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Japan Report

(FOUO 30/81)

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MILITARY

JAPAN'S SHARE OF THE DEFENSE BURDEN ANALYZED

Tokyo SANKEI in Japanese 12 Mar 81 p 3

['Special Report 1981' Column, Article by Akimasa Negishi: "Japan's Standstill Posture Not To Be Tolerated"]

[Text] "If things keep going like this, Japan's international position, which centers on our relations with the United States, will only get worse." This sense of crisis is spreading throughout the government and the LDP as the May U.S.-Japan summit meeting approaches. This is because, with increasing strain in the international situation, the United States is asking Japan for active participation as an ally in the peace-keeping structure. It is asking Japan to assume a greater share of its own defense burden. The Suzuki government is prepared to parry this with the excuse of "domestic circumstances" and the optimistic approach: "They'll understand us if we talk things over." Less than 2 months remains until the summit meeting. The Japanese leaders need to recognize more clearly that a change is being demanded, from sliding by with peace handed to us on a platter to helping bear the burden of maintaining a peaceful order. Otherwise, Japan cannot help becoming an orphan in the world again.

Government Putting on Cool Front to Weinberger Proposal

"What we expected has finally arrived. This is the authoritative version of the U.S. demand for an increased Japanese defense effort." This was how most LDP and government officials, especially in the Foreign Ministry, took the news when U.S. Secretary of Defense Weinberger emphasized the "establishment of a system for division of labor in defense among the Western allies" in a report to the U.S. Senate Military Affairs Committee on 4 March. However, Prime Minister Suzuki and his associates reacted more coolly. Chief Cabinet Secretary Miyazawa remained impassive. "This is nothing now. What does he mean [by division of labor]?"

Chief Cabinet Secretary Miyazawa has a great deal more international awareness than most and there is no reason that he would not understand what Secretary Wienberger is saying. In short, Chief Secretary Miyazawa is feigning ignorance. Right now the Japanese Government, led by Prime Minister Suzuki, is not psychologically prepared to accept the U.S. view of the world situation and act positively in undertaking a greater defense responsibility befitting the new situation. Perhaps that is why the Chief Cabinet Secretary, as the government representative, can do nothing but play dumb.

It might be more accurate to say that Prime Minister Suzuki and his group, rather than not being psychologically prepared, have simply misunderstood the meaning of the U.S. demand. There is an element of playing up to one's superiors in Prime Minister Suzuki's excuses: "Japan is a peaceful country. It cannot perform a military role." Also, when he tells the reporters assigned to follow him, "The American posture is not so very strong. It is just as I have said," it sounds like an attempt to reassure himself.

When he states, "Japan will play an economic and technical assistance role," he seems to forget that America is demanding that Japan build up its defense capability as well as "playing an economic role." He also neglects the fact that the percentage of Japanese assistance to other countries remains to the right of the decimal point.

America More Serious Than Imagined

The United States is serious. Officials of the new Reagan administration have repeatedly made statements on the U.S.-Japan defense issue and "misunderstanding" on the part of Japan is becoming strained. Mr Abshire, an important member of the team for transition between the former Carter administration and the new Reagan administration and Director of the Center for International and Strategic Studies at Georgetown University, met with the prime minister and explained the American position. "We are not asking Japan to play a different role than in the past. We are not expecting new action by the Self Defense Forces. We do want you to tighten up your own defense." He did not demand any of the things which Prime Minister Suzuki is anxious about like going beyond the limit of the peace constitution or undertaking a military role in the Middle East. However, we should not overlook the fact that he emphasized tightening up the defense of Japan.

The views of the United States and Japan are completely opposite on the idea that "percentage is not a problem." In congressional testimony on 28 January, Secretary of State Weinberger said, "Percentage is not a problem. However, the budget necessary to improve defense must be raised as much as necessary." In short, he meant to say, "Do not put a ceiling on defense buildup with percentages." This U.S. posture must be recognized as harder, not softer, than before. During budget formulation at the end of last year, the government took the approach that "expenditures for defense and social welfare should be about the same." This will not do.

Former Prime Minister Ohira Had Made Up His Mind

Last May, in the meeting between Prime Minister Ohira and former President Carter, Japan announced for the first time that it was an ally of the Western nations, led by the United States, because of the dramatic changes in the international situation such as the Afghanistan situation and the captivity of the American hostages in Iran. Ohira promised to make a serious effort to build up Japanese defense capability. Mr Ohira had just as much a sense of mission in rebuilding public finances as Prime Minister Suzuki. However, he had made up his mind that the time had come to stop getting a free ride with world peace based on the efforts of the United States and Europe and take an active role in creating peace. After

returning to Japan, he instructed former Defense Agency Director-General Hosoda to "work seriously to see how far we can possibly improve our defense capability." Even after Mr Ohira's death, a special ceiling remained for defense spending, a 9.7 percent increase compared to the previous year.

However the Ohira legacy stopped right there. With the emergence of the Suzuki cabinet, defense capability was "buried" under domestic issues. The Suzuki cabinet has been described as a carry-over from the Ohira cabinet but it has not taken over Prime Minister Ohira's new concept that reversed post-war Japanese foreign policy--the playing of a significant role as an ally of the Western powers.

A Return to "Perry-Style Diplomacy"

The U.S. leadership has clearly stated that it "will do nothing to embarrass the prime minister of Japan." The May meeting between U.S. and Japanese leaders will probably end without incident and without bridging the present gap in U.S.-Japanese relations. However, once it is finished, it is certain that the thought will arise in the United States that, in the tradition of Commodore Perry, there is no alternative to pressure diplomacy with Japan. And this American feeling will cast a dark shadow on future U.S.-Japan relations.

However, on the other hand, the coming U.S.-Japan summit meeting will be the perfect opportunity to put an end to the tragic repetition of post-war Japanese foreign policy. In order to do this, the leaders of the Japanese Government, beginning with Prime Minister Suzuki, must accurately grasp the present international situation. As an ally of the Western nations, Japan must take a big step toward creating peace through defense efforts that have international significance. As "one of the Western powers," a standstill posture cannot be tolerated any longer.

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ECONOMIC

OIL SERVES AS BOND TO STRENGTHEN JAPAN-MEXICAN RELATIONS

Tokyo BUSINESS JAPAN in English Vol 26, No 4 Apr 81 pp 41-47

[Article by Shigeo Tani, Americas-Oceania Division, International Trade Policy Bureau, Ministry of International Trade & Industry]

[Text]

WITH an area of 1,973,000 square kilometers – some five times that of Japan and the third largest in Central and South America – and a population of about 67 million, the second largest in Central and South America, Mexico is now attracting international attention as a well developed industrial country and a major oil producing one in the non-OPEC region.

It is well known that the country has been deepening its relationship with Japan in recent years. Especially its increasingly closer relations with Japan since last year through frequent personal exchanges and its efforts to enhance its mutual dependence with Japan in economic ties foretell the bright future of the relationship of these two countries.

Its closer ties with Japan in recent years were pioneered by the visit to Japan in April 1980 of José Andrés Oteyza, Minister of National Property and Industry and Mrs. José López Portillo, wife of President López in the same month. In October 1980, an economic conference between both countries was held in Tokyo. Mr. Raul Salinas Lozano, Director General of the Foreign Trade Agency, came to Japan to attend a Mexican exhibition. Other important guests from Mexico last year included Mr. Julio Rodolfo Moctezuma, chairman of the Committee for the Adjustment of National Development, and Mr. Jorge Diaz Serrano, governor of PEMEX, Mexico's national petroleum public corporation.

In addition, the late Prime Minister Masayoshi Ohira visited Mexico in May 1980, followed by Masumi Ezaki, a special envoy dispatched by the government who attended the Japan machinery fair in Mexico, and Parliamentary Vice Minister of International Trade and Industry Yamamoto who visited the country in November last year. This January, Rokusuke Tanaka, International Trade and Industry Minister, visited Mexico. Active personnel exchanges have thus been made between Japan and Mexico on both official and private levels.

With such continuing contacts between the two countries, the full-scale supply of oil was started last year by Mexico to Japan and two joint venture projects in the steel industry, one producing large-bore pipes and the other for manufacturing cast and forged steel products, were initiated, foretelling expanding economic relations between the countries in the coming years.

Reflecting the closer ties in economic fields, mutual trade has sharply expanded in recent years. Two-way trade in 1980 amounted to some $2,150 million, including $1,220 million from Japan and $930 million

from Mexico, about 3.5 times that in 1976.

The trade relations are characterized by the facts that both countries are important to each other as trade partners, the trade is mutually beneficial, and the trade balance is favorable to Japan.

As for the first fact, Mexico assumes second place in Japan's trade with Central and South American countries, though Mexico assumes only 29th place in Japan's exports and 30th place in Japan's imports. Japan assumes sixth place in Mexico's exports and second in Mexico's imports. Japan has thus become a highly important country for Mexico, playing a vital role in the Mexican economy. As Japan is expected to import from Mexico an increasing supply of oil, deepening its reliance on this source, the present characteristics of the trade relationship are expected to continue for a long time to come.

