu and Hitachi argued as follows: Given the impending liberalization of capital and imports, it is necessary to strengthen the competitive position of domestic computers. Specifically, unless a computer could be developed with price and performance superiority which could compete with IBM, Japan's computer industry would clearly be trampled under by IBM, just as the industry in the European countries was.

Thus the situation was tense, with no time to be wasted. To develop the anti-IBM computer that MITI was pushing as a large project while simultaneously pushing NTT's DIPS project would divide already scarce funds for research, and also scatter the available brain power.

IBM could not be defeated under such circumstances. Therefore, they argued, MITI's large project and the DIPS project should be combined. That would allow efficient use of funds and talent to develop a computer with which to oppose IBM.

NEC countered with the following argument: The computers to be developed under MITI's large project and the DIPS project were completely different in nature; combining them would be impossible. NEC would never yield in its insistence that the two projects be pursued independently.

Ultimately it was decided to pursue the two projects independently, as NEC had urged. It should be mentioned that the difficulty of coordinating the views of MITI and the Ministry of Posts and Telecommunications was a complicating factor.

Mission of Catching Up With Fujitsu

Why is it that Kobayashi did not join Fujitsu and Hitachi in a frontal attack on IBM?

Kobayashi had his own reading of the situation. He readily travels overseas, and takes 10 or more business trips abroad each year. It is not possible for one who stays in Japan to judge IBM's true strength. Having information from those well-versed in the situation overseas and from numerous excellent businessmen, Kobayashi had the most accurate grasp of IBM's hidden strength.

Of course Fujitsu, NEC and Hitachi together had only a 1 or 2 percent share of the world computer market, compared with IBM's share of 60 percent or more. Accurate figures on research and development expenditures are not available, but for the six domestic companies, from 1965 to 1975, that investment should have exceeded total sales.

Kobayashi was confident that given those figures, joining a four-way struggle which included IBM was not a course management should choose. At the time Kobayashi said: "We shouldn't talk about toppling IBM; IBM must not be underestimated."

There were two reasons for Kobayashi's insistence on separate development of the MITI large-scale project and the DIPS project. The first was that if combining the projects meant defeat in a frontal assault against IBM and withdrawal from the computer sector, it might turn out that even the NTT market would be lost to IBM. Then Japan's electronics industry, with computers at its heart, would be completely dominated by IBM and other foreign forces. That would amount to domination of the nation.

The second reason was that by keeping the two projects separate the stronghold of NTT could be defended even in the face of a loss to IBM. That would keep alive the chance to challenge IBM again later.

Consequently, Fujitsu and Hitachi formed a group and began development of an IBM-compatible computer. NEC, on the other hand, chose the course of noncompatibility with IBM.

With this mixture of philosophies existing among Japanese computer companies MITI gave in to the mounting pressures for liberalization, and decided on a policy of partial liberalization in July 1971.

As the international climate surrounding the computer industry became harsher, Kobayashi stepped back to make a calm and accurate assessment of that climate, and to set the future course of NEC computers. His direct motivation was the gap between NEC and Fujitsu; NEC had even fallen behind Hitachi. This began about 1970. Closing the gap is NEC's great mission at present. NEC has gradually caught up with Hitachi, but the gap separating it from Fujitsu is bigger than ever.

The "error" of Kobayashi's computer strategy is strictly a question of results. It is not a fatal error like Toshiba's having to withdraw from the field of large, general-use computers. Fujitsu's and Hitachi's aggressive line against IBM had the backing of MITI, but in fact it succeeded beautifully.

Fujitsu has taken the top place from Japan-IBM, and it has pitted itself against IBM on a worldwide scale. It is the same with Hitachi; the IBM industrial spying incident of June 1982 can be called a product of the fight between Hitachi and IBM. The better things go for Fujitsu and Hitachi, the worse Kobayashi's "error" will look.

Regaining Lost Ground with C & C

On scrutinizing the success of the Fujitsu-Hitachi line against IBM, Kobayashi decided to develop and aggressive computer strategy. His slogan is "C & C" for computers and communications.

"C & C" was coined by Kobayashi. Simply put, it means that a logical, civilized society--a Computopia--will be built by connectiang computers though communications networks and using them extensively.

Of course, modern society is, as Kobayashi points out, rapidly progressing toward C & C. Kobayashi has begun to regain lost ground in the computer field with this powerful weapon.

Kobayashi has often stuck out his chest and said: "NEC has the world's best telecommunications technology and market. It also has computers. NEC is the only one that has both. IBM doesn't. This is the era of NEC." And, he has boasted, "C & C generally means computers and communications, but NEC is communications and computers."

Making the computer sector a theoretical weapon in C & C is a characteristic act for Kobayashi, ever the theorist. That characteristic was the motive force which led to success in catching and surpassing Hitachi.

There is a surprisingly strong boom in personal computers now; Hitachi has boasted of its overwhelming strength in that field. It has sold over 100 billion yen in personal computers alone. And together with Mitsubishi Electric and Toshiba, it is at the top of the office computer field.

It was a timely move to make the active Sekimoto president of NEC just when the company was being forced to work out a positive management strategy by advances in distributed processing systems under C & C, and by the development of personal computers and of office automation including Japanese word processors, facsimile machines and office computers.

One improvement made under Sekimoto was the activation of sales channels. The sales network has been strengthened. Another improvement was a sweeping reorganization. It is often said that: "After Sekimoto became president, the idea that sales come first was quickly reflected in such things as product development." The employees are charmed by Sekimoto's vitality, which has brought deep confidence in him. With Sekimoto in control, NEC is sure to continue steady growth.

But that does not mean there are no problems; a number of obstacles lie in NEC's path. NEC's future depends on how these problems are solved. Let us examine a few of them.

The first is semiconductors. As mentioned, NEC follows TI as the world's second largest manufacturer of semiconductors. It is certainly strong. At present (the end of October 1982), it is set to produce 2 million units per month, and by the end of March 1983, it will be set to lead the industry by producing 3 million units per month.

In the analysis of an influential industry source: "NEC's 64K DRAM may well be a loser." But even if it is losing at present, it could become a winner with monthly production of 3 million units. It would be premature to say NEC's semiconductor division faces a crisis just because there is a deficit at present. But the influential industry source says: "Hitachi and Fujitsu are completely in the black." Hitachi's monthly production capacity for 64K DRAM's was 1.95 million at the end of October, and the figure for Fujitsu was 2.0 million. In other words, all three companies have about the same production capacity, but NEC alone is unable to show a profit.

The 64K DRAM can be called the entryway to VLSI production, and a false step at that point will affect the future course of semiconductor operations. For that reason, industry attention is focused on NEC's "negative profit" theory.

Many Problems in the Path of C & C Strategy

Technological innovation in semiconductors is really amazing. Even though the heavy demand period for 64K DRAM's is still to come, the industry has already taken up the issue of 256K DRAM production. Toshiba and Hitachi plan to begin shipping samples early in 1983.

This 256K DRAM consists of about 600,000 elements mounted on a silicon chip a mere 5 mm square, and requires ultraprecision (2 microns or less) processing technology. Establishing production technology for the 64K static RAM was one step in establishing production technology for the 256K dynamic RAM. The 64K static RAM is comprised of about 400,000 elements.

Hitachi, Toshiba and Oki Denki have already entered this arena, but NEC has been standing by silently. Hitachi has said: "Commercial production of that product could be accomplished at any time. The technical difficulties have been solved." As to whether they have really been solved, the general view of the industry is that "If it had solved them, it would have announced it."

The competition to develop semiconductor technology is a marathon with no finish line. NEC has always been out in front with a considerable lead, but its lead is disappearing. There are beginning to be instances where someone pulls ahead. How to maintain the lead in the increasingly intense competition is a matter of concern for NEC.

Computers are next. NEC is continuing favorable growth in its course of noncompatability with IBM. It does not share with Fujitsu and Hitachi the necessity of watching IBM's moves while planning strategy. NEC's computer strategy, which Kobayashi calls avoiding the mistake of direct competition with IBM, has succeeded so far.

But while the performance of hardware will be an important factor in the future uses of computers, software will be even more important. This is a matter of advances in the technology of using computers. In other words, the accumulation of software will become the key to competition in computers.

Because Fujitsu and Hitachi have taken the path of compatibility with IBM, the fiercer competition between IBM and NEC has spread. But Fujitsu and Hitachi are able to use software developed by IBM without having to adapt it. At the same time, the software houses that develop and sell software turn their attention first to software which can be used by IBM computers. That is natural, since there is a great potential market for software used by the computers with a 60 percent share of the world market. The market share held by IBM and IBM-compatible computers together is probably more than 80 percent of the world total.

Thus, huge volumes of software are produced between the IBM group and the software houses. The gap between that and the software accumulated by the noncompatible group is growing rapidly.

Business has fallen off for Burroughs, an American example of the noncompatible companies. Britain's ICL, Europe's largest manufacturer of computers, is in a difficult situation, and the British Government has asked Fujitsu's cooperation in rebuilding it. America's NCR is similarly unable to grow.

The "software gap" has hurt business for the manufacturers which are not IBM compatible; those manufacturers may not survive into the 1990's.

How NEC will solve the "software gap" problem is an important issue which may make or break the company. It will be watched whether Sekimoto will find the correct solution to this difficult problem.

Under the slogan of C & C, Japan [as published] has developed a clever sales strategy, and has met with success. But proclaiming the slogan has not created a large C & C network. There are even those who say Fujitsu's distributed processing network is better than NEC's. It is certainly true that Fujitsu started first in the C & C field NEC is talking about.

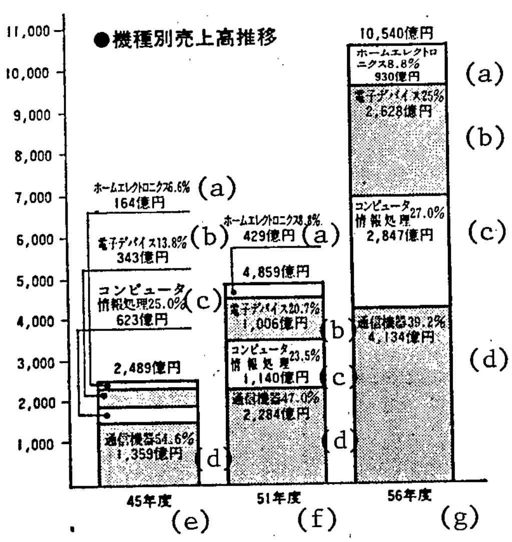
At the same time, Japan-IBM has begun steadily increasing its efforts in regard to distributed processing networks. And it is commonly thought that its technology in the field of distributed processing networks is far ahead of NEC's. NEC has created an excellent drawing card with C & C, but it is not yet certain that it has products to match. Because distributed processing will be a major factor in the future use of computers, the ability to actually provide C & C is a major task facing NEC.

●日本電気の主要指標の推移

	(a) 受注高	(b) 売上高	(c) 当期利益	(d) 1株あたり当期利益	(e) 1株あたり配当額	(f) 総資産額	(g) 1株あたり純資産額	(h) 技術研究費	(i) 設備投資額	(j) 従業員数
	百万円	百万円	百万円	円	円	百万円	円	百万円	百万円	名
52年度 (k) (52.4.1～53.3.31)	577,033	538,535	7,030	8.68	5.00	639,922	117.21	23,042	15,048	31,170
53年度 (l) (53.4.1～54.3.31)	659,744	615,440	7,612	9.29	5.00	679,241	124.63	31.216	19,750	31,106
54年度 (m) (54.4.1～55.3.31)	787,107	719,773	13,131	15.19	6.00	743,171	146.80	43,296	26,453	31,625
55年度 (n) (55.4.1～56.3.31)	936,591	892,810	18,045	19.26	6.50	859,851	175.17	49,318	36,355	32,800
56年度 (o) (56.4.1～57.3.31)	1,082,991	1,054,049	21,328	21.77	6.50	991,126	197.37	55,288	50,598	34,061

Trend of NEC's major indicators

(a) Total orders (million yen)
(b) Total sales (million yen)
(c) Earnings (million yen)
(d) Earnings per share (yen)
(e) Dividend per share (yen)
(f) Total equity (million yen)
(g) Equity per share (yen)
(h) Technical research costs (million yen)
(i) Facilities investment (million yen)
(j) Employees
(k) FY-77 (1 Apr 77 - 31 Mar 78)
(l) FY-78 (1 Apr 78 - 31 Mar 79)
(m) FY-79 (1 Apr 79 - 31 Mar 80)
(n) FY-80 (1 Apr 80 - 31 Mar 81)
(o) FY-81 (1 Apr 81 - 31 Mar 82)



(a) Home electronics
(b) Electronic devices
(c) Computers and information processing
(d) Telecommunications equipment
(e) FY-70
(f) FY-76
(g) FY-81

Figure 1. Sales trends by product sector (unit: 100 million yen)

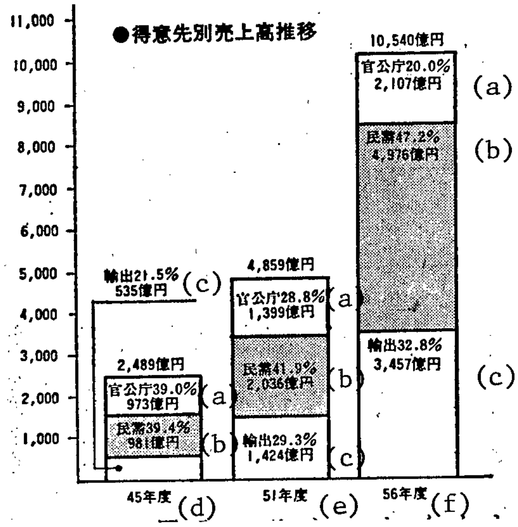


Figure 2. Sales trends by purchasing sector (unit: 100 million yen)

(a) Government
(b) Private demand
(c) Exports
(d) FY-70
(e) FY-76
(f) FY-81

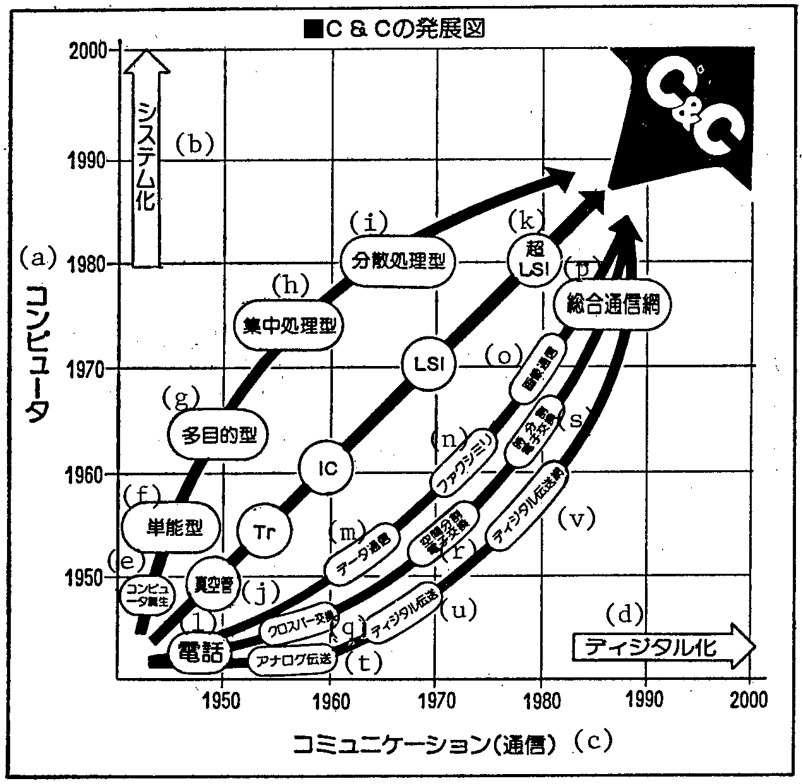


Figure 3. Development of C & C

(a) Computers
(b) Systemization
(c) Communications
(d) Digitalization
(e) Birth of computers
(f) Single function
(g) Multipurpose
(h) Central processing
(i) Distributed processing
(j) Vacuum tubes
(k) VLSI
(l) Telephone
(m) Data communications
(n) Facsimile
(o) Video communications
(p) Integrated communications network
(q) Crossbar switching
(r) Space division switching
(s) Time division switching
(t) Analog transmission
(u) Digital transmission
(v) Digital transmission network

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ETS-III's FUTURE EXPERIMENTS DISCUSSED

Tokyo KEISOKU TO SEIGYO in Japanese Feb 83 pp 53-55

[Article by Kiyoharu Tahata of the National Space Development Agency and Masamichi Shigehara of Toshiba Corporation]

[Text] Question--Engineering Test Satellite III (ETS-III) was developed by the National Space Development Agency [NASDA] with Toshiba as the primary contractor (Photo 1 [not reproduced], see "Products Introduction" in the February 1982 issue of this magazine). The satellite was launched at 2 pm, 3 September 1982 by the N-I (N-9) rocket launcher from Tanegashima Space Center by NASDA. The satellite was safely put into a circular orbit at an altitude of 1,000 km, inclination of 45°, with about 107-minute period. This satellite is the 24th for Japan, and it was nicknamed "Kiku No 4."

Today, we would like to ask you various questions about this satellite, such as its features, development history, and future prospects. How is the satellite's flight statu after launching?

Answer--By the end of December 1982, the satellite would have circled 1,600 times, and it is sailing smoothly. As for the mission of the satellite, the "initial attitude capture" operation was automatically and flawlessly completed as planned. This operation, which made the orbiting satellite a 3-axis satellite, was the most important initial task for Kiku No 4. The operation consisted of stopping the rotation of the satellite immediately after its separation from the launcher, expanding the solar-cell paddles, pointing the antennae side toward earth, correcting the orbital direction of the satellite, and tracking the sun with the paddles.

During the initial stage that consisted of the first 70 days after launching, operating conditions of the basic equipment and experimental apparatus on board have been confirmed (called "health check"). At the same time, operations of redundant parts of the equipment were also confirmed. All equipment on board is operating normally.

At present, planned experiments are being carried out as a part of normal operations.

Q.--Could you explain what a 3-axis satellite is? What are the goals of Kiku No 4?

A.--As is done in Sputnik and other conventional satellites, the cylindrical main body of a satellite is spun [around its axis] to maintain a stable attitude, and it is called a spin satellite. When a satellite becomes larger, spinning is not suitable because it is necessary to always point large solar-cell paddles toward the sun, and its observation instruments must be stationary and always pointed toward earth.

A 3-axis satellite carries a control system inside, and it independently controls its attitude. It detects attitude by an earth sensor and a gyrocompass, judges the correctness of its attitude by an on-board microcomputer, and issues necessary commands to adjust the attitude using reactions to the rotation of reaction wheels, which are (flywheels) installed on three axes of the satellite.

The main goal of ETS-III is to establish this 3-axis technique as an independent, Japanese technique. We will also confirm [the establishment of] related techniques such as extension of solar-cell paddles, tracking function, and thermal control function.

As a part of the engineering technology satellite series, technology for spin satellites has been developed through ETS-I and II, which are in revolving and synchronous orbits, respectively. For the first time in Japan, ETS-III will be used to develop and test a 3-axis satellite in an orbit rotating around the earth.

Q.--What kind of tests are being planned?

A.--The mission period of the satellite is one year. Its primary goal is to monitor the behavior of a 3-axis satellite in orbit during this period, and collect data that will be useful in developing future 3-axis satellites. Details of these planned tasks are listed below.

(1) Confirmation of the 3-axis attitude control function: "Initial period attitude capture" such as despinning and pointing to earth, and equipment operations in the initial stage have been confirmed. In the normal stage, maintenance of attitude correction capability against external disturbances will be monitored. Furthermore, experiments will be carried out on yaw-around which reverses the satellite's attitude with respect to its direction of orbital motion about every five weeks. Experiments will also be done on unloading of accumulated momentum in the reaction wheels using gas jets, and correction of orbital altitude also using the gas jets.

(2) Confirmation of extension and tracking function of the solar-cell paddles: Extension of the solar-cell paddles was confirmed immediately after launching. The electric power generated from the paddles and whether they are constantly rotating toward the sun have been continuously monitored since launching.

(3) Confirmation of active thermal control function: In contrast to a spin satellite, a 3-axis satellite receives sun light from only one direction, and hence it is necessary to have active thermal controls. The proper functioning of temperature control is confirmed by collecting temperature data from various parts of the satellite under different conditions, such as under direct sunlight or in shade.

Kiku No 4 has four experimental apparatus on board. The second test is to test the functioning of these apparatus in orbit. The following tests will be conducted.

(a) Visicon camera: A 3-tube visicon camera with different wavelengths will be used to take pictures of the earth's surface, and basic experiments for the techniques needed in future earth observation will be carried out. The surface of the earth will be photographed every 5 or 25 seconds. Each photograph covers [an area] 280 by 210 km, and resolution is about 400 m. It uses a Japanese camera, and we have, for the first time, obtained sharp pictures of various parts of Japan.

(b) Ion engine unit: Propulsion tests will be conducted with an ion engine unit on board, which is an electrical propulsion system with high specific thrust. This type of engine is expected to be used in the future. Mercury is the propellant. It is vaporized by a porous tungsten carburetor, and plasma is generated by bombarding this vapor with electrons in a discharge chamber. The engine generates a thrust of about 2×10^{-3} N [newton]. In addition to the tests on function and propulsion of short duration, a lifetime test lasting tens of hours of continuous blasting will also be carried out.

(c) Active thermal control unit: The satellite is loaded with an experimental apparatus, which consists of heat pipes and thermal louvers, as an active thermal control unit that will be needed in the future. The apparatus will be tested. Heat pipes are already widely used in devices such as audio sets. As you may know, a heat pipe uses the change in latent heat of ammonia gas as it changes phase during evaporation and condensation. Heat pipes are used for rapid dissipation of heat from hot spots. A louver opens or closes its blades, depending on the temperature of the surface it is installed on, and controls the effective emissivity of the surface. The temperatures of all apparatus are controlled by adjusting the temperatures of their mounted locations using heaters. The thermal control function will be tested [by monitoring these temperatures].