As for the second point, Mexico imports from Japan such important industrial products as machines, equipment and steel products, while Japan imports from Mexico silver (30% of Japan's total imports from Mexico), crude oil (20%), cotton (10%) and salt (10%). In order to foresee the trend of the trade between the countries, it is necessary to review Mexico's trade policy along with the fact that Japan's trade with Mexico has been always favorable. Mexico's exports to other regions of the world, however, have been expanding year after year since it started the full-scale supply of crude oil in 1977, and its total exports in 1979 expanded some 2.7 times over the figure for three years earlier.

Nevertheless, as Mexico's demand for equipment and material for its economic development sharply increased from 1978 along with the progress of its industrialization, its trade deficit has tended to expand. The figures reached $1,900 million in 1978 and as much as $3,200 million in 1979. In order to compensate for such huge deficits, Mexico has been exerting efforts to promote exports of farming and fishing products, and chemical products while restricting imports of some 200 items of non-essential products by adding them to the list of items for whose import permission must be obtained in advance. Though the weight of crude oil among its export items has sharply increased in recent years, judging from the Mexican government's basic policy of continuing crude oil exports only within a framework in which currency income accrued from such exports can be soundly absorbed into the nation's industrial production setup in the process of its industrialization, it is not likely that its crude oil exports will increase dramatically in the future. (In the Mexican government's plan for energy sources development announced last November, it was decided that foreign currency income accrued from oil exports should be maintained at below 50% of the nation's total foreign currency income.) Mexico has been also holding to its basic policy of avoiding excessive reliance on the U.S., and exerting efforts to diversify its trade partners. Against this background, Mexico has been insisting that its trade with Japan should be balanced without regard to crude oil and wants Japan to expand its imports of agricultural and fishery products, and chemical products.

As for the trade imbalance between the two countries, Japan's trade surplus sharply contracted to some $290 million in 1980 and it is expected that the balance will reverse this year as Japan's crude oil imports from Mexico will markedly increase.

In order to facilitate the trade relations with Mexico, however, Japan must keep the importance of the trade with Mexico in mind. When Japanese International Trade and Industry Minister Tanaka visited Mexico this January, he proposed the idea that Japan would dispatch a trade mission to Mexico to promote Japan's imports from Mexico. It is important for Japan to further exert efforts to promote mutual understanding to maintain amicable relations with Mexico.

Talks between both governments concerning the establishment of two joint ventures for producing steel products, including large-bore pipes and cast and forged products, were concluded last August, and it was decided that Japan's governmental funds (from the Economic Cooperation Funds) were to be provided for Japanese-Mexican joint ventures in

Mexico for the first time. Then investment companies were established in Japan for these projects. Following this, Grupo Industrial NKS, a joint venture company, was set up in Mexico last September to produce cast and forged products, and Productora Mexicana de Twberia was established in Mexico last November to manufacture large-bore pipes.

Minister Tanaka, on his visit to Mexico this January, also pledged to extend funds to Mexico in the form of mixed credits including yen credits amounting to ¥30 billion and export credits for Mexico's project to electrify the national railways and expand facilities. The funds will be provided when requirements are outlined by the Mexican government in concrete terms.

The Mexican government places expectations also on the possible cooperation of the Japanese government for such future projects as the construction of industrial ports, development of tourist resources and development of the fishing industry. The Mexican government hopes to obtain both capital and technical cooperation from Japan for these projects.

Mexico boasts huge crude oil reserves. Its confirmed oil reserves amount to some 60 billion barrels, according to a presidential message released in September 1980. Mexico's intention to diversify its sales of crude oil in order to develop its economy and Japan's policy to diversify the sources of crude oil imports correspond well with each other's needs. In August 1979 it was agreed by both governments that Mexico was to provide Japan with 100,000 barrels per day in 1980. The supply was started last April. The daily volume was finally achieved last October as pledged in the agreement with the average daily supply of some 35,000 barrels throughout 1980.

Since the late Prime Minister Ohira's visit to Mexico in May 1980, the Japanese government has been strongly requesting Mexico to supply 300,000 barrels of crude oil per day starting in 1982 at the latest. And Japan's International Trade and Industry Minister Tanaka successfully gained a pledge from the Mexican government that it would exert strenuous efforts to increase the supply to that level at the earliest possible opportunity. Great expectations are placed on this possibility. However, judging from Mexico's economic policy, and its oil policy which is directly connected with it, there are some difficulties in the way of any sharp increase in crude oil supply. Furthermore, the type of crude oil which is expected to increase in supply is what is known as Maja crude oil, a heavy-quality oil. If the increase is made in this type of crude oil, Japan's demand structure for oil products would be affected because of the peculiar nature of this type of crude oil. Also, in refining it, there would be some technical problems. Concessions must be made by both governments until the increased supply is materialized.

Japan's investments in Mexico have become active in recent years with the number of investments reaching some 160 valued at $730 million as of the end of last August. This assumes 2.3% of Japan's total overseas investments, and 12th place among countries in which Japan has ever invested.

Mexico wants Japan to invest more in the country. The Organization to Promote Investment in Mexico was set up in Japan in January 1980 and has been active in facilitating such investments as symbolized by its sending a mission to make a survey on the possibilities for such investments in Mexico.

It is not necessarily easy to promote overseas investments because of the strict foreign exchange law in Japan. But we would like to place expectations on the furtherance of such investments in Mexico by attempting to promote mutual understanding on both official and private levels.

Lastly, we would like to point out the facts that the Exhibition of Mexico of Tomorrow held last October in Tokyo under the co-sponsorship of the Japan External Trade Organization and the Foreign Trade Agency of the Mexican government was tremendously successful and the exhibition of Japanese-made machines and technology will be held again this May in Mexico. Mexico will hold another exhibition in Tokyo in the fall of 1982. These activities will serve to strengthen the friendly relationship between these two nations. □

CSO: 4120

SCIENCE AND TECHNOLOGY

PROGRESS IN BIOTECHNOLOGY DEVELOPMENT DESCRIBED

Legal Protection for New Plants

Tokyo NIKKAN KOGYO SHIMBUN in Japanese 22 Jan 81 p 1

[Text] With the newly legislated "seedling law," the Ministry of Agriculture, Forestry, and Fisheries has confirmed its policy of protecting new varieties of agricultural, forestry and fishery products to be developed by gene splicing or cell fusion, and has begun research. The objective is to promote the Japanese breeding industry, to counter the exclusive technologies of Euro-American conglomerates and others for developing new varieties, and to prepare against future food problems. At the same time, the ministry has established the new variety protection system as the third intellectual proprietary right, along with copyrights and industrial proprietary rights, and it plans to take the leadership in the biotechnology development program.

Leadership in Biotechnology Development Sought

The seedling law is a new law enacted in December 1978 to protect new plant varities. It is a radical revision of the agricultural seedling law, which was designed to protect only the names of varieties. As a result of the revision of this system, the newly created varieties themselves will be protected. Presently, 365 crops are protected, including food crops such as grains, industrial art crops, vegetables, feed crops, fruit trees, flowering plants and trees, mushrooms, seaweed, and so forth. One big difference from the patent law is that it includes field examination in which experts examine growth conditions, etc., of the applicants' varieties.

At the time this new variety protection system started, the chief objective was to register new varieties bred by using conventional techniques of asexual reproduction such as cutting and grafting, and sexual reproduction by pollination.

However, due to the recent remarkable developments in biotechnology, new techniques for developing new plant varieties, such as gene splicing and cell fusion, are highlighted, and the problem of protecting these techniques has emerged with importance.

In the field of cell fusion in particular, the Max Planck Institute of West Germany created a plant that did not previously exist, called a "pomato," a hybrid of a tomato and a potato, thus signaling the fact that the practical use of technology in the field of food production is near.

These techniques have come to be valued due to the circumstances that 1) the development of agricultural chemicals has become restricted because of environmental safety problems, 2) oil-dependent forms of agriculture have become difficult to maintain due to the energy crisis, and 3) the technological development related to chemical fertilizers has reached a peak, and growing revolutionary new varieties is regarded as the only way to tide over a worldwide food crisis in the future.

Because of all these reasons, giant capitalists in Euro-American countries have focused their attention early on the development of new varieties by gentic manipulation and cell fusion. For example, corporations such as FMC, ITT, Monsanto, Pfizer, Union Carbide, Upjohn, and Royal Dutch Shell have embarked on this industrial field.

Furthermore, in an effort to have exclusive genetic sources, the United States and the Soviet Union have taken a daring step by dispatching exploratory groups to the developing countries to seek the seeds which become the source of extant grains. (Many of the developing countries are native habitats of grains such as rice, wheat, etc.)

In view of these circumstances, the Ministry of Agriculture, Forestry, and Fisheries made the judgment that plant breeding is no longer in a pastoral state, in which it can be left to eager farmers or seed breeders as in the past, and has confirmed its plan to counter the Euro-American technological monopoly by promoting a breeding industry with full use of the seedling law.

To enforce it, they plan to grant exclusive rights, similar to the case with patented industrial inventions, to new plant varieties produced by gene splicing or cell fusion to promote participation from industrial fields such as pharmaceuticals, chemistry, food, etc., and elevate Japanese breeding technology to the top world level.