(d) Magnetic attitude control unit: To control the attitude of a satellite, this method uses a torque generated by interaction between earth's magnetism and the magnetic moments generated in coils installed along the three axes of the satellite. For Kiku No 4, control patterns, i.e., on/off patterns of the coils, will be computed on the ground. Tests for unloading of the wheels and the elimination of residual magnetic moments will be carried out by commands from the ground according to these control patterns. These tests will be useful in the future for making the control system lighter and its lifetime longer.

Q.--What are the special features of Kiku No 4, in particular with respect to its systems?

A.--Kiku No 4 has many unique features that do not exist in other 3-axis satellites. First of all, it is operated, in principle, from ground stations in Japan. For a low altitude satellite that revolves around the earth 14 times a day, the satellite is invisible from Japan half of the time, or 7 revolutions. Even during the visible 7 revolutions, the satellite is really visible only under favorable conditions, about 15 minutes at the most. Operations of the satellite, i.e., retrieval of data and commands, must be finished during the limited time available. This is fundamentally different from controlling a geosynchronous satellite, which is visible all the time. For this reason, we automated operations as much as possible, and also took measures to make the satellite safe even when it malfunctions.

For instance, during the initial period attitude capture between launching and setting up a satellite as a 3-axis one, a series of operations, which are most important and troublesome, was controlled using an on-board computer so that the satellite could adjust itself without any help from the ground. Operations that would take several days in a geosynchronous satellite were all completed within 90 minutes of launching. When the first revolution was finished and the satellite became visible again, the paddles were already open correctly, and the 3-axis attitude had been established. Although the satellite was carefully designed and tested before launching, we were slightly worried whether it would really work as planned. When the satellite reappeared safely, we all sighed with relief. In addition, all normal operations, such as attitude control, tracking the sun for the solar-cell paddles, and wheel unloading, are automatically carried out on board.

For safety measures, we have adopted redundant constructions to avoid single failures. In addition, operation of attitude control electronics, which is a crucial component equipped with a digital computer, is monitored, and there is a built-in trouble-shooting system on board that can automatically switch to a backup system when an abnormal case is detected. Various key parameters in the electric power supply system are monitored, and the power load is designed to be minimized if any of the parameters exceed their limits.

Since the satellite has an orbital inclination of 45° and is not synchronized to the sun, the paddles are tilted about 20°, in contrast to the conventional satellites in which the paddles stretch out at right angles, in order to absorb solar energy into the solar cells as uniformly as possible throughout the year. Moreover, when seasons change and the sun moves over to the opposite side of the orbital plane, then the satellite's attitude is reversed in the forward-backward direction by yaw maneuver.

Q.--I believe the satellite was difficult to build. How long did it take to develop it? How was it carried out? What kind of problems did you have?

A.--Conceptual design of the satellite began in 1973, and the project took almost 10 years. After the preliminary design, Toshiba was chosen as the primary contractor in 1977, and actual development began. In Japan, Mitsubishi Electric, Nippon Electric, and Ishikawajima Harima Heavy Industries worked together. General Electric of the United States provided technical assistance for techniques related to a 3-axis satellite, which Japanese technology lacked at that time.

Basic and detailed designs were completed in 3 years, verification tests were carried out on a prototype, and the flight model was completed in April 1982.

The basic guideline was to promote independent design and domestic technology, and a steady, step-by-step approach was adopted. Every design was verified through analysis, simulation, and testing. Nevertheless, we kept repeating trial-and-error since this was our first 3-axis satellite and we were crossing unknown territory. For instance, launching a 3-axis satellite with the N-I launching vehicle was a new experience! and it was necessary to define various, new interface conditions. In particular, toward the latter half of the design stage, the design had to be changed much to add a new rate gyro. This was necessary to cover a large rotation rate from a bobbing motion that could be initiated when the satellite and the launcher separated. We had trouble in figuring out how to put this change into the system.

Also during development, a new problem was discovered in a satellite program of the United States. It was found that the effect of single radiation events on IC's, not the accumulated effect, cannot be ignored. We had to carry out new radiation tests, analyze, and evaluate them on highly integrated static RAM's (random access memories) used in attitude control electronics.

Q.--Finally, could you tell us the achievements of this development and future prospects?

A.--First of all, we have established a foundation for local production of a 3-axis satellite, which was the goal of Kiku No 4. Specifically, we have learned integration technology for a 3-axis satellite, and now have a group of engineers to support it. Integrating a satellite means building an optimum satellite by freely manipulating parameters in attitude control, thermal, structural, and other systems. We have succeeded in developing mathematical models needed for integration, revised the models many times as designs progressed, and they were verified through tests.

In addition, we have built unique hardware technology such as light-weight construction, expandable solar-cell paddles, and high-voltage power supply. Above all, the best achievement is the fact that we now have the "knack" for a 3-axis satellite by developing everything ourselves, including design, fabrication, testing, and orbital manipulation. These skills can be used to develop future satellites.

Kiku No 4 is still in orbit, new experiments are being carried out, and valuable data are being sent continuously. In the example of attitude control data, the [satellite] behavior from separation from the launcher to despin became clearer, and useful data were obtained about the motion of flexible structures, including that of the paddles in orbit.

Finally, we would like to pay our respects to NASDA and the Science and Technology Agency, which embarked on such an ambitious satellite project 10 years ago. We also would like to thank everyone who participated in this project at the National Aerospace Laboratory, Electrotechnical Laboratory, and subcontractors.

At present, demand is increasing for large satellites such as communications, broadcasting, ocean scanning, and earth observation satellites in Japan. These satellites require much electric power, and 3-axis satellites are best suited for these purposes. The experience gained in Kiku No 4 is directly related to the development of such satellites, and we plan to use it well in the new space technology of Japan. (Received 16 December 1982)

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SCIENCE AND TECHNOLOGY AGENCY LARGE-SCALE PROJECTS DISCUSSED

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1. History and Outline of Large-Scale Industrial Technology Research and Development System

1-1 Introduction

This country must resolve the problems of continuing to maintain its social activities, materially improving its people's standard of living, and developing a higher level industrial structure under the conditions of growth and restriction in areas such as energy throughout the eighties.

The role of technological development in the efforts to meet these demands of society is very large, and the subject of a "path to a technological state" is a major goal we are expected to aim toward in our commercial industrial policy vision for the eighties.

The Large-Scale Industrial Technology Research and Development System (commonly called the large-scale project), which was started in 1966 and which has already brought forth some major accomplishments, is one in which the nation itself promoted large-scale industrial technology research and development in order to raise the level of the industrial structure and seek a rational development of natural resources. Great hopes are placed on it to guide the way to a technological state.

1-2 History of the System

The large-scale project system was initiated in 1966 with three projects--"Super-High-Performance Electronic Computer," "Desulfurization Technology," and "Magnetohydrodynamic (MHD) Power Generation"--with an annual budget of about 1 billion yen.

At that time, the degree of freedom in Japan's economy was increasing at a rapid tempo, and its technological level was undergoing fast improvement through digestion and absorption of technology introduced from the West; however, there was little desire or effort to engage in creative technological development, and there was also a need for measures on research and development directed at large-sclae production, greater academic involvement, and greater industrial involvement. It was in this situation that the nation's financial resources and private industry's research and development capacity were linked to establish this system.

This was followed in 1974 by the New Energy Technology Research and Development System (Sunshine Plan) and in 1978 by the Conservation of Energy Technology Research and Development System (Moonlight Plan), which were created in response to the needs of the time with this original project as the parent body. It may be said that this project plays the role of precursor to the large-scale research and development of the Ministry of International Trade and Industry.

This year, 1982, which represents 17 years since the inception of this system, the number of projects under way totals eight and the annual budget has grown to 16.3 billion yen.

During this period, 19 projects (excluding the "Magnetohydrodynamic (MHD) Power Generation" and the "Waste Heat Utilization Technology System," which were transferred to the "Moonlight Plan") were started, and the sum advanced by the government totals roughly 150 billion yen.

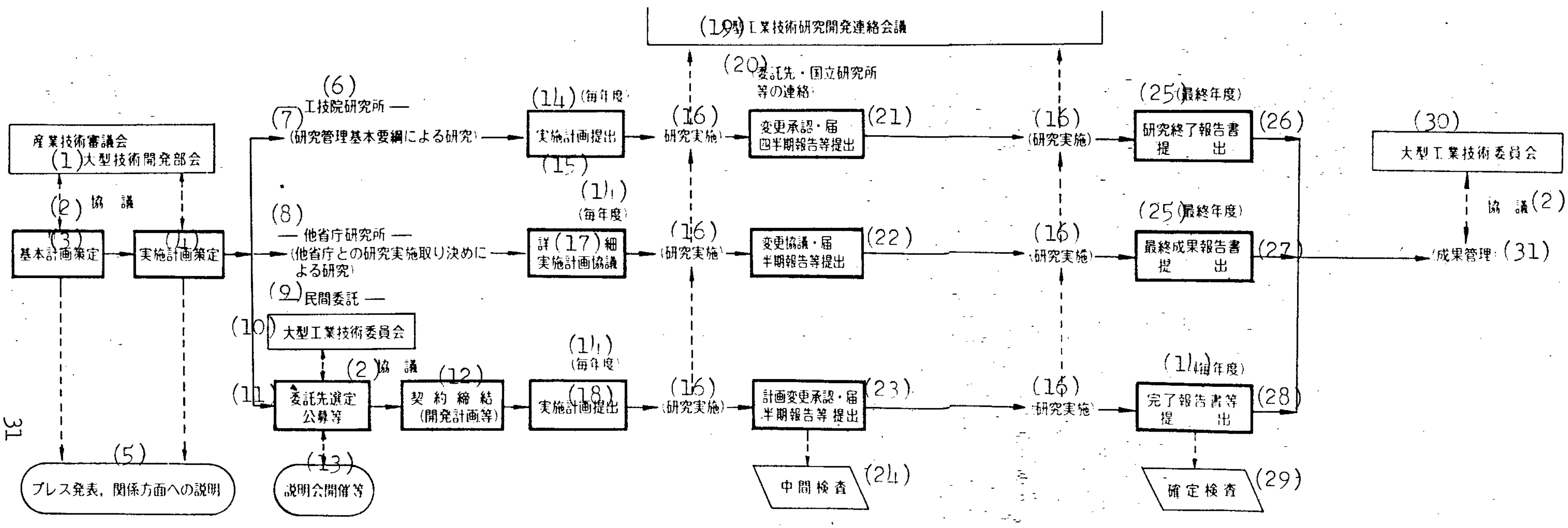
1-3 Outline of System

This system involves large-scale industrial technology considered important and urgent to the people's economy for which the research and development requires a large investment and a long period of time as well as entailing a very large risk, thereby making it impossible for private industry alone to bear the burden. As a result, the country has assumed responsibility for the financial burden, and an initimate cooperative system has been established between industry and academia aimed at the development of these resources and at achieving environmental safety, together with the improvement of the people's living standards and welfare through the efficient promotion of planned research and the development of innovative and leading technology.

The research and development under this system is centered on the Agency of Industrial Science and Technology under the Ministry of International Trade and Industry and is promoted by a system which consolidates the research and development capabilities of industry and academia together with related government people coming under the umbrella of the ministry. The large-scale technology development group comprised of the Industrial Technology Council and similar groups which are consultative organs for the Ministry of International Trade and Industry continually hold hearings with regard to the selection of appropriate themes, the research and development plan for each theme, and the program to be executed each year. Related academic people with good experience and research and development leaders comprise a Research and Development Liaison Council which has charge of comprehensive promotion (see Figure 1). The administrative function in this research and development promotion is entrusted to a research and development officer in charge of each project and a general research and development officer, both operating under the direction of the director of the Agency of Industrial Science and Technology. These officers perform the administrative duties, and a technology council member maintains systematic control of the operation of an entire project.

The actual research is divided into research conducted by the Agency of Industrial Science and Technology and related research laboratories coming under the various related ministries and bureaus, and research assigned to private research organs. This assignment is made by soliciting applications from industries wishing to participate in research and development along the lines of the basic plan of the research theme (an outline of this subscription is published in the bulletin of the Ministry of International Trade and Industry before the research and development program is initiated). The technological research capability, research system, accounting capability, and reliability are evaluated, and a final decision on a selection is made after listening to the opinions of the Large-Scale Industrial Technology Committee comprised of members from the Agency of Industrial Science and Technology, experimental laboratories, and various offices of the Ministry of International Trade and Industry.

Figure 1. Large-Scale Industrial Research and Development Flow Chart



Key:

1. Industrial Technology Council, large-scale technology development section
2. Consultation
3. Selection of basic plan
4. Selection of plan to be executed
5. Press release, explanations to related fields
6. Agency of Industrial Science and Technology laboratories
7. Research by basic network for research management
8. Other government laboratories (research conducted by arrangement with other government organs)
9. Assigned to private sector
17. Conference on detailed plan to be executed
18. Submission of plan to be executed
19. Large-scale Industrial Technology Research and Development Liaison Council
20. Liaison between private contractors and national laboratories
21. Acknowledgment and transmittal of changes, quarterly reports, etc
22. Acknowledgment and transmittal of changes, quarterly reports, etc
23. Acknowledgment and transmittal of changes, quarterly reports, etc
24. Intermediate examination
25. Final FY

Key to Figure 1 continued

10. Large-Scale Industrial Technology Committee
11. Subscription for candidates for participation
12. Signing of contract (development plan, etc)
13. Explanatory meeting, etc
14. (Each FY)
15. Submission of plan to be executed
16. Execution of research
26. Submission of final research report
27. Submission of report on final results
28. Submission of report on completion
29. Confirmatory examination
30. Large-Scale Industrial Technology Committee
31. Results management

Table 1-(1) Outline of FY-82 Large-Scale Projects

(1) プロジェクト名	(14) 56 年 度	(19) 57 年 度	(20) 研究開発期間	(31) 研究開発費総額
資源再生利用技術システム (2)	(15) 千円 1,500,943	(15) 千円 733,090	(21) 51～57年度 (第二期計画) [48～50年度 第一期計画 約 13 億 円]	(32) 約113億円
超高性能レーザー応用複合生産システム (3)	2,745,154 (16) [うち 研究施設費 27,362]	3,533,215 [うち 研究施設費 221,897] (16)	(22) 52～58年度	(33) 約130億円
光応用計測制御システム (4)	2,418,648	3,237,812	(23) 54～61年度	(34) 約180億円
一酸化炭素等を原料とする基礎化学品の製造法 (5)	901,782	2,526,674	(24) 55～62年度	(35) 約150億円
マンガン団塊採鉱システム (6)	50,000	882,422	(25) 56～64年度	(36) 約200億円
科学技術用高速計算システム (7)	30,000	813,221	(26) 56～64年度	(37) 約230億円
自動縫製システム〔新規〕 (8)	——	30,000	(27) 57年度～	(38) 未　定
重質油を原料とするオレフィンの製造法 (9)	3,155,562	245,363	(28) 50～56年度	(39) 約138億円
航空機用ジェットエンジン (10)	1,901,156	3,357	(29) 51～56年度 (第二期計画) [46～50年度 第一期計画 約 69 億 円]	(40) 約130億円
その他 (11)	619,182	160,557		
海底石油生産システム (12)	3,514,946 (17) [一般会計 118,472 (18) 特別会計 3,396,474]	4,093,766 [一般会計 103,753 特別会計 3,990,013] (17) (18)	(30) 53～59年度	(41) 約150億円
(13) 合　計	16,837,373 (17) [一般会計 13,440,899 (18) 特別会計 3,396,474]	16,259,567 [一般会計 13,269,554 特別会計 3,990,013] (17) (18)		

備考　研究開発期間，研究開発費総額は，基本計画に定めたもの。(42)

Key to Table 1-(1)

1. Name of project
2. Resources regeneration and utilization technology system
3. Super-high-performance laser application composite production system
4. Light application measurement control system
5. Method of manufacturing basic chemicals using CO and similar raw materials
6. Manganese nodule recovery system
7. High-Speed computing system for science and technology use
8. Automated sewing system (new)
9. Method of producing olefins using heavy oil as a raw material
10. Aircraft jet engines
11. Other
12. Sea bottom oil producing system
13. Total
14. FY-81
15. 1,000 yen
16. Including cost of research facilities
17. General total
18. Special total
19. FY-82
20. Research and development period
21. FY 76-82, (second-phase plan) (FY 73-75, first phase plan about 1.3 billion yen)
22. FY 77-83
23. FY 79-86
24. FY 80-87
25. FY 81-89
26. FY 81-89
27. FY 82-
28. FY 75-81
29. FY 76-81, (second-phase plan) FY 71-75, first-phase plan about 6.9 billion yen
30. FY 78-84
31. Total research and development cost
32. About 11.3 billion yen
33. About 13.0 billion yen
34. About 18.0 billion yen
35. About 15.0 billion yen
36. About 20.0 billion yen
37. About 23.0 billion yen
38. Undetermined
39. About 13.8 billion yen
40. About 13.0 billion yen
41. About 15.0 billion yen
42. Note: The research and development period and the total research and development funds were those designated in the basic plan

Table 1-(2) Outline of FY-82 Large-Scale Projects

(1) プロジェクトの概要	(13) 57年度の主要研究開発計画
資源の有効利用並びに都市固形廃棄物処理の円滑化を図るため，資源再生利用にねらいを置いた都市固形廃棄物処理の技術システムの研究開発。 (2)	メタン発酵，熱分解油化，熱分解ガス化サブシステムの長期連続運転研究を実施する。 また，前年度までの研究開発及びパイロットプラントの運転研究実績をふまえて，資源再生利用技術システムの総合評価研究を行う。 (14)
多品種少量生産の機械構成部品を，金属素材から一貫したシステムで柔軟かつ迅速に生産できる複合生産システムの研究開発。 (3)	前年度に行った複合生産システム実験プラントの詳細設計研究に引続き，同プラントの製作を行うとともに，総合運転研究に必要な実験棟の建設を行う。 また，素形材加工技術については，試作装置による本格的成形加工実験を行い，20kWレーザ発振器については，設計・製作を行う。 (15)
工業団地内又は大規模プラント内など，一定区域内で発生する画像を含む大量情報を，電磁気的その他悪環境下でも有機的に計測し，総合監視，制御を可能とする光を用いた計測制御システムの研究開発。 (4)	トータルシステムについて，各サブシステムを有機的に組合わせた実証システムの概念設計を行う。機能別サブシステムについては，詳細設計に引続き一部モデル試作を行う。また，光要素技術の開発を引続き進めるとともに光要素共通技術について，結晶成長技術等の本格的な研究を行う。 (16)
石油の供給上の制約等に対応して，石油化学の抜本的原料転換を図るための，石炭，天然ガス等から得られる合成ガス（一酸化炭素と水素の混合ガス）を原料とした，エチレングリコール等基礎化学品の新製造法の研究開発。 (5)	前年度に引続き，基礎化学品（エチレングリコール，エタノール，酢酸及び炭化水素）合成用触媒の探索研究を本格的に行うとともに，ガス分離膜開発のための製膜化研究等を行う。 (17)
非鉄金属資源の安定供給を図るため，水深4,000～6,000mの深海底に大量に賦存し，ニッケル，銅，コバルト，マンガン等の重要金属を含有するマンガン団塊を商業的規模で採鉱するための高能率かつ信頼性の高い流体ドレッジ式採鉱システム技術の研究開発。 (6)	トータルシステムについて生産技術の研究を行うとともに，海洋総合実験の基本計画を策定する。集鉱システム，揚鉱システム，ハンドリングシステム，計測制御システムの各サブシステムについては，要素技術開発に着手し，機器の選定実験，性能解析等を行う。 (18)
人工衛星から送られてくる画像の処理，核融合炉のプラズマシミュレーション等，現在の電子計算機では処理しきれない科学技術計算を現実的な時間で処理できる高速計算システムの研究開発。 (7)	高速論理及び記憶素子としてジョセフソン接合素子，高電子移動度トランジスタ素子，ガリウム砒素ＦＥＴ素子の開発並びに並列処理方式の研究を行う。 (19)
アパレル産業における消費者ニーズの多様化等に対処するための，縫製準備工程から仕上げまでを自動的に行う自動縫製システムの研究開発。 (8)	研究開発の全体計画を策定するとともに，自動延反裁断技術，自動組立縫製技術等各要素技術及びトータルシステムの概念設計を行う。 (20)
減圧残渣油等重質石油留分（いわゆるアスファルト）を原料として付加価値の高いオレフィン（エチレン，プロピレン等の総称であり合成樹脂，合成ゴム，合成繊維などの原料）を製造する技術の研究開発。 (9)	研究開発設備の撤去を行う。 (21)
(10) 騒音，排ガスによる大気汚染等の公害が少なく，総合効率が高く，頻繁な離着陸に耐え，保守点検整備の容易な民間航空機用の高性能ファンジェットエンジンの研究開発。	研究開発設備の撤去を行う。 (22)
(11) プロジェクトの効果的推進のための管理促進，調整等を行う。	
(12) 石油，天然ガス資源の安定確保と海洋開発技術全般の向上を図るため，大水深（水深300m以深）の海底石油生産に有効で，かつ，日本周辺の大陸棚等の海域においても適用可能な海底石油生産システムの研究開発。	前年度に引続き，海洋総合実験に供する装置の設計・製作及び一部について試作試験を行いほぼ完成させる。 またこれと並行して，海洋総合実験を実施するための詳細計画を完成させる。 (23)

Key to Table 1-(2)

1. Outline of project
2. Research and development on technological system for urban solid waste treatment aimed at resources regeneration and utilization which promotes effective utilization of resources and urban solid waste treatment.
3. Research and development on composite production system which enables production of machine parts of diverse types and small volume flexibility and rapidly through a through-process starting from the metal.
4. Research and development on measurement and control system using light which enables comprehensive measurement, observation, and control of a large volume of information, including graphics, which is generated within a fixed area such as a large industrial park or a large-scale plant even within an electromagnetic field or other adverse environment.
5. Research and development on new manufacturing methods of basic chemicals such as ethylene glycol using synthetic gas obtained from coal or natural gas (mixed carbon monoxide and hydrogen gases) in order to enable selective raw material conversion to counter restrictions imposed by the supply of oil.
6. Research and development on high-efficiency and high-reliability liquid dredge type ore recovery system for recovery on a commercial scale of manganese nodules with a high content of important metals such as nickel, copper, cobalt, and manganese which are present in vast quantity at the ocean bottom at depths of 4,000-6,000 meters in order to assure a stable supply of nonferrous metals.
7. Research and development on a high-speed computing system to handle science and technology calculations, including graphics, transmitted by artificial satellite or plasma simulation of nuclear fusion reactors within a reasonable time which cannot be handled by present day computers.
8. Research and development of automatic sewing system which automatically handles all sewing steps from cutting to sewing and which can respond to the diverse needs of apparel industry consumers.
9. Research and development on technology for manufacturing olefins of high add-on value (such as ethylene or propylene to serve as raw materials for the production of syntehtic resins, synthetic rubber, and synthetic fiber) using as raw material heavy oil distillate cut (so-called asphalt) such as reduced pressure distillation residue.
10. Research and development on high-performance fan jet engine for use on civilian aircraft which produces low noise and little atmospheric pollution through its exhaust gas, has high overall efficiency, is capable of making frequent takeoffs and landings, and is easy to service.
11. Conduct management promotion and adjustment to enable effective promotion of project.
12. Research and development on sea bottom oil production system applicable to ocean areas such as the continental shelf and the coastal areas around Japan effective for sea bottom oil production at great depths (greater than 300 meters depth) in order to assure a stable source of oil and natural gas and to improve overall sea bottom research and development.
13. Major research and development plan for FY-82
14. Put into execution long-term continuous operating research on methane fermentation, thermal cracking of oil, and thermolytic gasification subsystems.

Key to Table 1-(2) continued

Conduct comprehensive evaluation research on resources regeneration and utilization technology system based on the results of research and development up to the previous year and on the operational results of pilot plants.

15. Follow up detailed plan research on the composite production system experimental plant completed last year with the construction of the plant and construct an experimental plant for overall evaluation research.

Conduct actual shaping and finishing experiments using test fabricated equipment where shaping and finishing technology is concerned. Enter into design and test fabrication of 20 kW laser oscillator.

16. Make conceptual design of demonstration system which is a combination of the respective subsystems making up the total system. Carry out partial test production following detailed design of the different functional subsystems. Continue development of photo element technology and conduct research on crystal growth technology in the area of light element common technology.
17. Conduct search for catalysts for synthesis of basic chemical (ethylene glycol, thanol, acetic acid, and hydrocarbons) continuing the preceding year's work and enter into film making research for the development of gas separation membranes.
18. Conduct research on production technology of the total system and draw up basic plan for comprehensive marine experiments. Start element technology development on the various subsystems such as the ore collecting system, ore lifting system, handling system, and measurement and control system, and conduct equipment selection experiments and functional analysis.
19. Develop high-speed logic and memory elements such as the Josephson junction element, high electron mobility transistor element, or gallium arsenide FET element, and conduct research on parallel treatment mode.
20. Propose overall research and development plan and make conceptual design of automated multiple-layer cutting technology, automated assembly and sewing technology, and other element technology as well as the total system.
21. Withdraw research and development facilities.
22. Withdraw research and development facilities.
23. Design and test produce equipment to be used in the comprehensive marine experiment, continuing work from the previous year, and roughly complete one section of the design and production.

Also complete detailed design to execute the comprehensive marine experiment.

2. Outline of Ongoing Projects

2-1 Resources Regeneration and Utilization Technology System

(Research and development period: FY 73-82; research and development funds: about 12.6 billion yen)

(1) Outline of Plan

The idea of reconsidering urban trash and regarding it as a resource and of regenerating and utilizing this resource as much as possible, while also decreasing the disposal burden for this country with its very limited area, has been receiving added emphasis since the oil shock. In response, the Agency of Industrial Science and Technology of the Ministry of International Trade and Industry initiated this research and development plan in FY-73 as the Stardust Plan.

The contents of this plan include the mechanical separation of the urban trash collected in a mixed state without separation at the source, the regeneration of this trash, and the recovery of the greater portion as resources and energy. This project is divided into two phases: in the first phase, the basic element technology will be developed; in the second phase, these element technologies will be combined for the construction of a close to actual size plant which will be put into operation, thereby establishing the technology necessary to come out with a practical plant.

The first proposal based on the results of the first phase is what is called a material recovery system (MRS), in which mixed urban trash is divided into garbage (group I), paper (group II), and plastics (group III); the garbage is converted to compost, the paper into paper pulp, and the plastics are thermolyzed and converted to fuel gas, in addition to which sand and pebbles are regenerated as lightweight aggregate.

A pilot plant of 100 tons/day capacity has been constructed and is being operated on city-owned land in cooperation with the city of Yokohama in Kanagawa-ku to demonstrate this system. This plant was completed in 1978, and operational research has been under way using actual trash from the city of Yokohama. The system next conceived is called the energy recovery system (ERS), in which mixed urban trash is divided into garbage (group A) and paper and plastics (group B); methane gas is recovered from the former and thermolytically produced gas or oil is recovered from the latter group and the residue from the methane process.

A high-speed methane fermentation facility was installed at the Yokohama plant in order to demonstrate this system. In addition, a thermolytic oil-producing facility was constructed and operated at Umenoshima in Tokyo-to with the cooperation of Tokyo-to. This plant in Tokyo-to has a capacity of 22 tons/day of urban trash. These facilities were completed in the spring of 1981 and operations began in the fall of that year.

(i) Pretreatment Subsystem

This subsystem separates mixed urban trash into two or three types according to the desired objective and provides raw material suitable for regeneration at the next stage. The main body of this subsystem is a semi-wet type selective pulverizing and separating facility (SPC) which simultaneously crushes and separates the trash using comparatively little power.

This facility is comprised of a meshed rotating drum and a scraping plate which rotates within the drum and separates the ground particles utilizing the differences in particle diameters resulting from differences in brittleness. Paper is separated by sprinkling water inside the facility to wet the paper and increase its disintegration property. The results to date on Yokohama trash show that 90 percent of the total garbage, glass, sand and pebbles went into group I; 50 percent of the paper went into group II; 80 percent of the plastics went into group III; and 85 percent of the metals went into various categories. The content of paper in group II was 85 percent.

(ii) High-Speed Composting Subsystem

This process involves aerobic fermentation of group I raw materials to remove undesirable material and produce purified compost. A screw-type stirrer is installed in the fermentation vat to stir the waste and also to circulate air to make possible high-speed, large-volume treatment. Fermentation is completed in 7 days, and a hygienic product is obtained through favorable aerobic fermentation. The undesirable material is removed using a rotary sieve, a forced draft separator, and a repulsion separator, so the amount of impurities in the product is small. The results of fertilizing experiements using this compost product have been favorable.

(iii) Purified Pulp Subsystem

This sybsystem involves the application of a well-known paper regeneration technology to recover purified pulp from group II raw materials of high paper content; but the extraneous matter removal, bactericidal action, and bleaching process are greatly reinforced compared to previous paper treatment processes. The rate of recovery of pulp by this process is about 40 percent on a weight basis from the starting material; about 60 percent of the pulp in the starting material is recovered. When this product by itself was used to produce toilet paper, no hindrance to its actual use was experienced. Mixed pulp containing more than 40 percent of this pulp was used to make memo paper and file paper, and no practial problems were encountered.

(iv) Light Aggregate Subsystem

This process takes the portion of urban trash which in the past was considered most difficult to convert into a resource, including components such as glass, dirt and sand, ceramic fragments, and ashes and dust left after thermolytic gasification, and converts it into nonpolluting and effectively utilizable light aggregate material. This process involves calcination and pulverization of the starting material, the addition of bentonite to serve as a binder, further pulverization to a finer state, formation of pellets, and calcination at about 1,000°C. Because high-temperature calcination is used, the product is chemically stable and nonpolluting. This regenerated product satisfies the JIS specifications for concrete aggregate for structural use.

(v) Thermolytic Gasification Subsystem

This process involves thermolysis of high-calorie trash with a high plastic content and produces fuel gas; the system can be divided into the combination tower which generates the heat required for decomposition and the decomposition tower where decomposition takes place; heat is transferred between these two towers through a sand medium.

Roughly 60 percent of the starting material is gasified, the residue is in the form of solid fuel (char) and oil, and the components other than the gaseous product are used as fuel within the combustion tower. Because a fluidized reaction is employed, there is little danger of localized hot spots that can damage the tower wall. At the same time, line is added to remove hydrogen chloride, which was a problem associated with plastics in the past; the use of this fluidized reaction mode provides good catalytic action and enables extremely high removal effect. The volume of exhaust gas from the combustion is small, on the order of one-tenth that of the combustion tower; the content of contaminating gases such as nitrogen oxides, chlorine, or hydrogen sulfide is extemely small; and the waste gas treatment is simple.

This product gas contains 6,000-7,000 kilocalories per normal cubic meter heat content, the gas can be stored or transported, and it can be used as power plant fuel, industrial-use fuel, or regional heating fuel.

(vi) Thermolytic Oil Producing Subsystem

This system subjects trash high in plastic content to thermolytic decomposition to revocer oil' a unit-tower-type fluidized-bed thermolytic tower is used wherein the heat of thermolysis is supplied by partial combustion of the raw material. The thermolytic temperature is maintained at a lower level than for gasification in order to increase the recover of oil. About 50-60 percent of the plastics in the raw material is recovered as P oil, and about 10 percent of the plastics and 20 percent of the paper are recovered as solid fuel. The remainder is recovered as gas and cellulose oil.

The discharge gas from the combustion of this system is small--between one-half and one-third the volume of the combustion furnace--so the waste gas treatment is simple. At the same time, the unit tower construction provides a simple structure, and operation is relatively simple.

(vii) High-Speed Methane Fermentation Subsystem

This system involves the conversion of trash high in garbage content into a slurry which is then subjected to high-speed, high-recovery methane fermentation.

The methane fermentation takes place in two stages, liquid reaction and gaseous reaction; the optimum conditions for these reactions, including factors such as pH, differ for the two states, so these two steps are carried out in separate tanks under the respective optimum conditions to attain a high-speed recovery rate. Efforts are under way to introduce a preliminary stage of alkaline decomposition to promote the decomposition of bacteria.

This modification will result in cutting the fermentation time to one-fourth that required at present and in increasing the methane gas recovery 40-50 percent based on 100 percent methane conversion, while the purity of the methane will be raised 10-20 percent, to about 70 percent, compared to the old vat-type facility. This will also enable a reduction of the vat size to half what it was before.

(2) Status of Research

Operational research on material recovery has been completed, but research is continuing in an effort to introduce further improvements. This research involves reducing wear and tear in the pretreatment subsystem to the maximum in order to prolong its life as well as to facilitate maintenance. Research on the separation of unsuitable matter by a wet process is under way for the high-speed composting subsystem in order to reduce the glass content of the compost to less than 0.5 percent. A simple pulp-making technology, is being studied to handle special waste initially high in paper content, such as waste from offices, which handles the waste directly without pretreatment in the purified pulp subsystem. A thermolytic gasification subsystem is being studied to increase the yield and enable long-term operation.

To date, a nonstop, malfunction-free operation lasting 16 days has been realized. The energy recovery type which is a late comer is presently undergoing operational tests which involve long-term operation, improved yield, and a trash-handling operation adaptable to the changes in the nature of the trash with the seasons. To date, the thermolytic oil-producing subsystem has recorded 3 days continuous operation, and the high-speed methane fermentation subsystem 10 days continuous operation.

The economic features of future plants are also under study. Calculations based on the assumption of a 900 tons/day (equivalent to trash from a million people) material recovery system show the net total cost after deducting the income from the recovered material are on the order of 6,000 yen; the plant appears to be competitive with incineration plants presently in use. Next, calculations on the energy recovery type, again assuming a 1,000 tons/day plant, also result in a net operating cost of less than 6,000 yen, and this system is also competitive with the present incineration furnace.

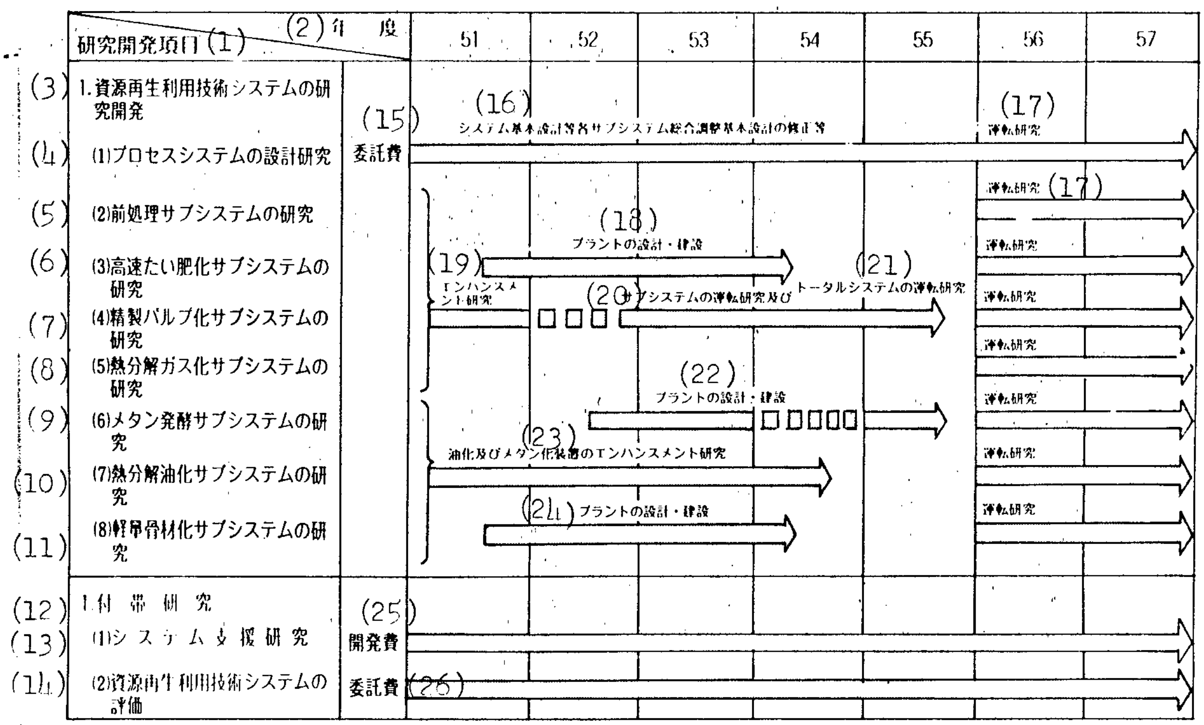
Part of the results of this research and development have already reached the practical stage. Three high-speed composting plants are already in operation, and two more are under construction. The first selective pulverization plant started actual operation recently in Geinishimura in Shikoku, and this technology was recently supplied to an Australian steel and machine manufacturer.

(3) Conclusions

This technology represents a maximum effort to convert trash to resources and utilize the product, and it not only reduces the volume of material for burial but also is aimed at reducing the cost of trash handling through utilization of the regenerated products. At the same time, many regenerative modes are employed to greatly increase the range of choices of utilization.

The Stardust Plan has produced some important technological results necessary for practical application, and these results are expected to be widely used both at home and abroad to solve the trash problem; however, developmental problems still remain before further commercial exploitation is possible, requiring more efforts from both the government and the private sector.

Figure 2. Research and Development Schedule for the Resources Regeneration and Utilization Technology Subsystem



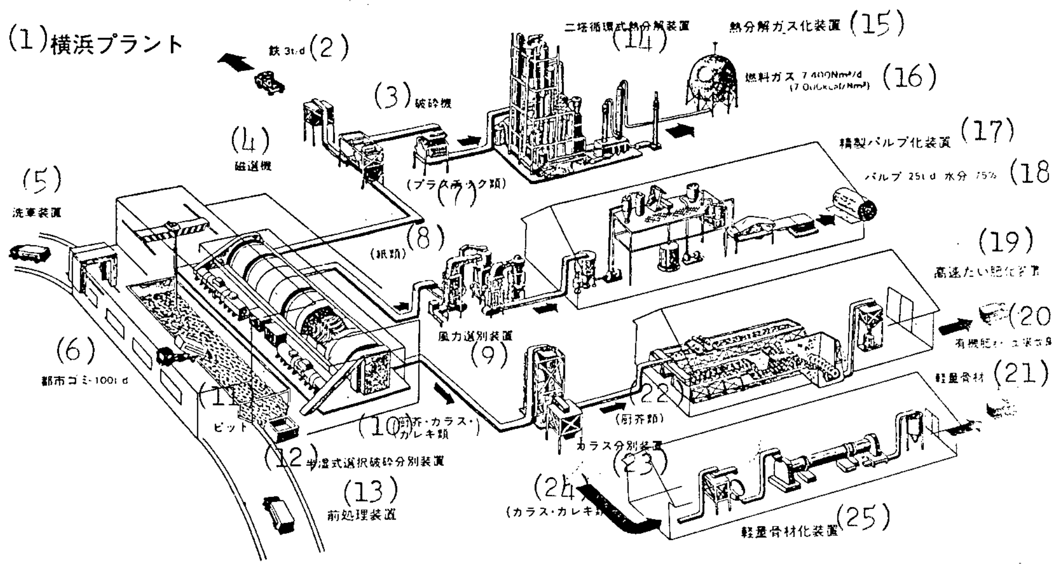
Key:

1. Research and development item
2. Fiscal year 76, 77, 78, 79, 80, 81, 82
3. R&D on resources regeneration and utilization technology system
4. R&D on process subsystem
5. R&D on pretreatment subsystem
6. Research on high-speed composting subsystem
7. Research on pulp-purifying subsystem
14. Evaluation of Resources Regeneration and Utilization Technology System
15. Consignment cost
16. Revision, etc, of various subsystems, comprehensive adjustment, basic design such as basic system design
17. Operational research
18. Plant design and construction
19. Enhancement research
20. Operational research on subsystem

Key to Figure 2 continued

8. Research on thermolytic gasification subsystem
9. Research on methane fermentation subsystem
10. Research on thermolytic oil producing subsystem
11. Research on light aggregate forming subsystem
12. Secondary research
13. System supporting research
21. Operational research on total system
22. Plant design and construction
23. Enhancement of research on oil-producing and methane-forming facilities
24. Plant design and construction
25. Development cost
26. Consignment cost

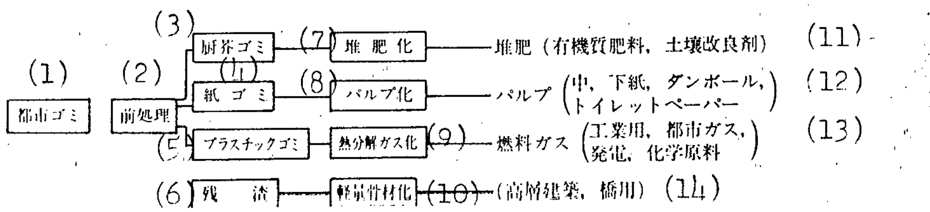
Figure 2. Material Recovery System



Key:

1. Yokohama plant
2. Iron 3 tons/day
3. Crusher
4. Magnetic selector
5. Car washing facility
6. Urban trash 100 tons/day
7. Plastics
8. Paper
9. Air powered separator
10. Garbage, glass, aggregate
11. Pit
12. Semi-wet selection and crushing facility
13. Pretreatment facility
14. Two-tower circulation type thermolytic facility
15. Thermolytic gasification facility
16. Fuel gas 7,400 Nm^3/day (17,000 kcal/Nm^3)
17. Purified pulping facility
18. Pulp 25 tons/day, moisture 75%
19. High-speed composting facility
20. Organic fertilizer (soil conditioner)
21. Light aggregate
22. Garbage, etc
23. Glass separator
24. Glass, solids
25. Light aggregate forming facility

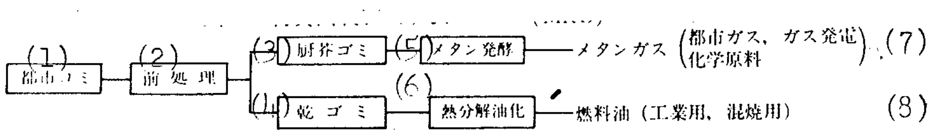
Figure 4. Mass Recovery System Flow (MRS)



Key:

1. Urban trash
2. Pretreatment
3. Garbage trash
4. Paper trash
5. Plastic trash
6. Residue
7. Composting
8. Pulping
9. Thermolytic gasification
10. Light aggregate formation
11. Compost (organic fertilizer, soil conditioner)
12. Pulp (medium-and low-grade paper, corrugated paper, toilet paper)
13. Fuel gas (industrial use, city gas, power generation, chemical raw material)

Figure 5. Energy Recovery System Flow (ERS)



Key:

1. Urban trash
2. Pretreatment
3. Garbage trash
4. Dry trash
5. Methane fermentation
6. Thermolytic oil production
7. Methane gas (city gas, gaseous power generation, chemical raw material)
8. Fuel oil (industrial use, wet combustion use)

2-2 Super-High-Performance Laser Application Composite Production System

(Research and development period: FY77-83; research and development funds: about 13 billion yen)

(1) Background and Object of Research and Development

The production technology for industrial products underwent great development in Japan and various other countries of the world during the 1955 and 1965 decades, particularly in the mass production area represented by automobile and household electrical products, and the machine industry displayed remarkable technological advancement in the area of high-performance automated production and a finishing system characteristic of this transformation.