However, because of its involvement with the food problem, the granting of exclusive rights to such technology has a far greater influence on society than do industrial patent inventions. Therefore, the ministry plans to study a flexible operational method of "arbitration system" by asking opinions of antitrust lawyers.

Regarding breeding technology by genetic manipulation or cell fusion, the international office of the International Alliance for Protection of New Plant Varieties also has expressed its intention to protect [new varieties] by means of the above treaty. The plan of the Ministry of Agriculture, Forestry, and Fisheries has attracted great international interest as well.

Interferon Research

Tokyo NIKKAN KOGYO SHIMBUN in Japanese 26 Jan 81 p 3

[Text] Although the image of the "arrival of a cure-all anticancer dream drug" has faded, interferon still has the possibility of being the new drug of many dreams. Full-scale research will begin on the efficacy of the drug to determine the facts. The Ministry of Health and Welfare is studying the efficacy of interferon with its research project into the clinical application of interferon (R. Kono, team director; chief, central virus laboratory, National Health Institute), and arrangements have been made for the project to receive supplies

of three kinds of interferon that are considered to have the highest practical use in the world as pharmaceuticals. In addition to the F-type interferon of Toyo Rayon (uses human diploid cells), Midori Juji will supply 2 billion units of the L-I type (uses leukocytes) of interferon monthly beginning this March, and Sumitomo Chemical Co., Ltd. will supply the L-II type (uses transformed leukocytes) developed by Wellcome. Clinical studies will begin on each type. Furthermore, interferon produced by the recombinant DNA technique is expected to be added to the clinical studies in a project supplied by Roche, an American company, during the year. Thus, interferon from all over the world will be gathered in Japan. The clinical project will use these interferon varieties and move into the second stage of research in 1981, focusing on "cancer" and "hepatitis."

Full-Scale Clinical Research

A U.S. firm will also participate this year.

"Special studies on the clinical application of interferon" is the world's leading systematic clinical research project on interferon. The Ministry of Health and Welfare inaugurated it in JFY 1978, and the first stage of the clinical studies will be completed in March. These studies have examined the clinical efficacy of interferon, which was labeled a cure-all drug, by using 1) eye, 2) skin, 3) cancer, and 4) hepatitis patients. The interferon used was the F-type, developed independently by Toyo Rayon.

As a result, they obtained the confirmation that interferon "can become a medicine" against eye diseases (viral disease patients) (Kono). This view was endorsed by data from cases that did not heal with chemotherapy but were cured by the use of interferon, or that resulted in an efficacy that provided healing which was more nearly spontaneous than was true with chemotherapy.

When interferon was administered topically in 61 cases (111 injection sites) of various viral warts, it was proven to have superior efficacy by causing the disappearance of warts in 102 sites. In addition, in eight cases of patients with malignant melanoma, a type of skin cancer, revolutionary data were obtained: complete disappearance occurred in four cases, more than 90 percent disappeared in two cases, and 50-90 percent disappeared in one case. These clinical cases gave the impression that interferon may be used as a cure-all drug.

However, this interferon did not demonstrate the efficacy expected at the beginning as the most valuable drug for "anticancer effect." Effects were examined in patients with acute leukemia, gastric cancer, malignant lymphoma, and myeloma, but "no case showed effectiveness" (Kono). This result was entirely different from a report from Sweden stating that favorable results were obtained after using interferon to treat osteosarcoma. The reason, as interpreted by Kono and Y. Sakurai, director of the chemotherapy center of the cancer research group, is that the Swedish interferon, unlike the F-type interferon of Toyo Rayon, is of the L-type, yielding a different result.

Another conceivable reason is that these two kinds of interferon have different physical properties. The F-type has a molecular weight of 20,000 to 22,000 and shows a slightly unstable characteristic to heat; the L-type, on the other hand, is comprised of two kinds of molecules, one weighting 15,000 to 17,000 and the other 21,000 to 23,000, and is thermally stable. In addition, "although both F-type and L-type interferon are comprised of 166 amino acids., the arrangement of the amino acids is different." (K. Taniguchi, research staff in the cancer research group's chemistry section); this is also considered to have a bearing on the difference.

Therefore, different interferons can be produced by different kinds of cells from which interferon is prepared, and more new types are expected to be added in the future. At the same time, it has become necessary to study which interferon is effective against which type of cancer.

For example, this specificity is revealed in the fact that the F-type interferon of Toyo Rayon, when injected into a brain tumor, caused it to shrink. This is an achievement unprecedented in the world, and further clinical studies have become necessary. As interferon is analyzed, new questions also arise, such as what the effect of its combined use with chemotherapeutics would be.

Consequently, a new stage has arrived, as pointed out by Sakurai: "Although it was revealed that no drastic effect is present, numerous studies must be advanced by spurring clinical studies using more interferon." A large quantity of interferon is needed for this. Based upon past examples, it is said that a total of 200 million units of interferon per cancer patient is indispensable. In order to study the various types of cancers, an enormous amount of interferon is necessary.

Toyo Rayon is currently supplying the clinical research project of the Ministry of Health and Welfare with 2 billion units of interferon monthly, and [the company] plans to increase it to 4 billion units by 1985. Toyo Rayon's interferon uses human diploid cells (fibroblasts) as the interferon-producing cells.

The technique involves growing these cells on a glass surface by using a multiple-step plate culture technique, and then stimulating these cells with poly IC (a polymer of inocinic acid and cytidine monophosphate) to have them release interferon into the culture media. A reasonable technique has been perfected, and the remaining problems involve how to mass-culture the diploid cells that have a proliferation limit, and how to extract interferon that has high purity.

In order to perfect this technology, the firm was granted a commissioned development fund (870 million yen) by the Research Development Corporation of Japan (Y. Takeyasu, managing director), and it is working to solidify the structure that enables it to supply sufficient interferon. Moreover, the firm "is also preparing for interferon production using the recombinant DNA technique" (Y. Hara, assistant chief, R&D planning division), considering the massive supplies expected in the future.

Midori Juji has also participated from the beginning in the applied clinical research of the Ministry of Health and Welfare. It was commissioned (a fund of 880 million yen) by the Research Development Corporation of Japan to develop interferon, as was Toyo Rayon, and it is producing interferon. The company plans to begin supplying 2 billion units of interferon per month, beginning in March.

This firm uses human leukocytes to produce interferon. The technique involves adding Sendai virus of Newcastle Disease virus to leukocytes as an agent to induce them to release interferon into the culture media. The purification of interferon took time, but the problem has been solved and the structure for supplying interferon is in order.

Since this interferon is the same type as the Swedish interferon, it can be used as the material to determine its effectiveness against osteosarcoma, and the clinical results are being looked forward to. If, however, the clinical results are the same as Toyo Rayon's, the drug cannot hold great expectations as a new carcinostatic agent. Consequently, it is being watched attentively. On the other hand, the interferon that Sumitomo Chemical imports from the British Wellcome Foundation is obtained from lymphoblasts, cancerized leukocytes. Because of the simple proliferation of lymphoblasts, it has the merit that interferon can be obtained in large quantities.

However, there is a risk that the interferon produced will become contaminated with foreign carcinogenic substances, and so its use is limited to cancer patients. As an L-type interferon of a slight different type, however, its efficacy is also being watched, and its clinical results are also looked forward to.

No other country is systematically studying these three types of interferon, and the Japanese research project on clinical application is attracting attention in various countries, with the anticipation of unveiling interferon and solving many mysteries.

(Note) Interferon--Cells of animals infected simultaneously by two kinds of viruses are affected by only one of them, but when the two kinds of viruses act in combination, the cells receive a destructive blow. A substance that causes this interference of viruses was confirmed in 1950 and was named "interferon," meaning a substance that causes an interference.

Consequently, it demonstrates various effects on viruses. It does not act directly on viruses, however, but demonstrates actions such as increasing the activity of a substance that inhibits viral proliferation in the cells invaded by a virus, or producing antiviral proteins.

Studies on the clinical applications are being made, but the most important fact is that interferon cannot be used "clinically" unless it is produced by human cells.

Industrial Competition

Tokyo NIKKEI SANGYO SHIMBUN in Japanese 29 Jan 81 p 1

[Text] Major chemical companies began to spurt all at once for commercialization of pharmaceutical and chemical products using biotechnological means such as genetic engineering. Since they had fallen behind Euro-American enterprises in the practical development of inteferon, the so-called "new dream drug," they set out with vigorous rollback tactics, sensing the necessity for some breakthrough in the field in order to win future international completion. At the same time, the present synthetic chemistry industry, centered on the petroleum chemistry, has virtually reached a fully developed technical stage, and no major technical innovations

such as have been seen in the past are in prospect with respect to lowering costs. Thus, various firms are hoping to lead other firms in bioengineering technology, which holds unknown possibilities. Industrial competition focusing on biotechnology will be more keen in the future.