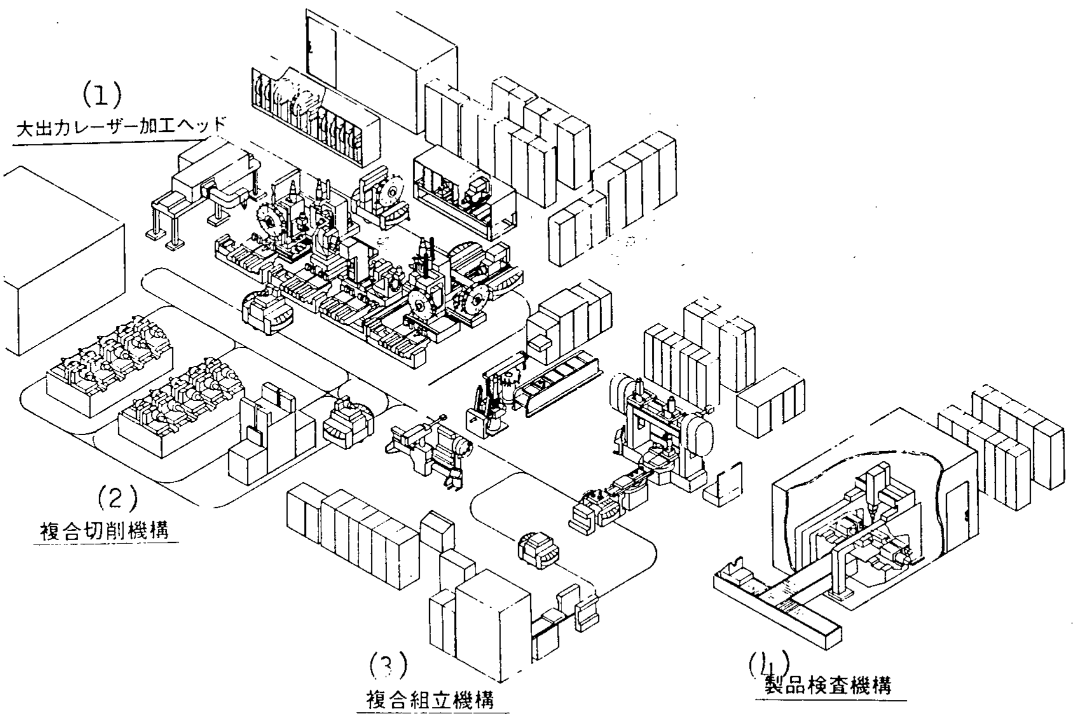
As the 1975 decade began, there was a shift in emphasis in the competition for development of production technology to automated systems for the rapid production of diverse types of small volume products, or in other words, development and application of automated production systems of high flexibility. These changes had as their industrial background the rationalization of the multiple-product, small-volume mode and multiple-variety, diverse-type trends in industrial products, which will be discussed later.

Production modes used in the past depended almost entirely on the work of experienced hands to provide the flexibility demanded by a multiple-item, small-volume production system That is, every time there was a change in the product being manufactured, the flexibility in knowledge of the work provided by the person with technological experience was the only means to respond to such a change. Now, such a production mode naturally was not only difficult to rationalize systematically,but eventually the portion of the work dependent on human effort became disproportionately large even in the matter of partial automation or renovation of the production facility, thus making it difficult to achieve great advances in productivity. When one considers that about 70 percent of the total production in the machine industry is in the area of multiple number, small-volume items, it may be said that the economic effect resulting from the development and practical application of an automated system of high flexibility will be very great. Recently, this diverse production mode has also begun to appear in the area of industrial products which heretofore had been considered to belong to the mass-production area. For example, the automobile was considered a representative example of a mass-production product, but users' demands have been taking varied directions, and now the economic features of a system geared only to the production of a large volume of the same type car are found wanting.

Thus, the introduction of a flexible production mode is becoming increasingly necessary in order to adapt to a situation wherein various types of passenger cars must be produced to respond to the varied demands of the consumer while the number of production lines is decreased.

With this background, the large project "Super-High-Performance Laser Application Composite Production System" was initiated to establish revolutionary production technology for multiple-item, small-volume production.

Figure 6. Conceptual Plan of an Experimental Plant of a Super-High-Performance Laser Application Composite Production System



Key:
1. Large output laser finishing head
2. Composite cutting mechanism
3. Composite assembly mechanism
4. Product inspection mechanism

(2) Outline of Research and Development

The large project "Super-High-Performance Laser Application Composite Production System" covers a 7-year period, from FY-77 through FY-83, with total research and development funds of 13 billion yen. As mentioned before, the objective of this project is the establishment of the technology necessary for the development of a "composite production system which can flexibly and quickly produce multiple-variety, small-volume machine parts.

The function most greatly required in multiple-variety, small-volume production is the "flexible and quick" property, and "flexible" referes to the flexibility by which the production process can be freely altered to accomodate the diverse products to be manufactured; the flexible and rapid treatment functions are considered in a common light in all the research objectives of this project.

There are seven elements of research considered necessary for the development of a composite production system: the total system, cutting and finishing technology, unit part finishing technology, automated assembly technology, laser application technology, automated diagnostic technology, and design and management technology. These various items are outlined below.

(i) Total System

Research will be conducted on making the system design the main activity of the composite production system; a manufacturing design based on the conceptual design and associated facilities of the composite production system experimental plant and the basic design for a practical system for some of the parts suitable for a complex production system will be drawn up.

(ii) Cutting and Finishing Technology

The cutting mechanism used in a composite production system must quickly and flexibly respond to the various products that conceivably can be produced by the system; however, not only are the types of cutting and finishing operations diverse, but the type and number of processes required also vary over a wide range according to the products required. To this end, constituent units called "modular units" will be produced with the same dimensions for the cutting mechanism, and appropriate combinations of these functions in line with functional and finishing space specifications will be used to make up the overall mechanism by the so-called modular mode.

The modular unit construction to be developed for this project will allow the installation or removal of units with the desired functions quickly and automatically in order to provide the desired rigidity, operational functionality, and precision.

The cutting and finishing technology sought will include technology for the composite cutting mechanism, high-level cutting performance technology, general-use mounting technology, and control and driving system for use in these various cutting and finishing operations.

(iii) Unit Part Finishing Technology

The essence of the unit part finishing technology related to multiple-product, small-volume production technology is the development of metal molds of flexible construction and the development of forming technology to finish shapes freely without the use of molds.

An assembly-type metal mold comes to mind as a representative example of the former. When the unitized construction metal mold of the past is applied to multiple-product, small-volume production, a vast number of different molds will be required, and this will require development of a multiple-axis forging technology which makes metal molds of divided construction, involves assembly of combinations of unit shapes to comprise a basic metal mold which fulfills the necessary shape conditions, and uses forming and finishing through a multiaxial forging machine. Where the latter is concerned, any desired shape will be formed without the use of metal mold through the test fabrication of a forging machine with a high degree of freedom, a hot powder forming machine using static hydraulic pressure, and a disk-ring forming machine, as well as the development of highly efficient forming technology.

(iv) Automated Assembly Technology

The important point with regard to the development of automated assembly technology is the need to assure quality equal to or better than that of products assembled by human assembly processes of the past. In contrast, the automated assembly machines in practical use today are sole-use machines capable of only single-assembly operations.

In such a situation, this project seeks to establish automated assembly technology which will be capable of multiple-product, small-volume production which will be a spectacular advancement over the present automated assembly technology of single items. In this case, it will be difficult to adapt the technology of the past which has been geared to the single-process, one-machine concept. That is to say, every effort will be made to get away from the transportation of parts and to develop assembly technology in which composite assembly and finishing of various stages will be performed at one site (station). This assembly technology will include intelligent judgment capability and flexible control capability which will allow the selection of any desired operation, the selection of the optimum tool for the assembly operation, and the ability to exchange tools and functions. To this end, it is necessary to develop the technology to insert, push in, screw in, and automatically position part and tool, and automatically exchange tools together with the technology for automated loading of assembled products onto transporting rigs.

(v) Laser Application Technology

Laser oscillation technology is new: about 20 years have passed since the start of research and development on it. Its application technology is presently being utilized in areas such as measurement, finishing, communication, information processing, and medicine.

The applications of lasers to composite production systems which come to mind include the cutting, welding, and heat treatment of items to be measures or finished. The development of a large output carbon dioxide gas laser for finishing metal materials, its control technology, and the technology for the finishing are necessary to this end.

The development of a 20-kW class oscillator is targeted for the large output carbon dioxide gas laser, and a 5-kW class oscillator was developed as a first step in this direction. The development of various optical parts to be assembled into laser oscillators is also being promoted. In addition, cutting, welding, and surface heat-treatment technology will be established, and the development of a medium-output (300 W) YAG laser suitable for precision finishing will be pursued where laser finishing technology is concerned.

(vi) Automated Diagnostic Technology

The operating state of a production system must be continuously monitored to assure that the quality of the product is maintained in the state the system was designed for, and measures must be taken to repair any abnormality immediately so that the production system will operate normally and will continuously produce the products for which the system was intended. This type of automated diagnostic technology is an indispensible adjunct to the system technology.

This project is involved with the development of malfunction-diagnostic technology, precision compensation technology, and automated inspection technology. First of all, diagnostic methods for tool disbursing and tool edge location correction technology must be developed in order to compensate for tool location where precision compensation technology for the diagnostic mode for turning, hole drilling, or milling finishing systems are concerned. At the same time, the traversing technology of sensors which are the main constituent parts, rotational precision detection technology, and vibrational noise detection technology must be developed where automated inspection technology is concerned.

(vii) Design and Management Technology

Regarding the automated design technology required for a composite production system, a program to convert to numerical form shape and structural values which are the basic functions of the automated design treatment mode, a part diagram display program related to shape, and a parts information management program will be developed. At the same time, algorithms for selection of the optimum finishing process for products and basic programs for process design will be developed in the area of management technology.

(3) Status of Advances in Research and Technology

As mentioned before, this project is a complete program for the production of multiple-type, small-volume machine parts, starting with the metal, in which research and development on the seven items which comprise the technology necessary to the development of a "composite production system" is being carried out to produce these products flexibly and rapidly.

Test production research and experimental research were conducted on element technology such as the constituent mechanisms indispensable to this composite production system architecture up to FY-80, and the basic technology for the design of an experimental plant based on this basic technology was drawn up in FY-81; and production design drawn up the previous year will be the basis for the principal constituent mechanisms--composite cutting mechanisms, composite assembly mechanisms, and automated inspection mechanisms--which will be produced in FY-82. At the same time, an experimental building will be constructed for installation and operational research on the experimental plant.

(4) Results Expected of the Research and Development

The following are the results which are expected to be obtained from the development of this project.

(i) Technological Leadership

Technological leadership targeted by this project is expected in the following areas.

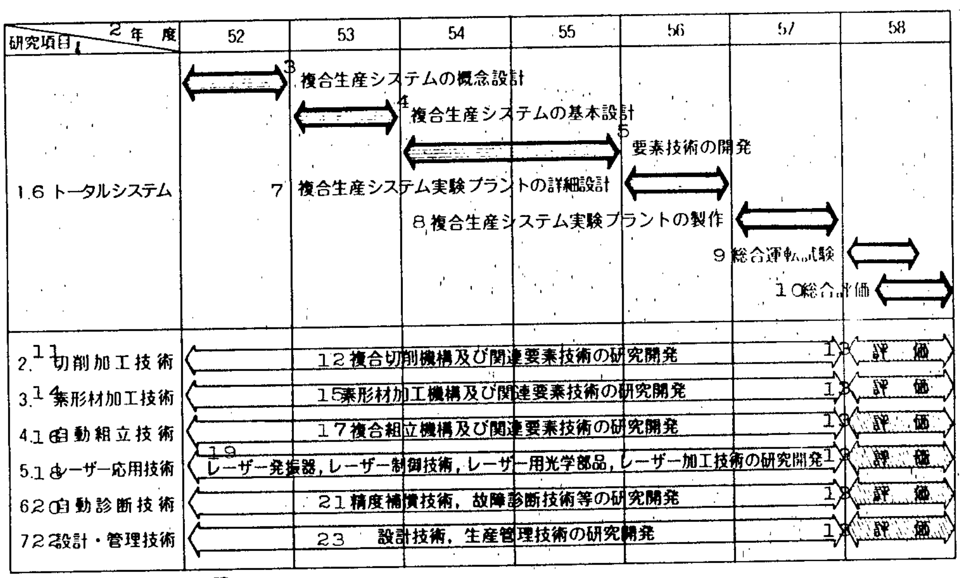
(a) Application of the laser to the machining of metals to enable automated finishing through a composite production control system.
(b) Complete automation of composite assembly and finishing.
(c) Automation of product inspection and feedback of inspection data online to the finishing process.

(d) Coupling and systematization of the production process from machining to inspection.

(ii) Expected Results

(a) The exploitation of machine technology and electronic technology to introduce maximum automation of multiple-type, small-volume production of precision parts or special parts, thereby developing systems that will operate around the clock with a minimum of manpower.
(b) Adequate utilization of the high-speed finishing capability of a laser to greatly increase productivity.
(c) Compensation for the lack of experienced workers in the machine industry and improvement of the working environment where dirty work and hazardous operations are involved.
(d) Medium-size and small industries can freely select or discard according to need the finishing technology, assembly technology, and laser application technology which make up this system.
(e) Roughly 70 percent of the total production in the machine industry which multiple-type, small-volume production accounts for can utilize this system technology.

Figure 7. Research and Development Schedule for Laser Application Compsite Production System



Key:
1. Research item
2. Fiscal year 77, 78, 79, 80, 81, 82, 82
3. Conceptual design of composite production system
4. Basic design of composite production system
5. Development of element technology
6. Total system
7. Detailed design of composite production system experimental plant

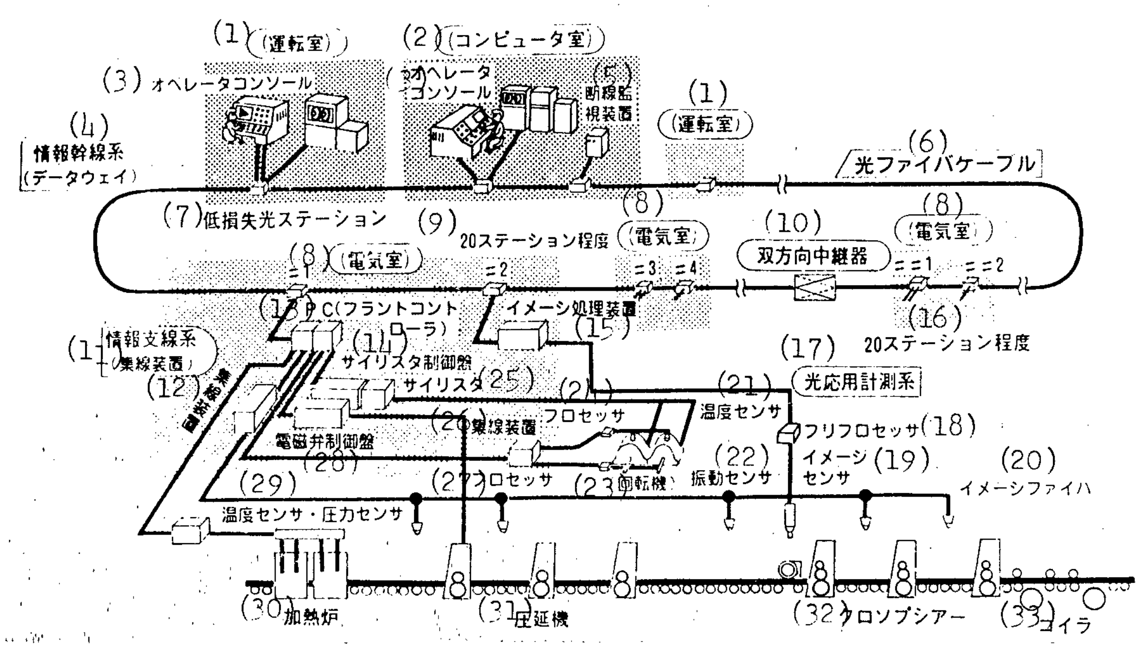
Key to Figure 7 continued

8. Construction of composite production system experimental plant
9. Overall operational experiment
10. Overall evaluation
11. Cutting and finishing technology experiment
12. Research and development on composite cutting mechanism and related element technology
13. Evaluation
14. Shaping and finishing technology
15. Research and development on shaping and cutting mechanisms and related element technology
16. Automated assembly technology
17. Research and development on composite assembly mechanisms and related element technology
18. Laser application technology
19. Research and development on laser oscillators, laser control technology, optical parts for laser use, laser finishing technology
20. Automated diagnostic technology
21. Precision compensation technology, malfunction diagnostic technology research and development
22. Design and management technology
23. Research and development on design technology, production management technology

2-3 Light Application Measurement Control System

(Research and development period: FY79-86; research and development funds: about 18 billion yen)

Figure 8. Conceptual Diagram of Light Application Measurement Control System (High-Speed Process Information Subsystem)



Key to Figure 8

1. Operating room
2. Computer room
3. Operator console
4. Information trunk line (data path)
5. Broken line observation device
6. Optical fiber cable
7. Low-loss optical system
8. Electrical room
9. About 20 stations
10. Two directional relay
11. Information branching system (consolidation device)
12. Wire consolidation device
13. PC (plant controller)
14. Thyristor control panel
15. Image treatment device
16. About 20 stations
17. Light application measurement system
18. Preprocessor
19. Image sensor
20. Image fiber
21. Temperature sensor
22. Vibration sensor
23. Rotator
24. Processor
25. Thyristor
26. Wire consolidation device
27. Processor
28. Magnetic valve control panel
29. Temperature sensor, pressure sensor
30. Heating furnace
31. Rolling machine
32. Clone pusher
33. Coiler

(1) Background and Object of Research and Development

The object of this project is the development of the technology necessary to make practical systems capable of safe and stable measurement, transmission, and control of large volumes of information including graphic information in the presence of adverse environmental factors such as electromagnetic induction and flammable gases that are generated in social systems around large-scale industrial plants including the chemical industry and steel industry, industrial parks, and large office buildings in matters pertaining to business, traffic, and regional information.

The wire communication mode employed in the past used communication (transmission) cables made from material such as copper for current relaying information signals in analog or digital form by voice or graphics to transmit the desired information.

In contrast, a measurement and control system which uses light utilizes glass fiber (fibrous glass) in place of a communication cable (electric wire) and light (laser beam) in place of electrical current.

Transmission systems utilizing light have been introduced in recent years in power plants, communication systems, and plants, but these have mainly been introduced as anti-electromagnetic measures and do not incorporate technology to directly transmit graphics (in a space-parallel manner rather than a time-series manner). At the same time, the light source is almost invariably LED (light emitting diode), which does not possess the coherent nature (property of light to display a single wavelength and direction) of LD (laser diode), so high-speed, large-volume information transmission is not possible. In addition, the transmitting and receiving equipment consists of assemblies of separate individual elements, which results in the equipment being bulky and cumbersome.

The aim of this project is the practical development of a system which keys in on a laser with sufficient coherence to enable the development of a new semiconductor laser (LD) together with a new photoelectric integrated circuit incorporating LD, to end up with a system that incorporated small, highly reliable elements.

A measurement and control system utilizing light possess the feature listed in Table 1. It can be applied to the various sytems listed in which measurement and control are not possible because of various physical limiting factors, thereby exploiting its capabilities.

This project, which is an 8-year plan starting in 1979 and terminating in 1986, will be funded for a total of about 18 billion yen. The research and development schedule is given in Figure 9.

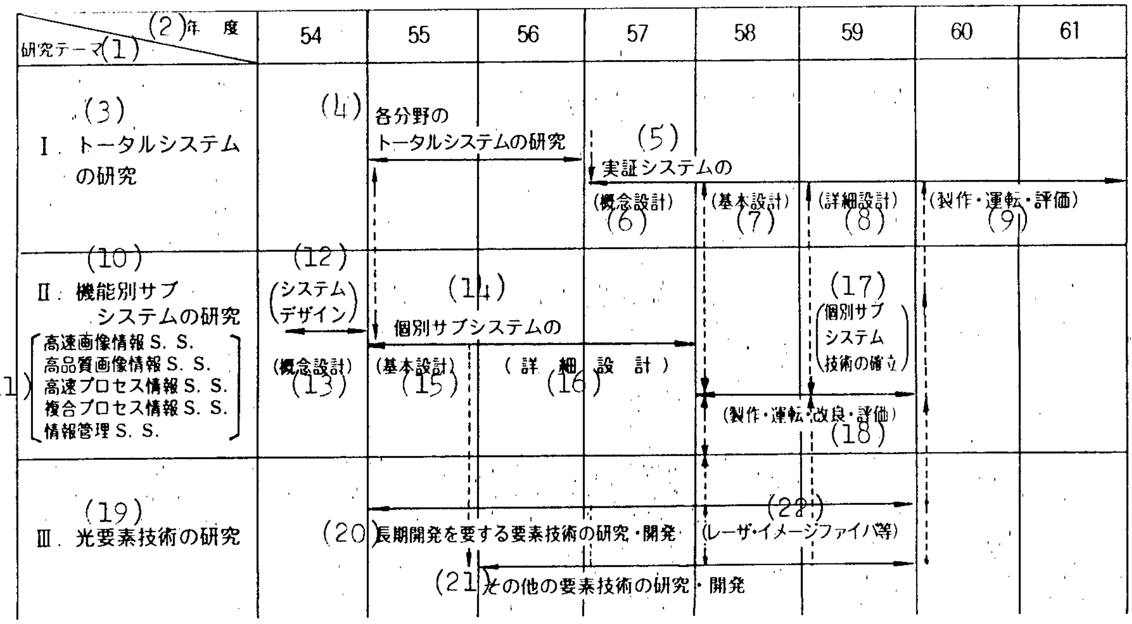
Table 2. Features of a Measurement and Control System Utilizing Light

(1) メリットと主な考察要因	(2) 機 能 特 徴
A. 光を使うことによるもの (3)	電磁誘導障害なし ショートなし スパーク発生なし アース設計容易 漏話なし 伝送容量が大きい 送受信系が小型 電波法の規制なし (4)
B. ファイバを使うことによるもの (5)	非電導性 軽 い 細 い 曲げやすい 耐火性 耐水性 耐腐食性 低損失 省資源 可視光を送れる 漏洩防止が容易 (6)

Key:

1. Principal merit factors to be considered
2. Functional features
3. Factors associated with use of light
4. No electromagnetic induction effects, no shorting effects, no spark generation, ready grounding, no dialogue leakage, large transmission volume, small transmission system, no restrictions due to radio laws
5. Factors resulting from the use of fiber
6. Nonelectroconducting, light, slender, readily bendable, fireproof, waterproof, corrosion resistant, low loss, conservation of resources, visible light can be transmitted, easy to protect against leakage

Figure 9. Research and Development Schedule for the Light Application Measurement and Control System



Key:

1. Research theme
2. Fiscal year 79, 80, 81, 82, 83, 84, 85, 86
3. I. Research on total system
4. Research on total system of each area
5. Demonstration system
6. Conceptual design
7. Basic design
8. Detailed design
9. Fabrication, operation, evaluation
10. II. Research according to functional subsystem
11. High-speed graphic information S.S., high-quality graphic information S.S., high-speed process information S.S., composite-process information S.S., information management S.S.
12. System design
13. Conceptual design
14. Separate subsystem
15. Basic design
16. Detailed design
17. Establishment of technology for each subsystem
18. Fabrication, operation, modification, evaluation
19. III. Research on optical element technology
20. Research and development on element technology requiring long-term development
21. Research and development on other element technology
22. Laser image fiber, etc

(2) Outline of Research and Development

As described above, this system is intended to establish a general-use system technology which can be used in various systems. The entire program is divided into the five subsystems: two related to graphics, two related to process information, and one related to information mangement. The development of optical technology necessary to the development of new transmission and reception optical elements is under way. At the same time, experiments and demonstrations are being conducted on the total system to develop demonstration systems which are combinations of subsystems technology of different functions.

These are outlined below.

(i) Research on the Total System

The application status of applied optical measurement and control systems in the area of plants, businesses, and social systems has been researched, and the results of such studies are the basis for the design, production, and operation of demonstration systems combining the functional subsystems discussed below, whereby the technology necessary for the practical use of applied optical measurement and control systems will be demonstrated.

(ii) Research on Functional Subsystems

(a) High-Speed Graphic Information Subsystem

The object of this subsystem is to make practical a system which effectively utilizes graphic information which is not projectable by TV cameras and similar equipment but which can be directly measured and transmitted at high speed, as well as a system capable of several monitoring steps to provide information on the state of the equipment and the environment.

(b) High-Quality Graphic Information Subsystem

The object of this subsystem is to develop a system which effectively collects graphic information and processes, records, assigns, and displays the information at any desired site on a 1,000 x 1,000 high-quality graphic element display chart for the control and operation of equipment.

(c) High-Speed Process Information Subsystem

The object here is a system which collects and transmits information at high speed from a number of sensors and actuators of the same type using a data pathway mode to collect, transmit, and process control 20 or more locations without the use of relays.

(d) Composite Process Information Subsystem

The purpose of this subsystem is to make practical a system which collects and transmits information from several sensors and actuators simultaneously, utilizing a multiple-wavelength overlapping transmission mode with 20 or more parallel channels to collect and transmit the composite information and exercise process control.

(e) Information Management Subsystem

The object is to develop a practical system which is comprised of a transmission network of high reliability and a high degree of freedom and which in combination with other functional subsystems will make possible information management at a speed greater than 1 Gb/s.

(iii) Research on Optical Element Technology

Development will be promoted on optical element technology necessary to the fabrication of various functional subsystems and demonstration systems. Development of the following will be promoted: visible light LD, high output LD, wavelength control LD, ultra-high-speed modulated LD, and a multichannel highly integrated optical switch in the transmission and reception optical element related area; direct graphic transmission paths (visible bundle fiber) and infrared transmission paths (infrared fiber) in the fiber related area; various optical switches in the optical circuit element related area; and temperature sensors, pressure sensors, and flow rate sensors in the sensors and actuators related area. In addition, research will be promoted on common technology for the production of photoelectron integrated circuits (OEIC).

(3) Domestic and Foreign Research and Development Status

There appears to be no other concentrated research and development effort on optical technology similar to this project elsewhere in the world. To be sure, there are a number of similar research and development projects where individual element technology is concerned. The information transmission sector appears to be the area of greatest activity. Research and development is very active in the comparatively monofunctional area of long-distance transmission with optical fibers using electrical signals converted to optical signals in place of the transmission of electrical signals over metal cables both in this country and abroad, and this is an area which is already evaluated as being highly economical. This is an area in which Nippon Telegraph and Telephone [NTT] Public Corporation and Kokusai Denden in Japan, the Bell System (USA), and various electrical communication organs in other countries are actively promoting development. In addition, the development of a new social information system possible only with optical technology is being promoted; examples in this country include the HIOVIS (living graphic information system) supported by the Ministry of International Trade and Industry and the CAPTAIN system of NTT. Research and development is being promoted in the United States (CATV related companies), the UK, and Canada.

(4) Research and Development Progress Status

The basic plan was established in FY-79 together with a call for participants, those areas of optical technology and plant design and control system with demonstrated capability and potential were selected, and the conceptual design of each functional subsystem and trends in various types of optical element technology were subjected to consigned research. This research was aimed at clarifying the system concept necessary to the respective subsystems discussed above as well as extracting basic functional data on the necessary element technology, taking into consideration trends in various types of optical element technology.

The basic design based on the conceptual design drawn up the preceding year was used to plan the various functional subsystems in FY-80, while research was conducted on systems in the aforementioned three areas where research on the total system was concerned. In the area of optical element technology, research and development was initiated on the seven-element technology--visible light LD, high output LD, wavelength control LD, super-high-speed modulated LD, multichannel highly integrated optical switch, direct graphic transmission pathway, and infrared fiber--necessary for this project.

At the same time, research on short wavelength LD, environment resistant optical element, super-low-loss fiber, magnetic optical element, and multifunctional optical control element related to this project is under way at the Electrotechnical Laboratory (Densoken) of the Agency of Industrial Science and Technology, together with initiation of basic research on the self-bonding effect of semiconductor laser, high-quality element technology, light-conducting wave-control technology, material evaluation technology for optical elements, and quadruple lens electron beam exposure technology.

Total system research was continued in FY-81, together with the drawing up of a detailed design of functional subsystems.

In the area of optical element technology, research at the Electrotechnical Laboratory was continued, while research on optical pressure-flow rate sensor, optical temperature sensor, wavelength sweep type optical digital sensor, hologram graphic scanner, optical control type optical switch, and optical gate array element was newly taken up through consignment.

In addition, on 1 October 1980 the Optical Technology Joint Laboratory was established by the Optical Application System Technology Research Group to develop optical electron integrated circuits (OEIC), and research was initiated on the following common technologies necessary for the practical development of OEIC to serve as nuclei for this program (see Figure 10).

(i) Research on Baseplate Crystal Growth Technology

The aim is to develop technology to draw out high-quality, and high-purity crystals to be used as compound semiconductor crystal baseplates for use in new functional devices (OEIC) with highly integrated optical and electron elements. Success in computer-controlled crystal drawing of GaAs was attained in January 1982.

(ii) Research on Selective Doping Crystal Growing Technology

This is a program aimed at developing technology to add impurity (doping) to a certain point on the surface of a baseplate on which OEIC is placed.

(iii) Research on Growth Technology for Layer Integrated Crystals

The object of this program is to develop technology for layering thin membranes of different materials to achieve highly integrated optical and electron elements which are the basic constituent elements of OEIC.

(iv) Research on Interfacial Application Technology

The object is development of technology to produce elements (such as electric field effect transistors) with physical phenomena applied at the interface of metal and compound semiconductors.

(v) Research on Compund Semiconductor Finishing Technology

The purpose is to develop finishing treatment technology including ion injection, annealing, and dry etching to perform fine pattern finishing of compound semiconductors for OEIC use.

(vi) Research on Material Evaluation Technology

The purpose is to develop technology for the evaluation of the crystal quality of a compound semiconductor crystal baseplate for OEIC use and thin membranes.

A conceptual design of the demonstration system will be drawn up for the total system in FY-82, while functional subsystems research, including detail design, will be continued.

At the same time, research on optical element technology will be continued at the Electrotechnical Laboratory, while research will be newly initiated on environment-resistant measurement cables which will be added to the research subjects already consigned. Emphasis will be placed on the research on common technology in optical elements that is under way at the Optical Element Joint Laboratory.

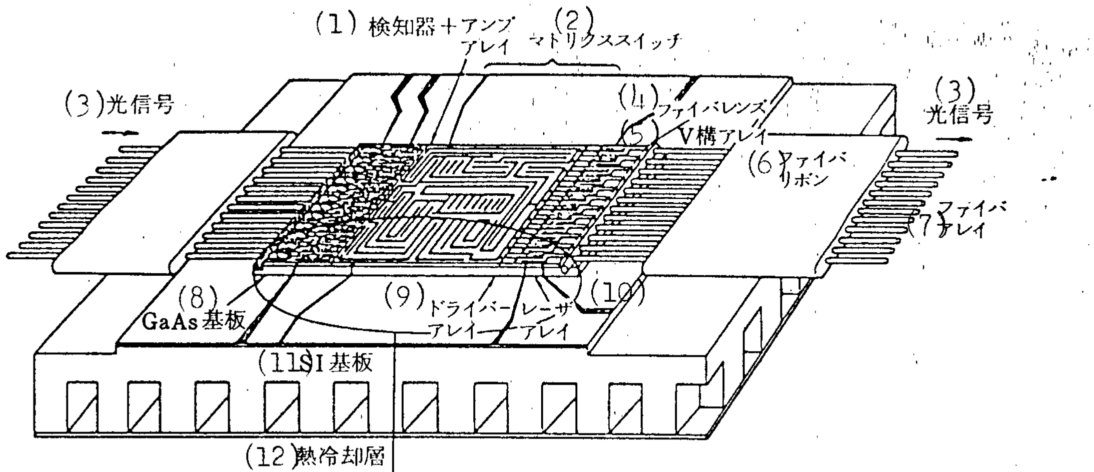
Here, OEIC is an acronym for opto-electronics integrated circuit; it refers to optical elements and electronic elements integrated on the same baseplate and concerns mainly compound semiconductor elements (such as gallium arsenide, GaAs).

(5) Future Direction in Research and Development

The conceptual design, basic design, and detailed design of the total system will be drawn up, after which the fabrication of the demonstration system, operation, and evaluation will be conducted to demonstrate the usefulness of an optical application measurement and control system where the total system is concerned.

Research on functional subsystems will concern conceptual design, basic design, and detailed design. In addition, fabrication, operation, and evaluation of an experimental-scale system will be conducted to demonstrate the functional nature of each subsystem to be used in the fabrication of the total system.

Development of element technology already under way will be continued, while element technology necessary for the various functional subsystems and the total system (demonstration system) will be developed as well.



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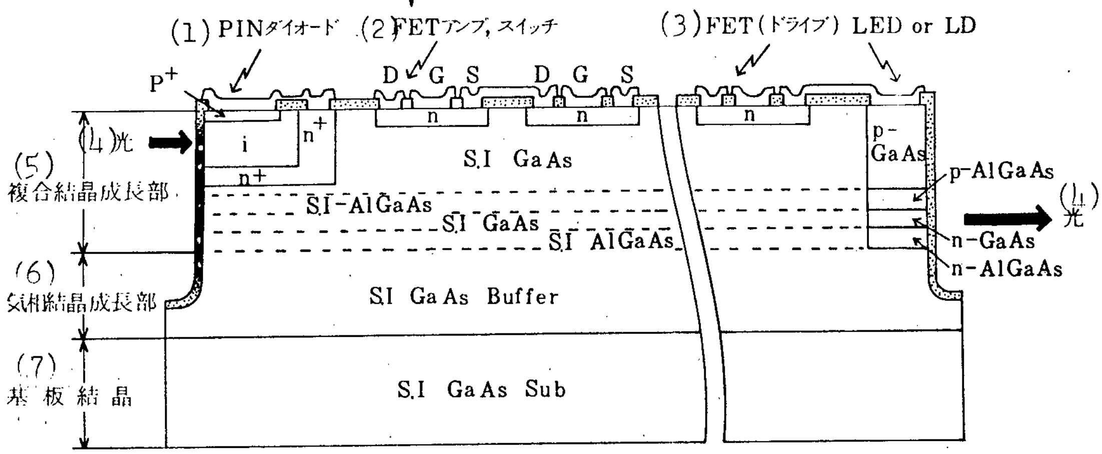


Key:

/Upper Figure/

1. Detector + amp array
2. Matrix switch
3. Optical signal
4. Fiber lens
5. V groove array
6. Fiber ribbon
7. Fiber array
8. GaAs baseplate
9. Driver array
10. Laser array
11. SI baseplate
12. Heated and cooled layer

/Lower Figure

1. PIN diode
2. FET amp, switch
3. FET (drive)
4. Light
5. Composite crystal growth section
6. Vapor phase crystal growth section
7. Baseplate crystal

2-4 Methods of Manufacturing Basic Chemicals Using CO, etc, As Raw Material

(Research and development period: FY 80-87; research and development funds: about 15 billion yen)

(1) Background and Purpose of Research and Development

Japan's petrochemical industry uses naphta (oil distillate) as the starting material for the production of industrial-use products such as ethylene glycol and acetic acid, as well as basic chemicals (petrochemical products) indispensable to the people's standard of living.

On the other hand, the sharp increase in the cost of oil during the two oil shock periods of 1973 and 1979 brought about major changes in the world's attitude toward energy, and the limitations in oil supply became evident.

Since then, stagnation of the world's economic situation, reflecting the effects of factors such as the high price of oil, has resulted in international demand for following a path of adjustment leading toward reducing the use of oil on a quantitative basis. On the other hand, it can be expected that for the medium and long term, there will be an increase in demand as the economy improves, leading to a new look at the oil situation, and cyclical and structural demand pressure will intensify. Qualitatively, the oil imported into Japan is shifting to heavier types. These trends are expected to intensify from here on.

In this situation, it will become necessary to establish technology for the utilization of raw materials so that it will be possible to assure a low cost and a stable supply of the basic chemicals necessary to the industrial world and the people's standard of living over the long term and to actively work toward shifting to a raw material other than naphtha for the petrochemical industry. Naphtha substitutes which come to mind are heavy distillates of oil and oil substitutes; the oil substitutes available in large quantities include coal, natural gas, byproduct gas from steelmaking, and oil shale.

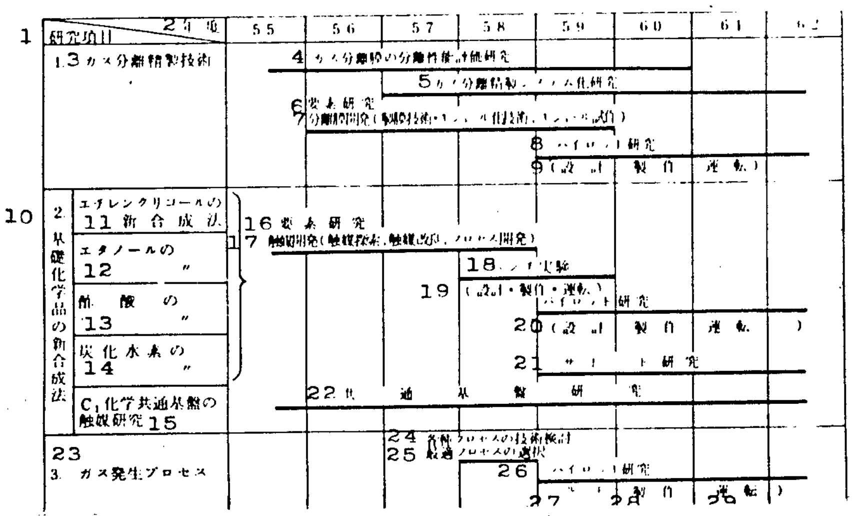
At the present time, there is essentially no technology that allows the direct use of these carbon resources as chemical raw materials. On the other hand, the heavy cut from oil or coal-type substitute carbon resources can be reacted with air or steam to readily produce carbon monoxide and hydrogen as the principal product gases. This product gas can then be separated into the respective gases and purified, after which they can be reacted in appropriate proportions to produce directly or, by way of methanol, industrially desirable products such as ethylene glycol, ethanol, acetic acid, or various hydrocarbons.

Research and development in this area has been conducted for some time in the leading countries of the West as a means to diversify the raw materials and disengage from dependence on oil. This is why it is thought that it is vital for Japan to nurture its own self-developed technology through its own independent research and development program.

(2) Outline of Research and Development

The aim of this project is to establish a new production technology for manufacturing basic chemicals such as ethylene glycol, ethanol, acetic acid, and various hydrocarbons using carbon monoxide as one of the raw materials; the specific details are described below. (see Figure 11).

Figure 11. Technology Development Flow Chart for Method To Manufacture Basic Chemicals with Carbon Monoxide as Raw Material



Key:

1. Research item
2. Fiscal year 80, 81, 82, 83, 84, 85, 86, 87
3. Gas separation and purifiction technology
4. Evaluation research on separation capability of gas separation membrane
5. Systematization research on gas separation and purification
6. Element research
7. Separation membrane development (membrane production technology, modulization technology, module test production)
8. Pilot research
9. (Design, production, operation)
10. New synthetic methods for basic chemicals
11. New synthetic method for ethylene glycol
12. New synthetic method for ethanol
13. New synthetic method for acetic acid
14. New synthetic method for hydrocarbons
15. Research on catalysts as common base for C_1 chemistry
16. Element research
17. Catalyst search, catalyst improvement, process development
18. Bench tests
19. Design, fabrication, operation (pilot research)

Key to Figure 11 continued

20. Design, fabrication, operation
21. Support research
22. Common basic research
23. Gas generation process
24. Technological study of various processes

(3) Progress Status of Research and Development

Research and development on this project was initiated in FY-80.

The preliminary research necessary for embarking on actual research on new methods of synthesis of basic chemicals and gas separation and purification technology was started in FY-80 (such as standard methods of analysis of the reaction products).

The following research on new methods of synthesis of basic chemicals was conducted during FY-81.

A. New Synthetic Methods for Basic Chemicals

(i) New Synthetic Methods for Ethylene Glycol

Research was initiated to find catalysts for direct liquid phase and direct vapor phase methods for the synthesis of ethylene glycol using a rhodium family catalyst and a nonrhodium family catalyst.

(ii) New Synthetic Methods for Ethanol

Research was initated to find catalysts for direct vapor phase and direct and indirect liquid phase synthesis of ethanol using rhodium family and nonrhodium family catalysts.

(iii) New Synthetic Methods for Acetic Acid

Research was initiated to find catalysts for the direct vapor phase synthesis of acetic acid using rhodium and nonrhodium family catalysts.

(iv) New Synthetic Methods for Hydrocarbons

Research was initiated to find catalysts for the direct vapor phase synthesis and indirect vapor phase of hydrocarbons using metal family, regular structure, zeolite type, and modified zeolite catalysts.

(v) Catalyst Research Common to C_1 Compounds

Studies were initiated to clarify the relationship between the method of preparing a catalyst and its activity or selectivity as well as on the effects of carbon dioxide on catalyst activity.

2. Gas Separation and Purification Technology

(i) Research on Evaluation of Separation Capability and Improving Performance of Gas Separation Membranes.

Permeation tests will be conducted using single gases on each type membrane, and separation tests on mixed gases will be initiated.

(ii) Research on Production of Gas Separation Membranes

Tests were initiated on wear-resistant properties of membrane material and studies on manufacturing conditions for membrane materials of a preliminary nature necessary for research on the manufacture of porous inorganic membranes, porous organic membranes, and nonporous organic membranes.

Promising catalysts discovered in the previous year's studies on new synthetic methods for basic chemicals will be used in research to improve catalyst performance in the 1982 program on new synthetic methods. At the same time, newly obtained information will be the basis for research to seek other new catalyst systems.

The conditions associated with the manufacture of flat membranes of organic nature for use in gas separation and purification technology will be established, and conditions for the manufacture of hollow fiber membranes will be studied. Studies will be conducted on the adhesive behavior between a binding agent and a hollow fiber membrane preliminary to studied on the modulization of inorganic membranes. In addition, research will be conducted on evaluation of the performance of membranes and improvement of their properties.

Future research and development activities in new synthetic methods will include a 3-year plan (up to the end of FY-83) for catalyst search research, prospective catalysts for bench studies will be selected through 1983, bench-scale experiments will be conducted starting in FY-83, and demonstration tests will be conducted with a pilot plant.

Membrane production technology will be established along with modular technology in the area of gas separation and purification technology to lay the groundwork for development of high-performance gas separation membranes. At the same time, these results will be utilized to develop gas separation and purifications systems and to conduct demonstration experiments with a pilot plant.

(4) Results Expected of Research and Development

Some direct effects of research and development on new synthetic methods for basic chemicals will be the ability to utilize heavy oil from petroleum as the raw material to replace expensive naphtha, exploit the availability of oil substitutes such as coal or oil shale, and the effective utilization of steelmaking byproduct gas--a hitherto unused resource--for the production of petrochemical raw materials, thereby paving the way for the diversification of raw materials for the petrochemical industry away from naphtha.

The present petrochemical processes using naphtha involve complex production systems which produce various byproducts, and it is very difficult to increase the production of a single item. Now, the development of C_1 chemistry will make it possible to alter at will the yield of any given product and to produce products in line with demand.

Third, C_1 chemistry enables the establishment of individual production systems and also makes possible the supply of combinations such as ethylene and propylene which can be tied in with present petrochemical production systems, enabling the setting up of production systems of great flexibility which will not be entrapped in present industrial combine form.

Fourth, an indirect extension effect will be the promotion of research on catalysts for C_1 chemistry which will be expected to improve the fundamental technology in catalyst research and to promote resources and energy conservation technology.

The direct effects from gas separation and purification research include energy saving effects at all stages of the membrane separation method compared to chemisorption methods, absorption separation methods, and deep freeze methods presently in use. The membrane to be developed will be required to possess heat resistance of more than 100-400° C, and once this requirement is fulfilled, high-temperature gases produced by C_1 chemical processes can be separated and purified without cooling and then directly used in the next reaction, thereby enabling a double energy conservation effect.