Mitsubishi Chemical Industry and Showa Denko in the forefront

Major Chemical firms involved in biotechnology

(Corporate Names)	(Name of Research Facilities)	(Recent Specific Activities)
Mitsubishi Chem. Industries, Ltd.	Life Science Research Inst. Mitsubishi Chem. Ind.	Developing new pharmaceuticals using gene-splicing technique.
Sumitomo Chem. Co., Ltd.	Biological Chemical Research Institute	Goal of practical development of interferon by cell culture
Showa Denko	Biochemical Research Laboratory	Commercialization of amino acids by semisynthetic processes, using fermentation techniques
Mitsubishi Petro-chemical Co., Ltd.	Biochemical Research Dept., Central Research Labortary	Mass production by recombinant DNA of enzymes for screening pharmaceuticals
Mitsui Petro-checmial Ind.	Biochemical Research Dept., Scientific Research Laboratory	Work designed to develop pharmaceuticals through mass culture of plant cells

At present, Mitsubishi Chemical Industries, the biggest firm in the chemical industry, is regarded as having the greatest accumulation in biotechnology. Although that firm exceeds its competitor, Sumitomo Chemical Co., Ltd., in sales, it is behind Sumitomo Chemical in the fine chemical field of pharmaceuticals, agricultural chemicals, etc. For this reason, it wishes to maintain its position as the top manufacturer of all chemicals by developing new pharmaceuticals using biotechnology as the weapon.

Mitsubishi Chemical Industries confirmed its policy to mass-produce certain physiologically active substances manufactured in the human body by using the gene-splicing technique. As in the case of Eli Lilly in the United States and Hoffmann-LaRoche in Switzerland, which have as their target the practical development of insulin and interferon, respectively, [Mitsubishi Chemical's] intention is to remove from human cells those genes that have the information to manufacture the substances, and to mass-produce them by splicing them into E. coli, etc., which have extremely rapid growth. Compared to Lilly and Roche, which are already in the clinical testing stage in which the mass-produced pharmaceuticals are administered to man, the company is lagging behind, as it is still in the gene "splicing" test stage. However, the company is determined "to commercialize in 5-6 years" (M. Niwa, director, Life Science Research Laboratory, Mitsubishi Chemical Industries, Ltd.).

On the other hand, Sumitomo Chemical Co., imported the technology for manufacturing interferon from the British pharmaceutical manfacturer Wellcome in August last year. Besides recombinant DNA, there are several techniques to mass-produce substances

such as interferon that the human body produces. The technology that Sumitomo Chemical imported is a technique for the continuous cultivation of one type of neoplastic leukocyte. The company's plan is to enter the interferon market, which is considered promising for now, by borrowing another firm's technology. The company, also is full of fighting spirit to catch up with Mitsubishi Chemical. H. Masatomo, managing director, states: "We would like to emphasize independent pharmaceutical development using genetic engineering technology, etc., in the future."

Opposing them, Showa Denko recently established a technique that enables it to lower the production cost of tryptophan, one of the essential amino acides, by using fermentation technology. They plan to market the tryptophan manufactured by this process as a feed additive sometime this year. Amino acids are made in the living body to begin with. Until now, however, the mass production process for industry has been possible only through chemical synthesis. But because it is a substance produced by complex reactions in the body, its synthesis is difficult and costly. Showa Denko's technique is called a semisynthesis process; man synthesizes the easy half and relies for the rest on the fermentation action of bacteria which has the property to manufacture tryptophan. According to industrial sources, Mitsui Toatsu Chemicals Ind. is planning to venture into the amino acid field using fermentation technology, and it is also developing a similar technique.

In addition, Mitsui Petrochemical Ind. emphasizes plant tissue culture and is aiming to market the products by using this technique sometime this year. Mitsubishi Petrochemical Ind. also is mass-producing enzymes by recombinant DNA for pharmaceutical screening. Thus, various companies are showing active movement. Furthermore, various companies are now beginning to emphasize the development of new chemical substances and the establishment of new processes for existing chemicals by applying biotechnology techniques.

Newspaper Commentators' Views

Tokyo NIHON KEIZAI SHIMBUN in Japanese 30 Jan 81 p 8

[Y. Shioya, K. Murakawa, Y. Takagi, Science and Technology Section; Moderator: T. Kono, chief, Science and Technology Section]

[Text] Biotechnology fever has been aroused in industrial circles. It was triggered by the development of genetic engineering, a "magical" new technology in which revolutionary new medicines are manufactured using E. coli. Does biotechnology hold a force for innovation comparable to electronics, currently in its heyday, as is being whispered in industrial circles? In addition, progress in biotechnology is even about to realize a cloned man, previously conceivable only in the world of science fiction, as well as revolutionary genetic therapy. Regarding biotechnology, in which expectations for innovative technology and fears of the "manipulation of life" are mixed, journalists in charge of science and technology for this newspaper exchanged their views.

The fever backstage

Moderator: Biologists are amazed at the recent biotechnology boom in industrial circles, saying: "We never have had such an experience." Particularly, "genetic engineering fever" seems to be conspicuous in Kabutocho [Japan's Wall Street] and Kitahama....

A. In the stock market, it is said that regardless of food, medicine, or chemicals, names that appear to have the slightest involvement are being bought one after another. For example, the stock of a firm that deals with a reagent called restriction enzyme, which is used in genetic engineering, is being bought even though the enzyme does not contribute very much to the sales. Things have become a bit overheated.

C. However, it has recently been disclosed that there is a trend to formulate a joint common research organization centered on Toyo Rayon and on prominent companies of the Mitsui group such as Mitsui Toatsu Chemicals, Mitsui Petrochemical Ind., etc. It is certain that they have seriously begun considering the necessity of developing biotechnology.

Moderator: Speaking of competition, I understand there is a shortage of talent in this field, and outstanding researchers are being vigorously recruited worldwide.

B. In Japan, also, those firms with foresight have been making efforts to train personnel by dispatching researchers to Euro-American universities, etc., for several years. However, the laggards that have just become aware of this importance, after being stimulated by the recent biotechnology fever, have begun hastily securing talent. Consequently, the shortage of talent has suddenly become apparent. Japanese researchers in this field are very active. However, the majority of them are working in Euro-American universities or national research organizations. There are apparently 40-50 researchers in the United States alone. Some firms prepared a talent map of Japanese researchers in the United States and are planning to recruit researchers from among them. But researchers in this field have by nature a strong belief in advancing research based on their own scientific interests. It is questionable whether they will easily respond to corporate persuasions for application first and commercialization first.

C. The Mitsui group's plan to formulate a common research organization also seems to have as an objective the formation of support for talent.

A. A surprising fact recently is that enterprises in different fields, such as shipbuilding firms, plants, engineering, etc., have also begun to show interest in biotechnology. For example, at Mitsui Shipbuilding, Chairman I. Yamashita and his subordinates are enormously involved. However, they do not directly handle microorganisms or genes, as do the pharmaceutical or chemical companies, but place emphasis on developing peripheral technology such as fermentation tanks or fermentation plant control techniques.

Moderator: Approximately what scale of growth potential does the biotechnological industry have in the future?

C. There is an estimate of 3 trillion yen in one of the biotechnological fields, genetic engineering concerns, alone. However, this is a very rough calculation, and it is difficult to forecast the future market scale now. It is certain, however, that this is a basic technology in which great expansion can be expected in the future.

Moderator: Compared with the electronics industry, which produced television and computers, how does it fare as a future technological innovative force?

A. The electronics of today is a technology that first blossomed because of the modern physics introduced in the first half of the 20th century--especially the basic science called quantum theory. Biotechnology is about a leap forward as an industrial technology based on biology, which made rapid progress after World War II, especially focused on the genetic engineering that appeared due to achievements in molecular biology, which attempts to understand life phenomena on the chemical level.

B. However, biotechnology is not going to manufacture new products like television sets or computers. I think it is a production technology for manufacturing existing commodities at low cost by conserving energy. Consequently, the fields of application are extremely broad, from pharmaceuticals to petrochemicals, agriculture, and energy. But, it must compete with conventional technology. I suspect that the road to commercialization may be harsher than expected.

Moderator: Euro-American countries are apparently even more enthusiastic about biotechnology than Japan.

C. In Europe, government and private bodies are working together. Semigovernment, semiprivate biotechnology research development enterprises are being established one after another, such as GBF (a bioengineering research institute) of West Germany, Transgene of France, Celltech of England.

A. In the United States, they do it a little differently. Although it is not quite a revival of the pioneering spirit of the West, private venture business has the leadership and is selling its technology to the world.

B. Genentech, Cetus, Genex, and Agrigene.... Genetic venture is indeed in full bloom.

Moderator: What is formidadble in the United States is the fact that giant capital is backing these ventures.

C. Cetus is backed by SOCAL, a major oil company. It is said that they are building a test plant in order to put to practical use the applied technology of the enzyme industry for petrochemical processes developed by Cetus with an investment of 15 million dollars.

B. Genentech is collaborating with the top insulin manufacturer, Eli Lilly, and the world's biggest pharmaceutical firm, Hoffmann-La Roche.

Moderator: Because of the technological accumulation in the fermentation industry, Japan is regarded as an advanced country in biotechnology, but we should not be caught off-guard. It appears that the Japanese Government also has begun to emphasize biotechnology so as not to fall behind Euro-American countries.

B. The next-generation basic industrial technology program of the Ministry of International Trade and Industry is a starter; the ministries of Agriculture, Forestry and Fisheries and of Education, as well as the Science and Technology Agency, each planned projects independently, causing the ill effect of divided administration, as usual.