A third indirect extention effect will be the ability of the separation membrane of this project not only to make component adjustment of hydrogen and carbon monoxide but also to be applied to the production of pure hydrogen and pure carbon monoxide and even to the production of membrane for oxygen enrichment.

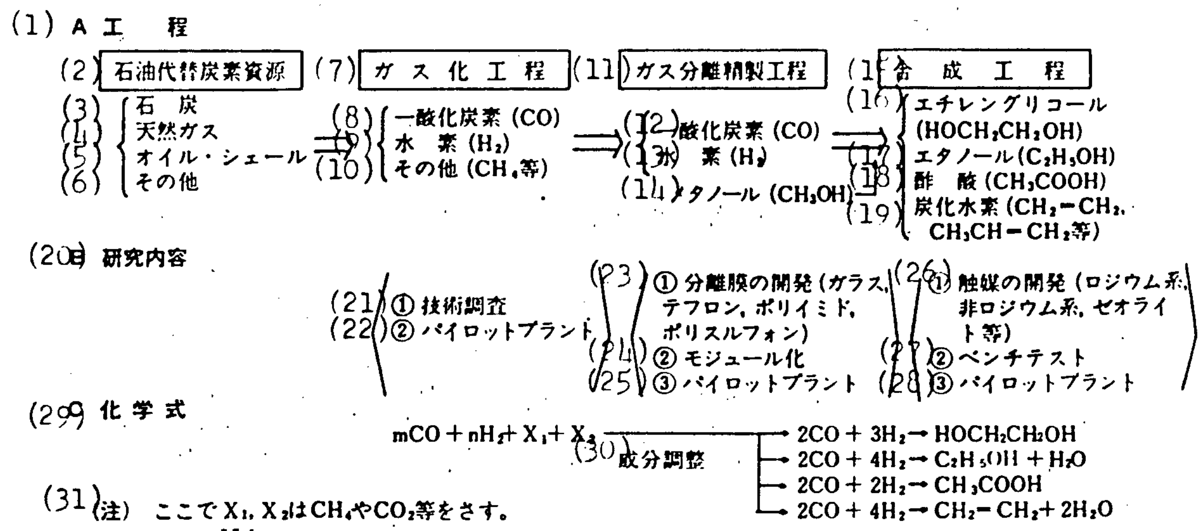
Some overall effects of C_1 chemical technology that can be expected are as follows:

The first effect is the utilization of low-cost coal resources as napththa or oil substitute, and the stabilized supply of basic chemicals through energy conserving processes to provide the people's necessities.

A second effect will be the development of C_1 chemistry within the petrochemical industry, which inevitably undergoes sharp changes in structure due to the sudden increases in price after each oil crisis and the uncertain status of the energy picture, to activate the industry.

A third effect will be the use of technology developed in this project by other countries, which also are being confronted with sharp structural changes resulting from the present world economy, to aid in assuring Japan a safeguard where economic stability is concerned.

Figure 12. Research and Development Schedule for Methods of Manufacturing Basic Chemicals from Raw Materials Such as Carbon Monoxide



Key:

1. A. Process
2. Oil substitute carbon resource
3. Coal
4. Natural gas
5. Oil shale
6. Other
7. Gasification process
8. Carbon monoxide (CO)
9. Hydrogen (H_2)
10. Others (such as CH_4)
11. Gas separation and purification process
12. Carbon monoxide (CO)
13. Hydrogen (H_2)
14. Methanol (CH_3OH)
15. Synthetic process
16. Ethylene glycol ($HOCH_2CH_2OH$)
17. Ethanol (C_2H_5OH)
18. Acetic acid (CH_3COOH)
19. Hydrocarbons (such as $CH_2=CH_2$, $CH_3CH=CH_2$)
20. B. Contents of Research
21. Technology survey
22. Pilot plant
23. Development of separation membranes (glass, teflon, polyamides, polysulfones)
24. Modulization
25. Pilot plant
26. Development of catalysts (rhodium family, nonrhodium family, zeolites, etc)
27. Bench test
28. Pilot plant
29. C. Chemical nature
30. Component regulation
31. Here X_1 and X_2 indicate CH_4, CO_2 and similar compounds

2-5 Manganese Nodule Collecting System

(Research and development period: FY 81-89; research and development funds: about 20 billion yen)

(1) Background and Purpose of Research and Development

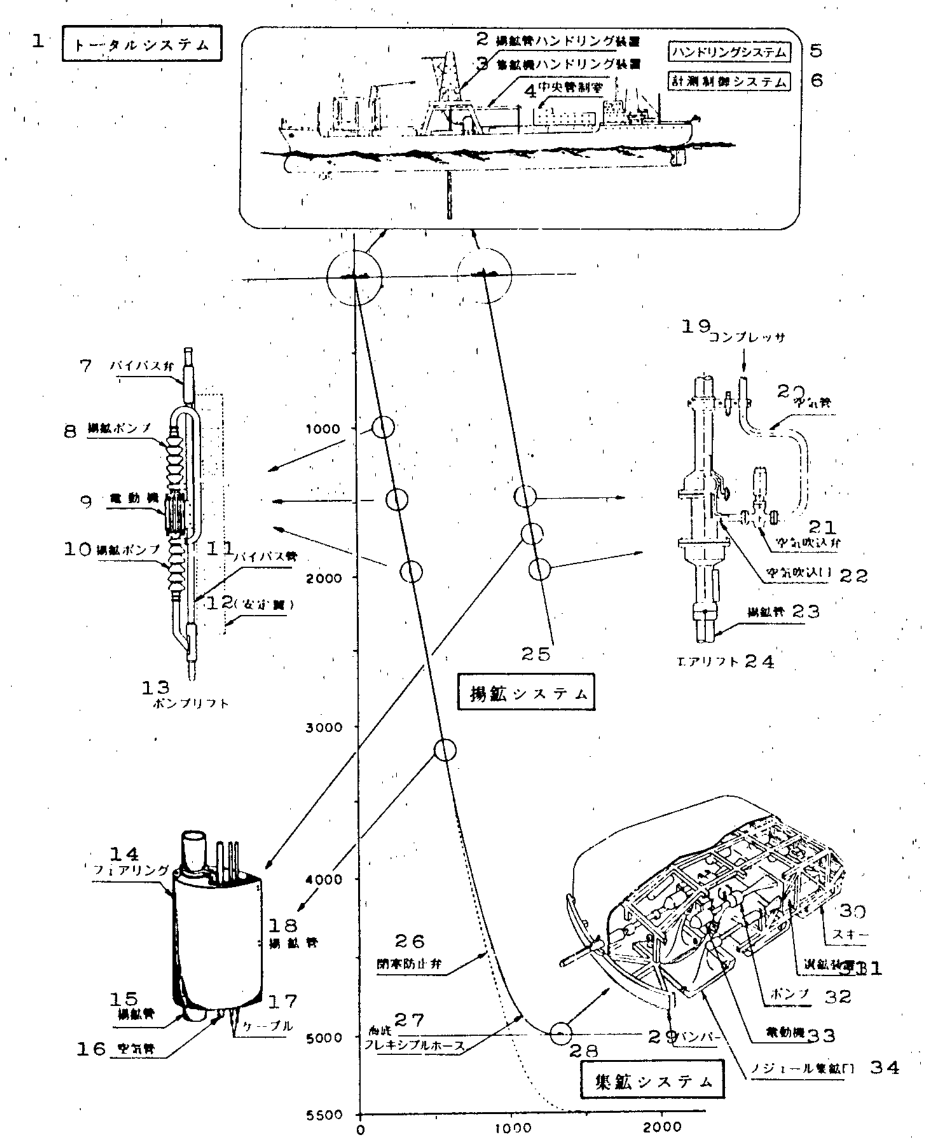
The manganese nodules which are found in profusion at the great depth of 4,000-6,000 meters on the ocean bottom are rich in nickel, copper, cobalt, and manganese-type heavy metals and represent stable resources of a quasinational nature unaffected by resources nationalism. As a result, Japan, which has to depend almost completely on outside sources for its necessary nonferrous metals, considers it important to develop manganese nodule collection technology as a stable supply source.

The exploitation of manganese nodules is a subject which is being deliberated by the UN Law of the Sea Conference, and the premise has been established that any country or private industry which seeks to acquire development rights must possess the technological capability to collect this resource and transfer the technology to international organs and similar groups. The development of ore-collecting technology aimed at the commercial development of collection efforts to be initiated near the start of the 1990's decade is being promoted in the leading countries, and there is a need for Japan to quickly initiate development of technology for a manganese nodule collection system.

(2) Outline of Research and Development

This research and development is concerned with the development of a liquid dredge type mineral collection system of high efficiency and reliability to collect manganese nodules on a commercial scale from the deep sea bottom (see Figure 13).

Figure 13. Conceptual Diagram of Manganese Nodules Collection System



Key:

1. Total system
2. Handling equipment for ore lifting tube
3. Handling equipment for ore collection
4. Central tube control room
5. Handling system
6. Measurement and control system
7. Bypass valve
8. Ore lifting pump
18. Ore lifting tube
19. Compressor
20. Air tube
21. Air injection valve
22. Air injection port
23. Ore lifting tube
24. Air lift
25. Ore lifting system
26. Clogging prevention valve
27. Sea bottom flexible hose

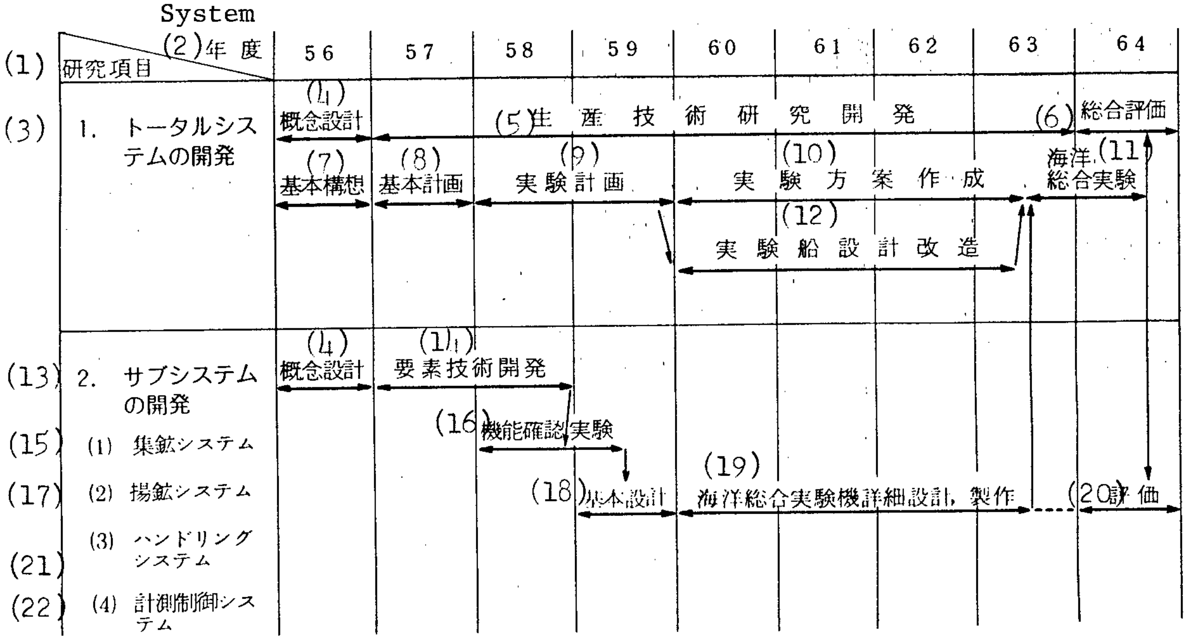
Key to Figure 13 continued

9. Electric motor
10. Ore lifting pump
11. Bypass valve
12. Safety vane
13. Pump lift
14. Fairing
15. Ore lifting tube
16. Air tube
17. Cable
28. Ore collection system
29. Bumper
30. Ski [phonetic]
31. Ore selection equipment
32. Pump
33. Electric motor
34. Nodule collection port

This system is comprised of the total system of the four units which are the ore collection system, the ore lifting system, the handling system, and the measurement and control system, and these systems will be systematized to complete a well-coordinated ore collection system (see Figure 14).

A conceptual design will be drawn up for the total system, followed by research and development on production technology such as system operation technology, ore-collection control technology, and maintenance-control technology, while experimental plans for a comprehensive marine experiment will be drafted. The conceptual design for each subsystem will be followed by development of element technology and performance demonstration tests to establish the basic technology necessary to a comprehensive marine experiment.

Figure 14. Research and Development Schedule for a Manganese Nodule Collection System



Key:

1. Research
2. Fiscal year 81, 82, 83, 84, 85, 86, 87, 88, 89
3. Total system development
4. Conceptual design
13. Subsystem development
14. Element technology development
15. Ore collection system
16. Capability demonstration test
17. Ore lifting system

Key to Figure 14 continued

5. Production technology research
6. Overall evaluation
7. Basic concept
8. Basic design
9. Experimental design
10. Drawing up of experimental policy
11. Comprehensive ocean experiment
12. Modified experimental ship design
18. Basic design
19. Detailed design, fabrication of total marine experimental system
20. Evaluation
21. Handling system
22. Measurement and control system

The results of the above studies will serve as the basis for detailed design of the experiemental system; equipment will be fabricated and comprehensive marine tests will be conducted to establish the ore collection capability and reliability along with coordination between the subsystems and the production technology in order to devise the technology necessary for commercial production.

The principal functions of the various subsystems are discussed below.

(i) Ore Collection System

Manganese nodules will be collected and picked up through an ore lifting tube at ocean depths of 4,000-6,000 meters traversing the soft, loose surface layers of the ocean bottom.

(ii) Ore Lifting System

The manganese nodules collected by the ore collection system will be transported directly overhead to the ore collection ship by this system, which will be comprised of an ore lifting tube and a slurry pump (pump lift mode and air lift mode).

The pump lift mode involves the use of a pump positioned in the water partway along the path of the ore lifting tube to provide the necessary ore lifting flow. The air lift mode forces air under high pressure down from the surface ship to provide the transporting flow necessary to lift the ore.

(iii) Handling System

This system consists of the suspension and towing of the ore collection and lifting systems through the use of equipment based on the ore collection ship at the surface along with the lowering and recovery operations.

(iv) Measurement and Control System

The various systems from sea bottom ore collection to shipboard operations will be measured, observed, and controlled in order to enable smooth, safe, and efficient operation.

(3) Domestic and Foreign Research and Development Status

(i) Research and Development in Japan

Experimental research has been conducted since FY-68 on the CLB (continuous line bucket) for the recovery of manganese nodules, by a segment of the industry; in FY-73, the Research Committee of the Resources and Energy Agency initiated survey research, while the Deep Ocean Bottom Mineral Resources Development Association (DOMA) (company) formed by related industries initiated survey research, indicating the wide front of this research.

Following the basic preliminary developmental research on ore collection systems by DOMA through FY-79, a technological development survey of ore collection systems was initiated in FY-80 by the Resources and Energy Agency (Assigned to the metal ore industry work group and DOMA).

(ii) Overseas Research and Development

Some large capital companies such as US Steel, Inco (Canada), Kennecott, and Lockheed formed an international consortium consisting principally of American interests to promote development of ore collection technology, and certain groups have achieved some success in ore recovery experiments.

At the same time, France, which possesses the nickel storehouse of New Caledonia, has been conducting surveys of manganese nodules in the interest of its resources strategy, and in 1980 it greatly expanded its activities and established a special company to exploit manganese nodules and promote development.

In addition, since 1960 the Soviet Union, which is blessed with a number of nonferrous metals, has been conducting survey activities, primarily in the Pacific Basin.

In addition, West Germany, the UK, Belgium, Holland, and Italy are participating in an international consortium of this industry and are engaged in promotion of manganese nodule recovery.

(4) Progress Status of Research and Development

In FY-81 research and development on this project was initiated, and FY-82 is the second year of its operation.

The total system, which is being emphasized during FY-82, is aimed at the construction of a simulation model on the basis of which the ore collection and operational capabilities of the overall system will be evaluated and the basic plan for a comprehensive marine experiment will be drawn up. Development of element technology will be initiated in the various subsystems, selection experiments will be conducted, and each subsystem's performance will be analyzed.

Some specific activities are discussed below.

(i) Total System Research and Development

The makeup of the ore collection experimental system will be studied, and ore collection and operation performance analyses will be initated for the entire ore collection experimental system. At the same time, the basic plan for the comprehensive marine experiment will be drawn up. In addition, a start will be made on the conceptual plan for operational technology.

(ii) Ore Collection System Research and Development

(a) Research on Recovery of Manganese Nodules

Measurement equipment for sea bottom mining capability will be designed and fabricated for the collection of basic data relating to the recoverability of ore.

(b) Research and Development on Ore Collection Equipment

Selection tests will be conducted on the ski [phonetic] unit, the ore collection unit, and the ore selection unit. At the same time, analysis of the ore collection system will be started.

(iii) Research and Development on Ore Lifting System

(a) Research Related to Ore Lifting Capabilities of the Ore Lifting System

Transport properties of solid-liquid two-phase flow will be analyzed using experimental data, and a vertical water tank will be contructed to house experimental equipment for vapor-liquid-solid three-phase flow experiments.

(b) Research and Development on Pump Lift Equipment

One stage of an underwater pump will be designed and fabricated, and shaft seal and shaft bearing selection experiments will be conducted. The performance of pump lift equipment will be analyzed at the same time.

(c) Research and Development on Air Lift Equipment

Selection experiments will be conducted on vapor-liquid-solid separation equipment. At the same time, performance analysis will be conducted on air lift equipment.

(d) Research and Development on Ore Lifting Tube Equipment

Welding experiments will be conducted on the ore lifting tube, and plans will be proposed for joint experiments. The performance of the ore lifting equipment will also be analyzed.

(iv) Research and Development on Handling System

Selection experiments and performance analysis will be conducted on rocking-compensation equipment. A conceptual design of the handling equipment will be drafted at the same time.

(v) Research and Development on Measurement and Control System

Experiments will be conducted for the selection of underwater cables and connectors.

(5) Effects Expected from Research and Development

(i) Assurance of Stable Supply of Important Nonferrous Metal Resources

The development of manganese nodules will not only assure a stable quasi domestic source of important nonferrous metals such as nickel, copper, cobalt, and manganese, but will also directly improve Japan's self-sufficiency rate. At the same time, it will enhance restraint on nationalism regarding resources and reinforce the important negotiating power with other countries (bargaining power).

(ii) Contribution To Elevating Japan's Industrial Structure

The development of a manganese nodule recovery system will require a number of high-level technologies to overcome the harsh natural conditions associated with recovery from the ocean bottom at depth of 4,000-6,000 meters, and it is expected that these various technologies will be established as part of this project, as a result of which a marine development industry will be nurtured and reinforced through an information collection industry, thus elevating Japan's industrial structure to a higher level.

At the same time, it is expected that the effect of extending funds to various areas such as shipbuilding, machines, and electronic equipment type related areas accompanying the start of commercial scale operations will be very large.

(iii) Large Technology Disseminating Effect

The development of various types of technology covering a number of areas directly related to the ocean will not only contribute to overall improvement in the level of ocean development technology, but it is expected that it will have a large ripple effect on other marine development areas, in addition to the development of a system covering the entire span from the sea bottom at depths of over 5,000 meters to the surface.

2-6 High-Speed Computing System for Science and Technology

(Research and development period: FY 81-89; research and development funds: about 23 billion yen)

(1) Background and Purpose of Research and Development

Today the dissemination of information has been developed tremendously in all areas of industry, education, society, and administration, and this is due to spectacular improvements in the processing capability of computers for high-speed handling of large volumes of information.

Computer technology has advanced from the vacuum tube stage through the transistor stage to the integrated circuit stage, and the improvement in handling capability has been astounding; however, there is great need in the science and technology computation area for even higher speed computation systems with far greater processing capability. Some examples of such computations include treatment of graphic information sent from artificial satellites, plasma simulation of a nuclear fusion reactor, and aerodynamic calculations in aircraft design, all of which require a massive volume of computation. These large-scale science and technology computations are closely related to resources, energy, food production, disasters, and other social activities, while at the same time they have a great effect on the upgrading of the level of industrial technology and various sciences in Japan, which aspires to become a technology-oriented country, so the establishment of this technology is highly desirable. On the other hand, these science and technology computations require considerable time even with the use of the large present day computers, as a result of which the situation today is that a large portion of these computations remain undone. In order to be able to perform these massive science and technology computations, a computer with a treatment capability at least 1,000 times that of present day computers, on the order of 10 billion FLOPS (the number of floating point computations a computer can perform per second), is required, which represents a spectacular increase in high-speed treatment capability over the present day computer systems.

This 9-year project was started in 1981 in an effort to meet such needs.

(2) Outline of Research and Development

LSI with silicon semiconductors as logic elements and memory elements are used in present day computers, but limitations in the properties of the material and the operating principle are such that these elements are already operating at close to their limit. In addition, many of today's computers use the successive treatment method, and this does not provide the handling speed necessary for such science and technology computations.

This project, which proposes to break through these limitations in present day technology, is concerned with research and development on new high-speed logic and memory elements to replace these silicon elements, research and development on parallel treatment modes for the simultaneous operation of a number of basic processors, and development of a comprehensive system based on these element technologies.

(i) Research on High-Speed Logic and Memory Elements

The development of high-speed logic and memory elements is indispensable to advancing the speed of computer processing to even higher levels. There are two approaches to increasing the speed of these elements: (1) increasing the mobility of the electrons and (2) decreasing the distance traversed by the electrons (integration).

The silicon semiconductor used in present day computers is associated with electron migration, which is near its limit; this, together with the large quantity of heat generated through element power expenditure with increasing degree of integration, makes cooling a major problem. Thus, integration also has its limits.

New high-speed elements need to be developed using material of low power expenditure and high electron mobility in order to break through the limits faced today. Therefore, in this project research will be conducted on the Josephson junction element (JJ element), the high electron mobility transistor element (HEMT element), and the gallium arsenide electric field effect transistor element (GaAs element) as possible substitutes for the silicon element.

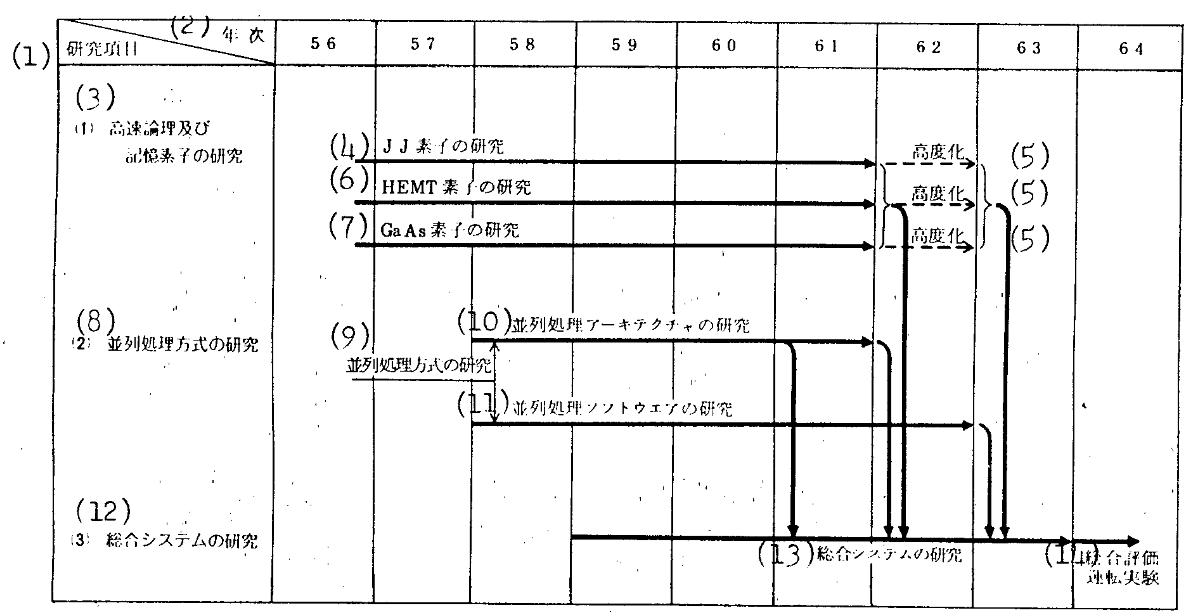
The JJ element is one with an entirely different operating principle from that of present day elements in that it utilizes the tunnel effect seen in materials at superconducting state in liquid helium at -267° C (4.2° K) such as a Pb or Nb system and is an element which operated at high speed, small power expenditure, and very high integration.

The HEMT element is a semiconductor element which utilizes a high electron mobility layer created at the heterojunction plane between GaAs and AlGaAs; it operates at high speed in a liquid nitrogen environment at -196° C (77° K).

The GaAs element is a semiconductor element used at room temperature with an operating principle similar to that of the silicon element, but the electron mobility in this material is higher than that in silicon, making it a readily usable element which can replace the silicon elements presently used on computers and enable greater speed of operation.

The performance of these elements are shown in Figure 16.

Figure 15. Research and Development Schedule for High-Speed Computing System for Science and Technology



Key to Figure 15:

1. Research item
2. Year 81, 82, 83, 84, 85, 86, 87, 88, 89
3. Research on high speed logic and memory elements
4. Research on JJ element
5. To higher level
6. Research on HEMT element
7. Research on GaAs element
8. Research on parallel treatment mode
9. Research on parallel treatment mode
10. Research on parallel treatment architecture
11. Research on parallel treatment software
12. Research on overall system
13. Research on overall system
14. Overall evaluation and operation experiment

(ii) Research on Parallel Treatment Mode

A single processor (treatment facility) was used for successive treatment of a problem in the mode adopted in computers of the past. This is a basic mode that has been in use since the initial stage of computer development, but a parallel treatment mode using a number of processors where in each processor performs part of the computations while the entire group performs the entire computation can greatly reduce treatment time for science and technology calculations.

Figure 16. Features and Targeted Performance of High-Speed Elements

		ジョセフソン接合素子 (1) (JJ 素子)	高電子移動度トランジスタ素子 (2) (HEMT 素子)	ガリウム砒素電界効果トランジスタ素子 (3) (GaAs 素子)
(12) 特徴	(4) 動作温度	液体ヘリウム温度 (5) (−269℃)	液体窒素温度 (6) (−196℃)	(7) 常温
	(8) 速度	シリコン素子の20～50倍 (9)	シリコン素子の10～20倍 (10)	シリコン素子の約5倍 (11)
	(14) 消費電力	シリコン素子の1/1,000以下 (15)	シリコン素子の1/10～1/20 (16)	シリコン素子の1/2～1/5 (17)
	(18) 原理	超電導現象を利用したトンネル素子 (19)	GaAs, AlGaAs積層半導体の境界層の高電子移動度を利用 (20)	GaAs半導体の高電子移動度を利用 (21)

Key:
1. Josephson junction element (JJ element)
2. High electron mobility transistor element (HEMT element)
3. Gallium arsenide electric field effect element (GaAs element)
4. Operating temperature
5. Liquid helium temperature (−269°C)

Key to Figure 16 continued

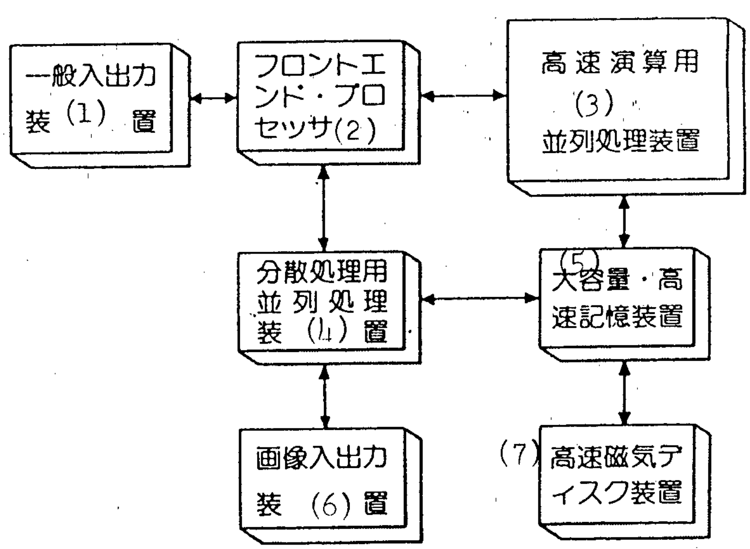
6. Liquid nitrogen temperature (-196°C)
7. Room temperature
8. Speed
9. 20-50 times silicon element
10. 10-20 times silicon element
11. About 5 times of silicon element
12. Features
13. Power consumed
14. Less than 1/1000 of silicon element
15. 1/10-1/20 of silicon element
16. 1/2-1/5 of silicon element
17. Principle
18. Tunnel effect utilizing superconducting phenomenon
19. High electron mobility in boundary layer between GaAs and AlGaAs semiconductors utilized
20. High electron mobility of GaAs semiconductor utilized

There are several variations to the parallel treatment mode, and this project will involve research on the architecture of the SIMD (single-instruction, multiple-data), MISD (multiple-instruction, multiple data) modes, together with combinations of them. There will also be research on parallel treatment algorithms to enable adequate exploitation of the parallel treatment facility, as well as software research including research on parallel treatment language and compilers to enable efficient parallel treatment.

(iii) Research on the Overall System

An overall system will be developed using new high-speed elements and parallel treatment modes in order to provide a high-speed computation system for science and technology applications (see Figure 17).

Figure 17. Diagram of Science and Technology High-Speed Computation System Makeup



Key to Figure 17:

1. General input-output facility
2. Front end processor
3. Parallel treatment facility for high-speed computation
4. Parallel treatment facility for dispersed treatment
5. Large-capacity, high-speed memory facility
6. Graphics input-output facility
7. High-speed magnetic disk facility

This research will involve development of parallel treatment facilities for high-speed computation, large-capacity high-speed memory facilities, and parallel treatment facilities for dispersed treatment. At the same time, front end processors, high-speed magnetic disk devices, and input-output devices will be augmented to back up the above equipment and make up a comprehensive system; overall evaluation and operation experiments will be conducted with an evaluation program; and a final evaluation of the high-speed technology computing system for science and technology use will be conducted.

(3) Progress Status of Research and Development

Research and development on this program was initiated in FY-81.

In 1981, basic studies were conducted on high-speed logic and memory elements and on parallel treatment mode, and the direction was set for future research and development.

The following research and development is under way in FY-82.

(i) Research on High-Speed Logic and Memory Elements

Research on the JJ element will include research on very fine finishing technology using Nb family thin membranes and basic logic circuit makeup involving direct bonded circuits and research on making high-speed Pb family elements, material process technology for a high degree of integration, and technology for LSI conversion.

Research on material process technology and LSI conversion technology will be pursued in the area of HEMT elements.

Research on GaAs elements will consist of SSFL (Schottky junction Schottky fine finishing technology FET logic), material process technology for higer integration and higher speed elements, and LSI technology.

(ii) Research on Parallel Treatment Mode

Architecture of MIMD type parallel treatment mode suitable for VLSI utilization and algorithms will be subjects of basic research, while evaluation research in the area of application computing on parallel treatment algorithm and architecture will be conducted.

2-7 Automated Sewing System

(Research and development period: FY 82- ; research and development funds: undertermined)

(1) Purpose and Background of Research and Development

Japan's sewing industry is faced with the need for development of high add-on value products and discriminating products in the midst of the severe environment of a diversity in consumer needs and a short product cycle.

In the face of this situation confronting the sewing industry, Japan must plan a rational international division of work with developing countries while building up a system that will deal with the concentration of information involving demand for a higher class of goods, diversity of goods, and individuality of goods and provide superior goods with high add-on value in a stable manner. The development of the apparel industry with high add-on value, which is closest to the consumer, plays an important role to this end.

Japan's apparel industry is a highly labor-intensive industry which requires great experience but involves monotonous repetition. It is difficult to keep workers on such work very long, so the necessary experienced labor for insuring stable quality is difficult to maintain.

At the same time, the number of piece products from a lot of fabric is comparatively large, and more than a month is required from receipt of order to shipment making speculative production inevitable with the net result that a high risk is entailed for the entire textile industry.

In order to deal with this situation, this project is aimed at developing automatic sewing systems which can flexibly and quickly produce multiple-variety, small-volume products through a highly flexible automated system.

(2) Outline of Research and Development

Research and development on an automated sewing system is faced with many problems, because where the NC tool machines of the past involved automation technology handling rigid parts such as machine parts, the new system must handle a material that is pliable by nature on which high-speed finishing is required. The element technology to be taken up in this project to counter these problems includes sewing preparation finishing technology, sewing assembly technology, base material handling technology, and system management technology research and development, together with the establishment of an overall production system that organically ties together the difficult element technologies.

(i) Element Technology

The element technologies listed below will be developed for establishment of technology necessary to develop equipment that is cheap, has superior operability, and which can be readily introduced even by medium-size and small apparel makers.

(a) Sewing Preparation Finishing Technology

This is technology wherein the starting cloth material is inspected, rolled out, and cut, along with the technology to mark the control information necessary for the apparel sewing and assembly steps on the starting material; development of the specific technologies listed below will be targeted.

Starting cloth properties evaluation technology
Starting material-stabilizing technology
High-performance pattern making technology
Starting cloth inspection, unrolling, and cutting technology

(b) Sewing and Assembly Technology

This is technology wherein the cut cloth with control information placed thereon is put through finish sewing to form parts which are then assembled to prepare the finished product; this is an area of technology which was essentially undeveloped in the past. Development in the following specific areas will be targeted.

Sewing pretreatment technology
High-performance sewing technology
High-performance press finishing technology

(c) Starting material-handling technology

This is technology to transport pliable starting material, which in the past was considered difficult to handle mechanically, to machines; development of the following specific technologies will be involved.

Fabric grasping technology
High-performance position determining technology
Pliable base starting material transporting technology

(d) System Management and Control Technology

This is technology to carry out system management and control of the entire production process, from the starting bolts to the finished product, in order to enable efficient, multiple-item production; development of the following specific technologies will be involved.

Overall system management technology
Inspection and malfunction diagnostic technology
Control information imparting technology
Information recognition technology

(ii) Total System

A test plant will be constructed whereby element technologies (a)-(d) listed above will be organically combined, and an automated sewing system representing an overall production system will be operated and evaluated.

(3) Domestic and Foreign Research and Development Status

(i) Research and Development in Japan

The technology level in Japan today is limited to partial automation of some individual processes.

(a) The automation of machines has seen development of an automatic pocket centerer aimed at conservation of power in a certain specific process and special equipment such as an automated sleeve sewing machine and an automated button attachment machine.

(b) The major problem besetting the automation of sewing processes is the difficulty of handling the base material cloth because of its pliability. This is why the development of technology to automatically perform fine operations (separation, transport, and stacking together basic steps) in line with the type of material being sewn, together with the basic planning of the systematic design of the sewing process, has been undertaken in the "research on automation of handling of pliable material such as sheets of cloth" project at the Fiber and Polymer Laboratory during FY 81-83.

(c) The "parts sewing material handling systematization technology development" project aimed at conserving labor in the operations preceding and following parts attachment, which account for more than 80 percent of the operational time, was conducted by the Medium-Size and Small Industry Promotion Work Group during FY 75-78.

(d) Some automated sewing processes have been developed by the industry; pattern grading, pattern marking, and cutting technology on the basis of the industrial-use master plan have been made practical to a certain degree.

(4) Overseas Research and Development

The progress of research and development in the automation of sewing processes in foreign countries is similar to that in Japan.

In 1967, the Singer Company of the United States, a sewing machine manufacturer, proposed the development of its "unmanned sewing system 2000" project, but in 1969 it announced the discontinuation of this project citing the very large risk involved for such an undertaking by an individual company.

In addition, during 1964-1968 basic research on base material handling technology was conducted under a subsidy of the U.S. Commerce Department, and basic technology was developed for the pickup and stacking together of two separate bolts of cloth. In 1967 this technology was applied by the jeans manufacturer Levi in developing a pocket sewing machine for jeans.

(b) Sewing machine development in Europe also has been focused on automation and labor conservation through the use of individual machines. For example, in 1980 the EC requested the American Curt Salmon Associates company to conduct research and development on a sewing automation project.

(5) Results Expected of Research and Development

(i) Raising the Level of Japan's Sewing Industry

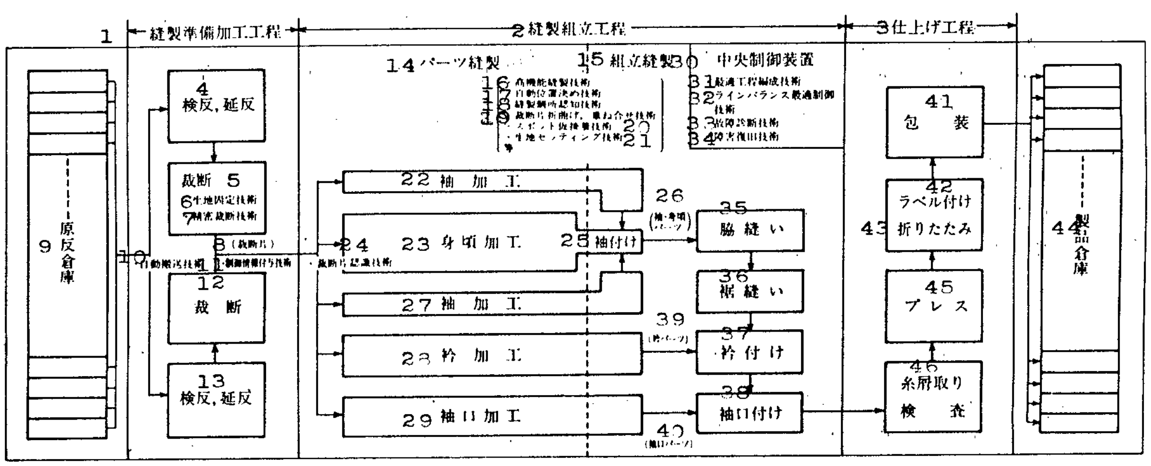
Once this system is perfected and the technology is established for the rapid production of multiple-product, small-volume items, not only will losses due to lack of expertise at the time of product changeover be reduced but production efficiency will be improved due to systematization of the overall production system, and a large reduction in cost at all stages of production can be anticipated.

(ii) Transition to an Actual Demand Production System Is Possible

At present, 20-40 days of work are required to produce 200-400 product units, thus entailing speculative production with its accompanying high risk. This system will provide the production system with flexibility, making possible rapid multiple-product, small-volume production which will be able to follow market trends closely; it will be possible to terminate production rapidly in line with orders, enabling a transition to a production system responding to actual orders.

As a result, the efficiency of the entire sewing industry will be improved, production loss and cost will be lowered, demand will be expanded and efficiency of the entire sewing process will be advanced, and conservation of resources and energy will be promoted.

Figure 18.



Key:

1. Sewing preparatory work process
2. Sewing assembly process
3. Finishing process
4. Inspection, unrolling
5. Cutting
24. Cut piece recognition technology
25. Sleeve attachment
26. Sleeve, body parts
27. Sleeve finishing
28. Collar finishing

Key to figure 18 continued

6. Cloth securing technology
7. Precise sewing technology
8. Cut piece
9. Starting material storage
10. Automated transport technology
11. Control information labeling technology
12. Cutting
13. Inspection, unrolling
14. Parts sewing
15. Assembly sewing
16. High sewing performance technology
17. Automatic positioning technology
18. Sewing site recognition technology
19. Cut piece folding and stacking technology
20. Spot attachment technology
21. Cloth setting technology
22. Sleeve finishing
23. Body finishing
29. Cuff finishing
30. Central control device
31. Optimum process assembly technology
32. Optimum line balance control technology
33. Malfunction diagnostics technology
34. Damage repair technology
35. Armpit sewing
36. Hem sewing
37. Collar attachment
38. Cuff attachment
39. Collar parts
40. Cuff parts
41. Packaging
42. Belt attachment
43. Folding
44. Product storage
45. Pressing
46. Scrap removal, inspection

2-8 Sea Bottom Oil Production System

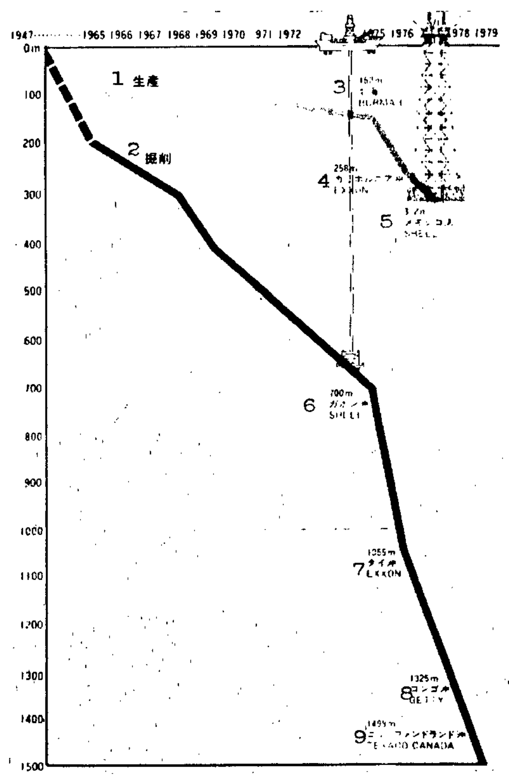
(Research and development period: FY 78-84; research and development funds: about 15 billion yen)

(1) Background and Purpose of Research and Development

The rate's of oil production from the seas throughout the world is now on the order of 20 percent, and the reserves of oil resources in the seas mean that it will be possible that this ratio will increase to 30 percent in the 1980's decade and to about 50 percent by the year 2000. At the same time, development will shift gradually from the shallow seas to the deeper ocean areas.

In this situation, if we look at production technology from the standpoint of various technologies of marine oil development including surveying, drilling, and production, the fixed platform type which is presently in use is associated with problems such as the fact that the quantity of steel required increases along with the construction time as increasing water depth is encountered, making oil development difficult from both the technological and economic standpoints, as a result of which this area has fallen considerably behind exploration and drilling technology (see Figure 19). Furthermore, the oil-producing countries have stipulated the existence of an intrinsic technology on oil production as the primary condition for negotiating operating rights, making most urgent the development of oil production technology to enhance our country's bargaining power.

Figure 19. Differences in Developmental Technologies



Key:

1. Production
2. Drilling
3. 150 meters, North Sea, Burmah
4. 258 meters, California, Exxon
5. 312 meters, Gulf of Mexico, Shell
6. 700 meters, off Gabon, Shell
7. 1,055 meters, of Thailand, Exxon
8. 1,325 meters, off Congo, Getty
9. 1,499 meters, off Newfoundland, Texaco Canada

The presence of oil reserves in the continental shelf of the seas along the coast of Japan is predicted, but the ocean depth is considerable, although there is a good possibilty that earnest oil exploration of a practical scale will be in force 4-5 years from now, making indispensable the development of independent technology to respond to these moves.

With this background in mind, a program of research and development on a sea bottom oil production system was decided upon aimed at assuring stable oil resources for our country through self-developed oil and also at improving the overall marine development technology through the establishment of a new production mode to replace the old platform mode; to this end Japan's oil development industry, shipbuilding, and heavy equipment and steel manufacturers are mobilized to join together with the government to promote research and development.

(2) Outline of Research and Development

A sea bottom oil production system involves technology to recover (produce) oil and natural gas from oil fields on the sea bottom wherein the necessary production equipment is placed on the ocean bottom, this has the major advantage that a platform is not required. At the same time, this system involves very large-scale technology, including technology to fabricate and install wellhead equipment, pipeline, manifold, and riser and oil storage facility hardware and software (operating technology) for use in conducting safe and stable oil production activities over the long term (15-20 years). Furthermore, the seas around Japan are covered by various types of fishing rights which have no counterparts elsewhere in the world, and the system must operate without causing adverse effects to the fishing industry.