The Ministry of Agriculture, Forestry, and Fisheries, by mobilizing the work force of the affiliated research organizations, emphasizes that it is the main house for biotechnology; the Ministry of International Trade and Industry counters with the technological and research association system, gathering vitality from the private sector; the Science and Technology Agency also asserts its position, using the role of "regulatory agency" as its shield mainly at the life science promotion division of the National Health Institute.

Light and Shadow

Moderator: Against this excessive enthusiasm, criticism of the promotion of biotechnology has been heard lately.

B. Progress in reproductive control techniques such as extracorporeal fertilization, cloned animals, surrogate mothers, etc., are related to biotechnology, and such shaded areas of this technology and their social effects are increasingly being pointed out.

A. In the field of animal husbandry, the surrogate mother has already become a practical technique, and fertilized bovine eggs of superior stock have been transplanted into "poor stock cows" to have them deliver calves of good stock. Reproductive control techniques, such as transplantation, artificial insemination, and multiple ovulation to produce twins and triplets, have precedence in the livestock industry, but according to the experts they are directly applicable to man if he wants them.

C. In that sense, the problem of life science related to social ethics is widely debated, and in fact, it is in need of some rules for research. For the moment, however, we have only the stereotyped warning to "put a brake on reckless research."

A. A certain scholar has stated: "Things are only at the stage of gaining the awareness of the general public." To be sure, it is necessary first of all to have accurate knowledge regarding biotechnology. Otherwise, it will end up in an unproductive argument between the cheap proponent theory for acquiring budget and research funds and the allergic-type opponent theory. I believe it is necessary to have more specific discussions.

Moderator: The question is whether social values and ethics allow it.

C. Technical feasibility and whether or not to use it in human society are entirely different questions. It is improper to relate the cloned mice in Switzerland directly to cloned man and to the mass production of Hitler's copies, and thereby to insist on terminating such research.

A. The time when we will be able to produce a copy of a man from a single human dermal cell is still a long way off. Cloned mice is a big topic in the sense that it constitutes research necessary to detect carcinogenic mechanisms or the process of cellular differentiation.

Moderator: Genetic engineering came into the limelight because of the manufacturing of interferon by an American firm, Genetech, and of a pure amino acid by Ajinomoto, among others. What else is attracting attention as a technology to support biotechnology?

B. The "tissue culture" well known as Toyo Rayon's interferon manufacturing process and the "cell fusion" being advanced by Mochida Pharmaceutical to develop a manufacturing technique for immunodiagnostic agents are attracting attention.

C. Tissue culture means sampling a part of the human body and propagating the cellular tissue. It is difficult to grow and propagate cells in an artificial environment such as a container, but if it can be done we can grow pancreatic cells and have them directly produce insulin for diabetes. An artificial liver also becomes feasible.

Moderator: What is produced by cell fusion?

C. Immune antibodies that kill viruses and bacteria by attaching themselves to them are produced by white blood cells. It is difficult to produce such antibodies commercially by artificially creating an environment identical to the inside of animal bodies. However, there are hardy white blood cells that grow anywhere. So they are fused with white blood cells that produce immune antibodies by using special viruses or special chemicals, and hybrid white blood cells are formed and cultured. The idea is to use antibodies produced in this way as diagnostic reagents.

A. The Max Planck Institute of West Germany is producing a "pomato" by fusing the cells of a potato and a tomato. Although it is possible to grow the plants hybrid cells into an adult plant, as in the pomato, it is very difficult to grow the hybrid cells of animals or animal and plants into a perfect parent.

Moderator: It is said that the final goal of biotechnology is the bioreactor....

A. This is a future technology seen in science fiction, whereby chemical factories no longer are gigantic plants, and everything is made by the system.

B. A living organism can be called an "ultraprecision chemical-production factory." If it can be applied to industrial production, a very efficient system can be developed that will save energy and resources. Bioreactors simulate this system.

C. Living organisms produce substances by combining many kinds of highly efficient catalysts (enzymes). Although that stage has not been reached, Tanabe Seiyaku for the first time in the world made practical a technique for fixed enzymes where one kind of enzyme is fixed by enveloping it with macromolecules so that the enzyme can be used for a long time. It is still the world leader.

Moderator: However, an ideal bioreactor cannot be made unless genetic engineering, cell fusion, tissue culture, etc. are combined properly.

A. For example, create a copious amount of microorganisms in which the genes of a milk cow are inserted by genetic engineering, and then fix all of them. Next, add chopped hay into the bioreactor tank, and milk will come out the bottom. Such a dreamlike mechanism is not entirely inconceivable.

B. However, rather than develop something like an "empty treasure chest" by spending an immeasurable amount of money and time the skillful conversion of existing inefficient chemical processes has priority. For example, Cetus Corp. has developed a system to use fixed enzymes in the process of manufacturing ethylene oxide and propylene oxide, raw materials for synthetic fibers and plastic by oxidizing ethylene and propylene.

A. Biotechnology, which is sometimes called the "second atomic power," has a broad base, and each field should be subjected to thorough assessment and be individually defined. Otherwise, it may well be terminated after merely dancing to the tune without being accepted by society.

C. There is also a problem of application for biological agents. I believe we have come to the stage where certain ordinances should be made as soon as possible between the developing party and the receiving society.

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SCIENCE AND TECHNOLOGY

U.S.-JAPAN TIE-UP TO SEEK MASS PRODUCTION OF INTERFERON

Tokyo BUSINESS JAPAN in English Vol 26, No 4 Apr 81 pp 28-29

[Text]

Green Cross, a drug manufacturer based in Osaka, announced on February 12 that it had signed an agreement with Collaborative Research Incorporated of Massachusetts, a leading American genetic research company, commissioning the latter to conduct research on mass production of interferon (IF) through recombination of yeast genes. The use of yeast bacteria, which is said to be more suited than colon bacillus germs for commercial production of IF, is revolutionary and without precedent. It is planned to complete the development of the process for mass production by May, and efforts will be made to get commercial production under way in a year and a half.

Green Cross has also reached an agreement with GENEX of Maryland to produce albumin from serum protein through colon bacillus germs, a two-year research and development project.

These agreements are the first joint effort on recombination of genes between a Japanese firm and American companies. If plans proceed as scheduled, gene engineering, which is regarded as the last industrial frontier, will have made great progress toward practical application of recombinant genes.

Yeast bacteria has been used since olden times as the fermenting agent in the production of alcoholic beverages, such as wine, beer and sake, and in condiments such as soy sauce, as well as for pickling. Compared to colon bacilli, it is safer and the technologies for cultivation and commercial production are very advanced. Although single-cell organisms, they belong to a high order, having functions similar to cells in human beings, animals and plants which make recombination of genes more difficult than in the case of colon bacillus germs. If recombination can be successfully achieved, it will be possible to obtain a much greater volume of proteins, such as interferon, from yeast bacteria than from colon bacilli.

In the mass production of IF using yeast bacteria, Green Cross claims that the process is very much the same as in fermenting beer. After it receives yeast bacteria with recombination genes from Collaborative Research, the company says it will seek to start commercial production within a year, or two at the most. Cost is expected to be less than one-tenth that of interferon made from white blood cells now being used in clinical tests. A dosage of one million units will cost less than $5.

As a result of these latest tie-ups, the drug industry in Japan will be thrust into the field of gene recombination on its home ground. Interferon is regarded as a new "dream drug" that holds the possibility of controlling cancer and all types of diseases caused by viruses, but at the present time there is an acute shortage of the drug for clinical use. It is believed that the recombination of yeast genes, along with the recombination of colon bacil-

lus genes, will quickly solve the supply problem which is holding up progress in gene engineering.

Also, if albumin can be commercially produced, efforts will surely be made to produce other drugs from serum. It may not be long before similar techniques will be applied to antibiotics and vaccines.

It will be the first time in the world that commercial production of interferon will be achieved through a recombination of yeast bacteria genes. There is also no precedent for drugs manufactured from serum being put to practical use.

Gene research in Japan has just started. Since gene engineering is now being taken up in both the public and private sectors, the latest tie-up agreements are sure to rock the entire drug industry.

New Phase in Gene Engineering

(Comment by Professor Yasuharu Oshima, expert on fermentation at Osaka University)

The commercial production of yeast bacteria genes through recombination opens up a new phase in gene engineering. My feeling is: Has it already progressed so far? As can be seen from the history of rice wine production, yeast bacteria can be cultivated on the basis of experience alone. It is extremely suited for commercial production. If recombination of genes progresses successfully it will be possible to use a variant yeast to produce rice wine first and then medical drugs. The Japanese are confident of their fermentation technology. If experts in the fields of chemicals, organisms and fermentation collaborate under capable leadership, the development of gene recombination in Japan comparable to that in the United States is very possible. I believe that Japan can catch up with the United States in this field just as it did with motor vehicles and computers.

CSO: 4120

SCIENCE AND TECHNOLOGY

JAPAN LAUNCHES DOMESTICALLY-PRODUCED N-II ROCKET

Tokyo BUSINESS JAPAN in English Vol 26, No 4 Apr 81 pp 25-26

[Text]

The first N-II, Japan's largest rocket, which will enable Japan to launch its own satellites for practical use, was shot into the atmosphere carrying the experimental satellite ETS-4 at 5:30 p.m. on February 11 from Tanegashima Space Center in Kyushu.

The N-II was launched for the purpose of confirming its ability to lift stationary satellites, and successfully put the ETS-4 in transfer orbit, one stage prior to the stationary orbit. That the satellite entered the destined orbit was confirmed in the afternoon of February 12, after detailed calculations were made when the satellite had circled around the earth and returned to pass over Japan. After 7 p.m. on the 11th, the National Space Agnecy announced, "The rocket made its flight accurately and the satellite separated from the rocket 27 minutes 34 seconds after launching and is presumed to have entered the destined orbit." The satellite was named "Kiku No. 3."

According to the program, Kiku No. 3 was scheduled to be placed in an elliptical orbit with a perigee of 230 kilometers and an apogee of 36,000 kilometers on a 10-1/2 hour cycle. Kiku No. 3 is Japan's 21st artificial satellite. It is the 18th launched by a Japanese-made rocket.

Since September 1975, the National Space Agency has used the N-I rocket to launch six artificial satellites, among them the Ume No. 2, a utility satellite to observe the ionosphere. Since 1976, the Agnecy has been endeavoring to develop a rocket of a higher power. In comparison with N-I, N-II is 2.8 meters longer and 45 tons heavier. Also, the solid-fuel supplementary rockets attached to the first stage were increased from the N-I's three to nine.

With the N-I, the flight was radio-controlled by the ground station, but with the N-II, the inertia inductive method of correcting orbital error was used for the first time to control the flight automatically by electronic instruments loaded in the second stage of the rocket. Also, whereas N-I is capable of lifting satellites of only the 130-kilogram class into stationary orbit, N-II is capable of lifting satellites of the 350-kilogram class and has three times the accuracy of its predecessor in placing a satellite into the planned orbit.

ETS-4 is the first large satellite to be produced solely with Japan's own technology. It is cylinder-shaped, 2.8 meters tall, 2.1 meters in diameter, and 64 kilograms in weight. Because the main purpose of this launching is

to confirm the flight efficiency of the N-II rocket, the satellite will not be stationary. The main body is loaded with numerous electronic instruments utilizing the most advanced technology in space development, such as an earth scanning sensor and pulse plasma engines, which will undergo space operation tests for approximately three months.

N-II Rocket Resume: The N-II rocket is Japan's largest rocket, replacing the previous N-I rocket, and is capable of lifting stationary satellites of the 350-kilogram class. It is 35.4 meters in length, 2.4 meters in diameter, weighs 134.7 tons and has three stages. The first and second stages of the rocket use liquid fuel and the third stage uses solid fuel. The first stage is equipped with nine supplementary rockets. It costs approximately ¥10.1 billion to manufacture one N-II rocket. The N-II is scheduled to launch eight satellites by 1985, including the stationary weather satellite No. 2 (GMS-2) which is to be launched in the summer of 1981 and the stationary communications satellite No. 2 (CS-2b) to be launched in 1983.

CSO: 4120

SCIENCE AND TECHNOLOGY

HITACHI PROJECTS TOTAL FACTORY OPERATION BY COMPUTERIZED ROBOTS

Tokyo BUSINESS JAPAN in English Vol 26, No 4 Apr 81 pp 26-27

[Text]

Hitachi Ltd. has launched a project to develop a robot to replace completely assembly-line workers. Its entire technical staff is involved in the effort. This includes the company's 5 laboratories and 17 factories with the Production Technology Department serving as the nucleus. According to the program, the company will introduce industrial robots to 60% of its mechanical assembly process five years hence, and eventually realize factories with unmanned workshops. In this project Hitachi aims at completing an intelligent robot which has built-in micro-computers as its brain. has senses of sight and touch, and moves, keeping pace with the flow of an assembly line. The company plans to commercialize the robots after it has installed them in its own factories.

This "assembly-line rationalization project" will involve some 500 technical staff members. There was a similar effort some years ago when a project team of 150 staff members was organized to produce video tape recorders at the Tokai factory in Katsuta City, Ibaraki Prefecture. The new project is on a far larger scale.

Hitachi has undertaken this project of developing an assembly robot because it has judged that manpower saving through the automation of assembly work, which constitutes a major part of the manufacturing process, will be a decisive factor in improving the company's labor productivity in the 1980s. According to an analysis of work at various factories of the company, assembly work takes up the largest amount of time, accounting for 35% of the standard working hours of all Hitachi employees, followed by mechanical work 15% and testing work 10%. Other work accounted for the remaining 40%. The company plans to reduce the number of its assembly-line workers by 70% of the present number by introducing robots, and at the same time, to improve productivity by 70%. Predictably, the introduction of robots will be accompanied by such labor management problems as personnel reassignment, but the company intends to cope with the problems through re-education and transfers for its assembly-line workers. As the company expects a particularly serious shortage of technical staff dealing with software, it will follow a policy of training blue-collar workers to fill the vacancies in this field. According to the plan, five years from now, the company will have some factories where blue-collar workers will completely disappear from assembly lines, which will be managed and operated by white-collar workers.

The new development project encompasses (1) standardization of assembly robots, (2) development of tools which will serve as limbs for the robots, (3) improvement in software and (4) development of sensors which will serve as sensory organs for the robots. In the field of software, the System Development Laboratory and

the Production Technology Laboratory of the company will lead the efforts to develop a robot language. As regards development of sensors, Hitachi Laboratory will take charge of the sense of sight, the Central Laboratory the sense of touch, and the Mobara factory in Chiba Prefecture and the Sawa and Naka factories in Ibaraki Prefecture will join in development efforts. A special feature of this project is the practical application of an assembly robot with attachments for walking, a new concept, with the aim of diminishing the amount of space it requires in a factory. At Hitachi Ltd. 150 industrial robots are currently in use, doing handling and welding work. Five years hence, the number of robots will be increased to about 600, most of them on assembly lines. If everything goes well, unmanned assembly lines will appear in some of Hitachi's factories as early as in the latter half of 1982.

Japan is said to be an "advanced country" for robot development, and Hitachi is one of the representative robot manufacturers. At its Narashino factory in Chiba Prefecture it produces some 30 industrial robots a month. It also plans to commercialize the new robots and put them on the market when they are fully developed.

CSO: 4120

SCIENCE AND TECHNOLOGY

HITACHI CHALLENGES IBM WITH HIGH-SPEED GIANT COMPUTER

Tokyo BUSINESS JAPAN in English Vol 26, No 4 Apr 81 pp 27-28

[Text]

Hitachi, Ltd. has recently placed on the market a super giant computer, HITAC-M-280H, and a medium-sized computer, HITAC-240H, the former being the world's fastest in computation. M-280 has been developed by Hitachi to rival the IBM-3081 that IBM introduced last November. This is the first attempt by any Japanese computer manufacturer to compete with IBM in the field of super giant computers. Hitachi's new giant computer has adopted in its logic circuits highly advanced hardware such as LSIs and photo channel adaptors with the world's fastest integrations and speeds. Hitachi has also prepared wide-ranging unbundling and 25 program products as software in direct confrontation with IBM's products.

This new computer has adopted as its logic circuits ECL-LSIs with 1,500 gates (circuit delay of 0.8 nano-seconds)/chip and 550 gates (circuit delay of 0.45 nano-seconds)/chip, the fastest integrations and speeds in the world. Especially the circuit delay of 0.45 nano-seconds in the case of the latter LSI with 550 gates/chip is 50% to twice as fast as conventional products.

Its control memory and buffer memory, each with a speed of 1K bits, are of bipolar type with an access time of 7 nano-seconds. The speeds of its main memory are 64K bits (with an access time of 150 nano-seconds) and 16K bits (with an access time of 100 nano-seconds).

The maximum capacity of its main memory is 32 bytes while the maximum number of connected channels is 32. Its total throughput is as fast as 90M bytes/sec. Hitachi believes that with such tremendous performance the new giant computer can well compete with fast computers made by IBM and other manufacturers for several years to come in total systems and TSS response.

As a result, in Gibson MIPS, it boasts 17 MIPS, 10% faster than IBM-3081 and the world's fastest in computation. This is also 20% faster than Nippon Electric Co.'s ACOS System 1000. In the case of the compact HITAC M-240H, its computation speed is 12 MIPS.

It has adopted photo channel adaptors in order to utilize photo fiber in its hardware. As a result, CPU's (central processing units) can be connected with a cable with a maximum length of 3,000 meters and a CPU and an input-output unit with a cable 1,000 meters long.

The fact that the new giant computer is equipped with so many program products is attracting wide attention. Hitachi has prepared such varied software in order to compete with IBM not only in the performance and price of hardware but also in software so as to definitely emerge as the winner in the giant-computer competition. Hitachi has prepared 25 program products including dispersed management programs, DISM/H, and host command control programs, HCCF/H.

The prices of the new computers start from ¥40 million per month for M-280H and ¥10 million per month for M-240H. Deliveries will start from the latter half of this year, roughly the same period as that of the IBM-3081.