Research and development will be conducted on four subsystems--wellhead system, manifold system, pipeline system, and riser-oil storage system--and the total system will be a combination of these subsystems to make up an overall system that is safe and highly reliable. The highlights of the research and development efforts of these subsystems are discussed below.

(i) Development of the Wellhead System. The wellhead system is equipment installed at the wellhead and is capable of cutting off oil and gas issuing from the well. It consists mainly of valves and of control and connecting devices.

This project develops a wellhead system which functions at a water depth of more than 300 meters. In addition to buried equipment which poses no threat to the fishing industry, the project consists of equipment installation technology and remote operating technology to detect and approach equipment sites. It also provides for the development of oil well conservation technology.

(ii) Development of Manifold System: The manifold system will consist of the pipeline used to collect oil and gas from each well installation and relay equipment capable of accurately selecting and sending pump down tools (P.D.T.) for maintenance of the equipment at each wellhead. The manifold will have a pressure-resistant shell in which the interior atmospheric pressure will be maintained at a level whereby men can go inside as necessary to carry out equipment maintenance.

This project involves development of the pressure-resistant shell, technology to maintain the environment within the shell, remote operation technology, and installation technology. In addition, a service capsule will be developed for transporting workers.

(iii) Development of Pipeline System: This system has the function of tying together the wellhead equipment, manifold, and riser base systems with the pipeline to transmit oil and gas.

This project emphasizes the pipeline tying together the wellhead with the manifold, technology for laying pipeline on the sea bottom and connection technology; technology to install pipeline that can be used in a fishing environment will be developed.

(iv) Development of Riser and Oil Storage System: The riser system involves the equipment to transmit the oil and gas produced at the sea bottom directly above to the storage facilities on the surface and will be provided with the ability to absorb the rocking motion of the storage facilities on the surface together with the ability to readily pass through pump down tools (P.D.T.)

The oil storage system will temporarily store the oil produced for shipping at the appropriate time, and it will also have the ability to deal with the oil and gas that is produced.

Importance will be attached to the riser system in this project; development of the riser main body, the universal joint, the riser base, and the P.D.T. passage mechanism will be carried out together with the development of riser installation technology and maintenance technology.

(v) Development of total system

The subsystems will be combined, comprehensive marine tests will be conducted, and the total system for sea bottom oil production technology will be perfected.

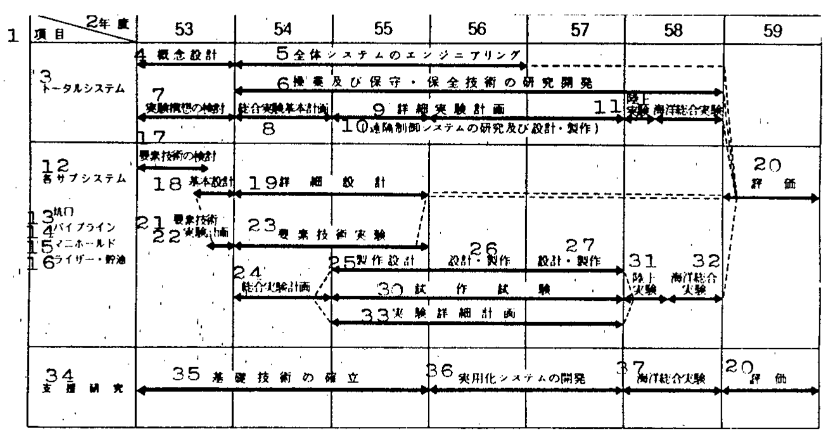
At the same time, research and development on software technology to operate this system will be conducted along with support technology common to the subsystems, and research and development on technology for detection of oil leaks and remote control.

In addition, research and development will be conducted on control technology for approaching items fixed in the sea along with pipeline installation diagnostic technology in support of this research and development.

(3) Domestic and Overseas Research and Development

Japan has a semisubmerged type drilling ship (Hakuryu Go) which has made test drillings in the seas around Japan to depths up to 200 meters. In addition, a fixed platform type oil production facility has been installed at a depth of 80 meters in the marine oil field off Aga in Niigata Prefecture, and pipeline has been laid (see Figure 20).

Figure 20. Research and Development Schedule on Sea Bottom Oil Production System



Key to Figure 20:

1. Item
2. Fiscal year 78, 79, 80, 81, 82, 83, 84
3. Total system
4. Conceptual design
5. Engineering of overall system
6. Research and development of operation and maintenance technology
7. Study of experimental concept
8. Basic plan for comprehensive experiment
9. Detailed experimental plan
10. Research, design, and fabrication of remote control system
11. Land-based experiments, comprehensive marine experiment
12. Various subsystems
13. Wellhead
14. Pipeline
15. Manifold
16. Riser, oil storage
17. Study of element technology
18. Basic plan
19. Detailed plan
20. Evaluation
21. Element technology
22. Experimental plan
23. Element technology experiments
24. Comprehensive experimental plan
25. Fabrication plan
26. Design, fabrication
27. Design, fabrication
28. Fabrication tests
29. Land experiments
30. Comprehensive marine tests
31. Experimental detailed plan
32. Support research
33. Establishment of basic technology
34. Development of practical system
35. Comprehensive marine tests

Research and development is actively being promoted overseas, such as in the United States, Canada, and France, and a number of experiments are under way in the oil fields.

3. Outline and Results of Completed Projects

3-1 Outline of Completed Projects

Research and development was completed on 11 projects from the initiation of this large project program in FY-66 up to the end of FY-81. The outline and results of these projects are given below.

(1) Super-High-Performance Electronic Computer

(Research and development period: FY 66-71; research and development funds: about 10 billion yen)

This research and development was aimed at domestic production of electronic computers with top-level capability in the world to counter the leading technology of IBM and other leaders in the early 1970's, when the transition from the third generation (IC) to the 3.5 generation (LSI) was taking place in world computers.

This project concerned not only electronic computers, but also the development of software and input-output devices to enable effective use, semiconductors for greatly improved, high performance hardware, and various memory devices.

The results not only have been utilized in many ways in domestically produced large electronic computers but they have greatly raised the technological level of electronic computers and semiconductors, closing the gap in technology between this country and the West and contributing greatly to the technological foundation for today's developments.

(2) Desulfurization Technology

(Research and development period: FY 66-71; research and development funds: about 2.6 billion yen)

With the increased consumption of heavy oil, the sulfur dioxide gas discharged into the atmosphere from the sulfur present in heavy oil created a number of social pollution problems, and this was the impetus for research and development on technology (direct desulfurization of heavy oil) to remove the sulfur directly from heavy oil and technology to remove sulfur dioxide gas from the exhaust gas resulting from combustion.

Among the dry methods for smoke desulfurization, the activated manganese oxide method and the activated carbon method were selected for pilot plant operational research. Among the many methods for direct heavy oil desulfurization that were investigated, the suspension bed method was selected for operational research using a test plant which was constructed for this purpose.

The results of this project were utilized not only in various large thermal power plants but they were incorporated into research and development initiated by the country at the time the pollution problem first became a concern of society, and since then there have been contributions to expanded desulfurization technology in private industry.

(3) New Methods of Producing Olefins, Etc

(Research and development period: FY 67-72; research and development funds: about 1.1 billion yen)

About 1965, the Japanese petrochemical industry, which had been witnessing a continued period of sharp growth, depended almost completely on naphtha--a light distillate of oil--as its raw material, but the prospects for a stable future supply of naphtha were not good. This situation was the background for initiating research and development on technology to convert to a raw material for the petrochemical industry which would be stable both in price and quantity and which could be separated directly to produce basic chemicals in the form of olefins (compounds such as ethylene, propylene). The "coke thermal medium methods," which is a sole technology of Japan, was taken up in this project, and test runs were conducted on a 5 tons/day scale of starting material to establish the technological feasibility.

The results were directly incorporated into the "method of producing olefins with heavy oil as the raw material" program, and this method is being actively employed as a technological foundation.

(4) Great Depth, Remotely Operated, Sea Bottom Oil Drilling Equipment

(Research and development period: FY 70-75; research and development funds: about 4.5 billion yen)

With the background in which the trend in oil drilling was moving from drilling on land to drilling along the coast and on the continental shelf, research and development on oil drilling equipment of a new type which can be used at great ocean depth was initiated.

This project adopted a mode by which oil fields at ocean depths of 200-250 meters will be drilled using equipment with the power section at the water surface and the greater part of the other drilling equipment on the sea bottom in which drilling operations will be remotely controlled, The initial objective of developing the mechanism for this equipment was attained.

The results of this project also are being incorporated as a technological foundation for the ongoing "sea bottom oil production system."

(5) Sea Water Desalinization and Byproduct Utilization

(Research and development period: FY 69-77; research and development funds: about 6.7 billion yen)

With the background of the intensifying social problem of depletion in water supplies in large urban areas, including the national capital, research and development was initiated on technology for producing fresh water at low cost and in large volume using sea water as the raw material and technology to recover sodium chloride and potassium salts as byproducts.

There are many methods available for desalinization of sea water; this project adopted the multiple stage flash vaporization process because it enables cheap production of a large volume of water, and research was conducted on a test plant (3,000 m^3/day water producing capacity) followed by partial test construction and operational research on a large desalinization facility (100,000 m^3/day capacity).

The results are not only being utilized at the Rishima nuclear power plant, but a number of plants have been exported to Saudi Arabia and other Middle Eastern countries.

(6) Electric Automobile

(Research and development period: FY 71-77; research and development funds: about 5.7 billion yen)

Automobile-caused pollution, such as atmospheric pollution resulting from automobile exhaust gas and automobile noise, has become a major social problem accompanying the densification of the population in large urban centers, so research and development was initiated on the electric automobile. Its merits are that it does not discharge exhaust gas, noise is greatly reduced, and it enables simple operation and facilitates automation of operation control.

This project resulted in the development of an electric automobile equipped with a hybrid type battery which enables 250 km travel on a single charge (compared to 100 km in the past), and a top level technology in the world was developed.

The results have been put to practical use in cities such as Kobe and Tokyo, in addition to which the large power transistor which was developed as element technology is being utilized in fork lifts and other equipment.

(7) Comprehensive Automobile Control Technology

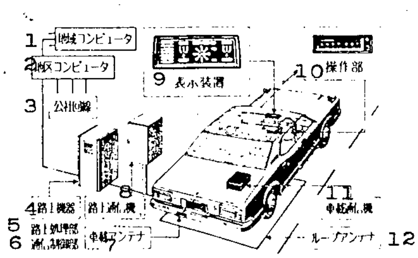
(Research and development period: FY 73-79; research and development funds: about 7.3 billion yen)

The sharp increase in the number of automobiles in Japan has resulted in traffic accidents, traffic stagnation, and exhaust gas pollution, which are important social problems particularly in the large cities. This project involved research and development on a new system which will transmit the necessary information to each automobile and make possible direct traffic control in order to rectify these problems.

Research was conducted on five subsystems--route guidance, running information, emergency information, variable information panel, and official vehicle priority--and the final step was a pilot step experiment conducted within the Tokyo area (about 30 km).

The results not only were put into practical use on the Keiba highway but they also contributed greatly to elevating the level of overall control technology. The results have been taken over by the National Policy Agency and the Ministry of Construction, where research is being continued to make the system practical.

Figure 21. Comprehensive Automobile Control Technology



Key:

1. Computer on car
2. Area computer
3. Public corporation circuit
7. Car antenna
8. Road bed transmitter
9. Display device

Key to Figure 21 continued

4. Road bed equipment
5. Road bed processing section
6. Communication control section
10. Operation section
11. Car transmitter
12. Loop antenna

(8) Pattern Information Processing System

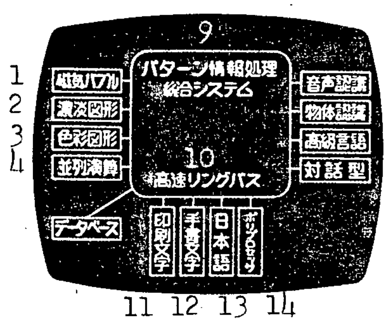
(Research and development period: FY 71-76; research and development funds: about 22 billion yen)

With the advance toward an information oriented society, an information processing system has become necessary wherein characters, objects, figures, and sound type pattern information which cannot be handled by present day computers can be directly entered and recognized. With this background, research and development was initated on such an information processing system with a target date in the 1980's.

The element technology for this project included input conversion equipment for pattern information processing, new parts material, functional elements, software, and operating system research and development to develop the highest level of technology in the world, and the final step was to combine these subsystems for the operation of a comprehensive prototype.

Among the results of this program, the memory elements developed as element technology are finding wide practical use, the technological level of pattern information processing has been advanced spectacularly and a great contribution has been made to expanding the information treatment objectives from just figures to characters and figures.

Figure 22. Pattern Information Processing System



Key:
1. Magnetic bubble
2. Dark-light pattern
3. Colored pattern
4. Parallel computation
5. Voice recognition
6. Object recognition
7. Sophisticated language
8. Dialogue type
9. Total system for pattern information processing
10. High-speed ring bus
11. Printed characters
12. Handwritten characters
13. Japanese words
14. Polyprocessor

(9) Direct Steelmaking Utilizing High-Temperature Reducing Gas

(Research and development period: FY 73-80; research and development funds: about 13.7 billion yen)

This project involved research and development on technology to utilize directly the high energy of the multiple-purpose high-temperature gas reactor, whose development is expected in the near future, in the steelmaking process, thereby resolving the pollution problem associated with present day steelmaking methods as well as enabling disengagement from dependence on raw material carbon.

This project included the development of high-temperature heat exchangers to transfer heat from the primary helium gas exiting from the reactor at about 1,000°C to a secondary helium gas, super-heat-resistant alloys capable of long-term use at a temperature over 1,000° C, high-temperature thermal insulation material, and a reducing gas production facility for producing reducing gas from low-cost reduced-pressure distillation residue; the technology was established for direct steelmaking pilot plant to be connected to a thermal output 50 MW scale multiple-purpose high-temperature experimental gas reactor as the initial objective.

Plans for construction of the multiple-purpose high-temperature gas reactor experimental facility have been delayed from the initial timetable, so construction of the direct steelmaking pilot plant has not yet begun, and future developments are awaited.

(10) Method of Manufacturing Olefins Using Heavy Oil as Raw Material

(Research and development period: FY 75-81; research and development funds: about 13.8 billion yen)

The petrochemical industry of Japan presently depends solely on naphtha as its raw material, and the diversification of raw materials has become an important subject. This is why research and development was necessary on technology to produce olefins, which are basic chemicals, using heavy oil such as the residue from reduced pressure distillation (so-called asphalt) which presently is not used as raw material.

This project was the recipient of the technological results of the previous project "new methods of producing olefins" using crude oil as the raw material; a large pilot plant of 120 tons/day capacity of raw material was constructed and operated continuously over a long period (1,000 hours).

Because research and development has just recently been completed, the results have not yet been put to practical use. Since it can be applied to oil sand and similar material, interest is being shown by some foreign countries.

(11) Aircraft-Use Jet Engine

First Phase (research and development period: FY 71-75; research and development funds: about 6.9 billion yen)

Second Phase (research and development period: FY 76-81; research and development funds: about 3 billion yen)

Jet engines for aircraft use require a very high level of technology, for which there was no self-developed technology in this country. This is why research and development was initiated on a low-polluting, high-efficiency fan jet engine for use on civilian aircraft.

The basic technology necessary for the jet engine was developed during the first-phase plan of this project, while the fan jet engine of the 5-ton thrust class with assured safety, wear, and reliability was developed during the second period.

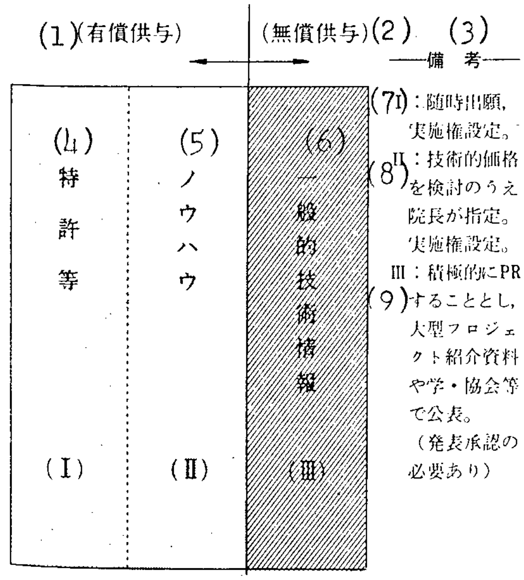
As a result of this project, the engine that was developed was placed on a STOL (short takeoff and landing craft) which was under development by the Science and Technology Agency, in addition to which the door was opened for joint Anglo-Japanese jet engine development (XJB plan), thereby contributing to elevating the level of technology in Japan.

3-2 Utilization of Results

The large-scale project system was initated in FY-66; to date 19 projects have been taken up which have brought forth many results. Some outstanding results from the research and development programs include electronic parts technology such as LSI and IC memory, a new high-performance battery, and sea water desalinization; up to the end of March 1982, there were 2,374 domestic applications for industrial proprietory rights and 192 applications from foreign countries, reflecting the number of results. In addition, the application of these research results has brought in 295.12 million yen to the national treasury, for another indication of the popular dissemination of the results. The outlines of the projects already completed are given elsewhere, but even those projects presently under way are bringing forth revolutionary results with the continuation of the project.

The Japan Industrial Technology Promotion Council (Inc) was founded in 1969 to disseminate research results from the national laboratories centered on the Agency of Industrial Science and Technology and to bridge the gap between the government laboratories and private groups. The results of these large-scale project research and development programs are also being actively disseminated to the industrial world through this group. Material is supplied to this group for this purpose, and any party wishing to use the results is quickly called in for consultations (see Figures 23 and 24).

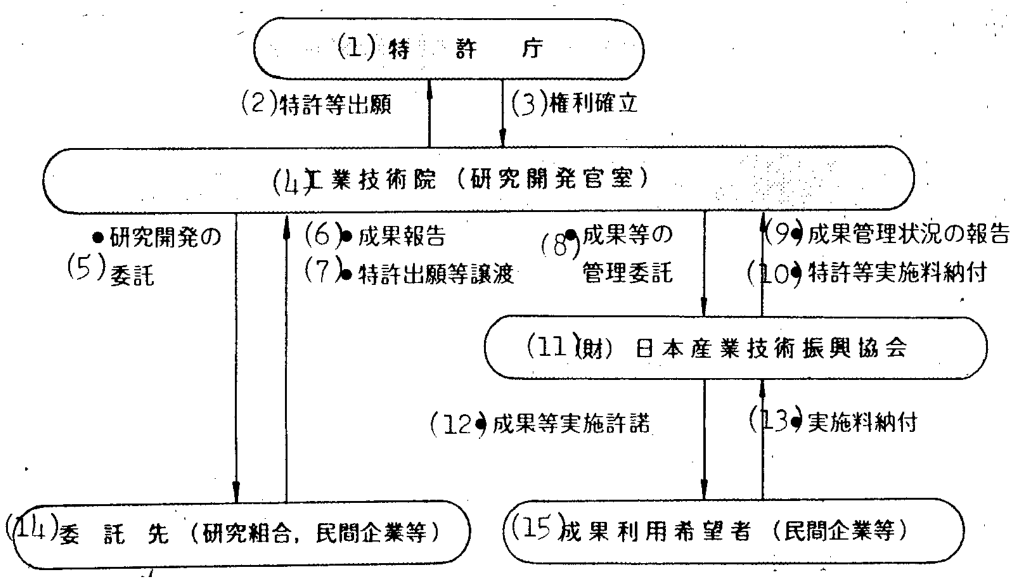
Figure 23. Method of Applying Results of Large-Scale Projects



Key:

1. Compensated contribution
2. Uncompensated contribution
3. Remarks
4. Patents, etc
5. Knowhow
6. General technological information
7. I: Apply promptly, establish license
8. II: Study technological evaluation, followed by director's assignment. Establish license
9. III: Actively promote PR. Publicize large projects and associated material in schools and associations (approval is needed)

Figure 24. Management of Results from the Large-Scale Project System



Key to Figure 24:

1. Patent Office
2. Patent Applications
3. Establish proprietory rights
4. Agency of Industrial Science and Technology (Research and Development Bureau)
5. Research and Development consignment
6. Report on results
7. Patent application conveyance
8. Consignment of management of results
9. Report on results management status
10. Payment of patent use fees
11. Japan Industrial Technology Promotion Association (Inc)
12. Consent to use results, etc
13. Payment of use fees
14. Consignees (research groups, private industry, etc)
15. Prospective users of results (private industry, etc)

3-3 Handling of Results

The results of research and development derived from the large-scale project system by the Agency of Industrial Science and Technology as well as other related government laboratories naturally will become the property of the government, but the results obtained through research and development efforts from consignment research (such as patent type industrial propriety, knowhow as designated by the director) will also become the property of the nation.

When these research and development results are such that the executional policies for these results should be applicable to the needs of other government and public areas, and the requestor possesses technological and economic capabilities to apply the results, approval for use will be granted. When there is no special abuse, priority may be granted to the industry performing the consigned research. The use fees will be based on the usual government-owned industrial patent rates.

4. Future Prospects

As discussed above, a number of products have been initiated under this system, which has achieved great success.

At the same time, the demands of society for such research and development results have greatly intensified in the past few years, and it is now considered that this country should take the direction of being technology oriented in the future.

In addition, technological development is recognized as being extremely important for promoting the reactivation of world economy and growth, as indicated at the Versailles summit some time ago. This system also envisions contributions on an international level, and joint international research and development cooperation with other countries is being actively promoted.

Thus, the contributions of this system to Japan, which places great hopes on being a technology-oriented country engaged heavily in international contributions, are expected to increase more and more in the future, and plans are being made to develop the system even more to respond to these expectations.

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END