Hitachi expects that within four years it can sell 120 M-280Hs and 500 M-240Hs.

CSO: 4120

SCIENCE AND TECHNOLOGY

IC, MACHINE TOOL INDUSTRY CONTINUES TO EXPAND

Tokyo BUSINESS JAPAN in English Vol 26, No 4 Apr 81 pp 33-34

[Text]

BADLY affected by the recession following the second oil crisis in 1979, most of Japan's industries are suffering from dull business. But there are exceptions and some industries are enjoying unprecedentedly good sales and favorable business results. They include those producing video tape recorders (VTRs), integrated circuits (ICs), machine tools, cameras, watches, and several others. Along with the progress in electronics, these industries have continued to show remarkable progress in output and sales. Exports are also steadily increasing. At the same time, it is obvious that they are exerting utmost efforts to develop highly advanced technologies and to increase sales.

VTRs

There has been a sudden increase in demand from general consumers for video tape recorders which now rival color TVs as the most popular choice when purchasing visual/audio equipment. The industry's total output of VTRs last year increased by 80% over the previous year to ¥730 billion including sales of video cameras and tapes. On the contrary, the output of color TV sets showed an increase of only 11% to ¥710 billion.

The number of units produced reached 4,430,000, roughly double that of the previous year. According to Matsushita Electric Industrial Co., the industry's output is expected to further increase by 50% to 6.5 million units this year. The prices of popular-type VTRs have now been reduced to less than ¥130,000, a factor that has sharply increased both domestic sales and exports.

One VTR maker says that the diffusion of VTRs is only at the threshold, and that great expectations are being placed on expanding sales in the future. The domestic diffusion rate at the present time is only some 7%, a figure that is expected to surpass 10% this summer. According to Tokyo Shibaura Electric Co. (Toshiba), all VTR makers are optimistic over the future growth of sales which are expected to show explosive growth.

Other VTR makers include only Philips of the Netherlands and Grundich of West Germany. The superiority of Japanese VTRs seems to be secure. All Japanese makers are increasing their outputs. Toshiba, above all, intends to triple its VTR production within this year.

However, there are some difficulties facing the optimistic Japanese VTR manufacturers. Austria, for instance, has recently taken action to restrict the import of Japanese-made VTRs, which might lead to a widespread trade boycott. Another problem is that an excise tax of 5% will be

imposed on VTRs from this October. The tax will be raised to 10% from next October and further to 15% in October 1983.

If trade friction becomes widespread in EC countries, Japan's VTR exports will be seriously affected. When the excise tax is imposed, the makers say, they will have to increase the prices of their products, perhaps from next year.

ICs and Semiconductors

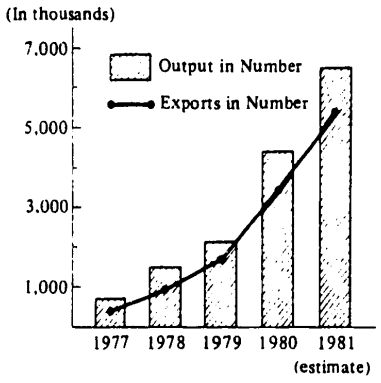
The output of ICs and semiconductors increased by 35% in value last year, but according to production estimates for this years, the output growth rate is expected to slow down to approximately 23% or so this year. All the manufacturers, however, agree that their output last year showed an excessive growth and feel that a 20% growth is more realistic. Plant and equipment investments in fiscal 1981 are expected to surpass those in the previous fiscal year. The industry's total production of ICs and semiconductors is expected to exceed the ¥1-trillion level for the first time in history this year.

The main factor that is supporting this tremendous growth is the export of ICs which assumes roughly two-thirds of the total output. While the output of ICs increased by 49% in value last year over the previous year, exports showed an increase of 69%. In addition, demand for ICs for general use is very strong as symbolized by VTRs which take almost the entire output of transistors produced by one leading manufacturer. One of the marketing managers says, "Japan's IC and semiconductor industry is far superior to its U.S. counterpart as its exports are still rapidly increasing because of the high quality of products. In addition domestic demand is still strong for use in general-purpose equipment."

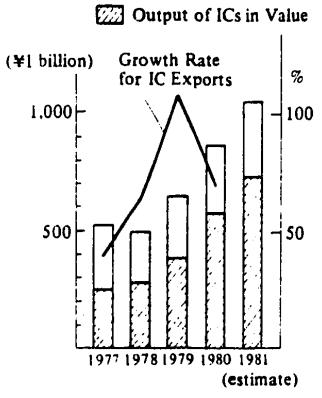
But the dark side of the IC industry is represented by 16 kilo memory elements for computers and ICs for use in automobiles. As the manufacturers produced an excessive number of memory elements, last summer's inventories reached a level corresponding to a five-month demand. The appropriate level is considered to be one to one and a half month's consumption. Prices tumbled and the unit price is now around $2, less than half the original retail price. But at least one manufacturer is still confident. "The prices will regain their original level by this summer," he says.

The competition among manufacturers is becoming more and more intensified. "Of the leading 20 manu-

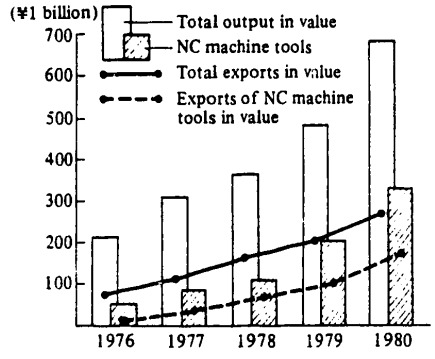
Output and Export of VTRs



Output of ICs and Semiconductors in Value and IC Export Growth Rate



Output and Export of Machine Tools in Value



facturers throughout the world, only five will be able to survive the harsh competition," says the manager of a leading manufacturing company.

Machine Tools

Against the background of active plant and equipment investments for labor saving in industries centered around the auto industry and favorable exports destined for the U.S. and Europe, the machine tool industry is enjoying expanding sales. The industry's total output in 1976 was ¥228,600 million including sales of the 68 member companies of the Japan Machine Tool Industry Association. Last year, however, the output reached ¥683 billion, roughly tripling in only five years. Exports also increased from ¥76,100 million in 1976 to ¥269,600 million, or 3.5 times.

Especially favorable are sales of numerically-controlled (NC) lathes supported by electronic technology and machining centers with built-in automatic tool changers (ATCs). These machining centers can be used for varied purposes such as drilling, thread cutting, grinding and milling.

The ratio of NC machine tools against the total output of machine tools was only 22% in 1976, but it reached more than 50% last year.

Japan's machine tool industry has been successful in taking the lead in the world's machine industry by skillfully adopting electronic technology. However, the EC Commission has recently decided to monitor Japan's exports of machine tools along with Japanese-made autos and color TV sets. Reflecting these unfavorable factors – and they have become phenomenal recently – Japan's machine tool industry has become prudent in investing in plants and equipment. No optimistic outlook can be anticipated by the industry.

Cameras

Leading camera manufacturers unanimously agree that the camera industry suffered most seriously from the depression in 1965 immediately after the Olympic Games in Tokyo, but this was their only setback. The industry was quick to recover from the depression following the first oil crisis in 1973. Accordingly, the industry has been enjoying a high level of sales for more than 10 years. In value, the industry's output increased by 17.4% in 1978, 9.3% in 1979 and 13% in 1980.

Though some people in the industry are cautious in their outlook – "Our exports are expected to drop considerably in growth rate from last year's 22% because of the uncertain business activities in the U.S. and the highly appreciated yen quotation," they say – many others insist, "Both our domestic sales and exports will increase by well over 20% this year with the output expected to exceed the ¥500-billion level.

Concerning the reasons for this success, industry sources explain, "We have developed new functions one after another such as automatic operation, the wider use of electronics, built-in flash units, automatic focusing and others. We have thus been creating new demands and exerting efforts to decrease costs, successfully widening the range of demand."

As for camera exports that assume more than 60% of the industry's total output, the president of one of the manufacturing companies says, "Our world market share reaches 100% in single lens reflex cameras and as high as 75% in middle-priced cameras. Yet we have not had trade friction problems." The camera industry is expected to enjoy highly favorable sales throughout the world for many years to come.

Watches

Domestic sales of watches, which have generally increased by 12% or so a year, showed an increase of only 6% last year because of sluggish personal spending. The industry expects that sales will recover in the latter half of this year along with the recovery of personal consumption.

What makes the outlook of the industry bright, however, is highly favorable exports. While no precise statistics are available yet concerning the number of units produced last year, the industry's output appears to have increased by 43% over the previous year to around 86 million units. Exports accounted for the steep increase.

Though it is expected that conventional mechanical watches are fated to gradually disappear because of the appearance of quartz watches, these old-type watches showed explosive sales in the Middle and Near East and Central and South America last year, and favorable sales are continuing. The industry's output of such watches increased by 30% last year and the industry has been forced to further increase production.

A key to the future growth of the industry is in determining how to expand the world demand for watches that now stands at 330 million a year.

CSO: 4120

SCIENCE AND TECHNOLOGY

TELECOMMUNICATIONS HEAD DISCUSSES PROGRESS IN COMMUNICATIONS SYSTEM

Tokyo BUSINESS JAPAN in English Vol 26, No 4 Apr 81 p 61

[Article by Arinobu Morizumi, Director General of Telecommunications, Ministry or Posts & Telecommunications]

[Text]

THE greatest problem relating to Japan's telecommunications immediately after World War II was to establish policies to rehabilitate and expand the telecommunications facilities that had suffered a crushing blow during the war so as to restore telecommunications services to the people. In order to achieve this goal, the government introduced legislation concerning telecommunications in the first half of the 1950s and established the basis for the current monopolistic setup for supplying public telecommunications services. These consist of Kokusai Denshin Denwa Co., Ltd. (KDD) and Nippon Telegraph and Telephone Public Corp. (NTT). As for domestic public telecommunications services, NTT has, since fiscal 1953, been exerting efforts to complete its facilities to fill the backlog of orders for installing telephone sets and to computerize all telephones throughout the country. Plans to expand telegraph and telephone services have been undertaken six times. Along with the marked growth of the nation's economy and the raising of the standard of living, demand for telephones increased at an unexpectedly rapid pace. NTT achieved its main targets through its managerial efforts and technical renovations in the first half of the 1970s. As a result, Japan's telecommunications are recognized by many nations for the quality of its uniform nationwide services as well as its technology. The number of telephone subscribers is expected to reach some 38,660,000 soon, about 25 times that at the time when NTT was established.

In the field of international telecommunications, KDD has exerted great efforts in installing wide-band communication trunk lines such as submarine cables and international satellite communications. Along with the diffusion and expansion of domestic communication networks in many countries, KDD has formed a global network of communications, thus enlarging Japan's vital role in the international society.

The diffusion and expansion of telephone services have thus reached a very high level, both domestically and internationally. In accordance with the improvement in the people's living, and the diversification and enhancement of society, new telephone equipment has been developed and communication services with moving vehicles – automobiles, trains, ships and aircraft – are being steadily expanded.

Along with the rapid progress of electronics and new demands from business, industry and the general public, more advanced and diversified communication means such as data communication and picture communication are becoming widespread.

Data communication, which uniformly transmits and processes data by connecting computers with communication circuits, was launched in fiscal 1964 in Japan. Since fiscal 1971 when restrictions placed on the use of telecommunications circuits were lifted, data communication has rapidly become widespread. During fiscal 1979, NTT counted for data communication 4,668 systems including management of inventories for sales, scientific and technical computations, information on the distribution of perishable foods and medical information. These services are now playing a vital role for the nation's industrial and economic activities.

In order to cope with such rapidly increasing diversified and improved utilization of telecommunications, the existing communication networks centered around telephone networks are rarely sufficient. New digital communication networks that can fit new technologies represented by very large scale integration and computers will be needed. For this purpose, NTT has begun to offer network services designed for new types of data communication. Known as DDX, a circuit exchange service was introduced in December 1979 and packet exchange service in July 1980. In addition, KDD has started in 1980 an international computer access service (ICAS) which maintains direct connection with a data base in the U.S., allowing retrieval of various information on line. Data communication between both countries is thus actively being promoted.

Along with data communication, facsimile communication is also rapidly growing. This method of communication is most suitable for Japan as complex Chinese characters are used in writing. Since 1971 when telecommunications systems were revised, facsimile communication has shown rapid diffusion, supported by the fact that the performance of facsimile has improved and costs have been reduced. The number of facsimile units now being used in Japan totals more than 100,000, the second largest number after the U.S.

The development of telecommunications heavily depends on technical progress. Constant efforts to promote research and development are needed. It is also necessary to establish highly reliable and economical telecommunications networks on a nationwide scale. Specialized equipment is a basic requirement. Negotiations between the United States and Japan concerning NTT's equipment procurement based on GATT (General Agreement on Tariffs and Trade) regulations on government procurement, as agreed to at the Tokyo Round (multiple trade negotiations) for the purpose of expanding trade, were concluded at the end of last year. As a result, NTT adopted ths so-called three-level system including competitive bidding and two stages of joint development. The new system took effect on January 1, 1981.

Development of the most advanced technologies through international competition and joint research and development among advanced industrial countries will assure the further progress of pioneering technologies. To promote this goal, NTT is responsible for encouraging competitive biddings, both internationally and domestically, concerning the procurement of required equipment and materials. On the basis of the newly concluded agreement, NTT is exerting efforts to implement the new procedures for procuring equipment and materials. □

CSO: 4120

SCIENCE AND TECHNOLOGY

NTT'S COMMUNICATIONS TECHNOLOGY FOR INFORMATION-ORIENTED SOCIETY DESCRIBED

Tokyo BUSINESS JAPAN in English Vol 26, No 4 Apr 81 pp 65-74

[Article by Masaya Yamauchi, Managing Director and Chief Engineer, Nippon Telegraph & Telephone Public Corporation]

[Text]

TODAY telecommunications networks in Japan have spread to cover every part of the nation, becoming indispensable for business, industry and the people in general. The role played by telecommunications as the central nerve center of our economic and social activities has become increasily important. At the end of fiscal 1979, the total number of telephones in use in Japan reached 53,630,000, which made Japan second in the world following only the United States, while the number of telephones per 100 people was 46.0, which ranked Japan in seventh spot.

On the other hand, the development of electronics such as LSI has accelerated creation of new telecommunications media, and is making required telecommunications services more sophisticated and diversified.

Under such circumstances, the role to be played by Nippon Telegraph & Telephone Public Corporation (NTT), Japan's principal provider of telecommunication services, is considered to be of vital importance as a knowledge-intensive industry. As such, it has a great responsibility for promoting techonological research and development.

For that reason, we of NTT must, first of all, strive for qualitative improvement in our telephone service so as to meet the needs of our technically advanced society, taking into account that telephone service will continue to be the main part of NTT's business, and that we have already become able to fully meet the quantitative demand for telephone service. In the future, NTT will promote the development of new, easy-to-use, low-cost telephone services, while at the same time improving the style concept and convenience of the equipment.

Secondly, NTT also must strive for expansion of various services other than the telephone service. To accomplish this, formation of a new communications network will become necessary. In addition to this, we must strive for further expansion of digital data exchange systems such as circuit switching and packet switching systems, construction of a public facsimile communication network, and the development of visual information services represented by CAPTAINS (Character and Pattern Telephone Access Information System) and VRS (Video Response System).

Thirdly, although our telecommunications technology has already attained the highest level in the world, we must continue our efforts, laying emphasis on the development of both basic and new technologies such as LSI, digital and optical fiber communication technology.

Digitalization of a network is very effective in terms of economy, reliability and flexibility. NTT plans to

digitalize individual networks such as the digital data network, public facsimile communication network and others whose digitalization is urgently required, while at the same time digitalization of the telephone network also is to be promoted. As a future plan, the individual networks will be integrated, and further efforts will be made to construct an integrated-services digital network (ISDN) aiming at a telecommunications network that enables economic and efficient provision of convenient, easy-to-use and diverse telecommunications services.

Improvement of Telephone Service

As to the telephone service, the basic service that enables us in general to talk with anyone no matter how distant the place on a real-time basis has already been realized. However, this situation is still far from the ideal telephone service where any person can communicate with any other person anytime and anywhere. For example, even though telephone conversations can be made from vehicles such as automobiles, trains and ships, or with the hard of hearing, these services are utilized only to a limited extent. It cannot be claimed, therefore, that the demands of the nation are fully being met.

Automobile radio telephone service was first provided in December 1979 in 23 Wards of Tokyo as a mobile communication service. At present, the service is provided in the Tokyo and Osaka areas. The service area will be gradually expanded to meet future demands.

Furthermore, NTT began selling in January 1980 the "Silver Phone Hibiki," a bone conduction telephone, for those with serious hearing problems who were not aided by "Silver Phone Meiryo," an earlier model for the hard of hearing.

Cordless telephone sets equipped with a radio circuit (using frequencies of 250 MHz band and 400 MHz band) replacing the cord on regular subscriber telephone set can be carried anywhere for convenient use. Cordless telephone sets were introduced into service in May 1980 in four cities, Tokyo, Yokohama, Nagoya and Osaka.

Collect call service was inaugurated in August 1980.

Data telephones equipped with an instrument to display the telephone number called on pushphones (push-button telephone sets) and provided with a store-and-forward function of the telephone number called can be used as an input/output device for data communication as well by connecting it to a data processing center for processing such transactions as credit card verification, sales management, reservation and credit advice. Sales of this data telephone began in December 1980 in Tokyo, Osaka and Nagoya.

In addition, the development of the EK-50 type key telephone system is being promoted to realize improvement in service functions and miniaturization of paired cables through introduction of microprocessors in an area where the number of extension telephones exceeds 20.

Data Communications Services

Data communications have made steady progress. With the recent development of communications and computer technology, the variety of material processed by data communications has become wider and the equipment more sophisticated. The number of domestic data communications systems at the end of fiscal 1979 reached 4,668, while at the same time domestic data communications circuits in use totaled 107,086,

Since the telephone network has its limitations in transmitting digital signals, NTT has promoted the development of a digital data exchange network to overcome this problem. A circuit switching service was inaugurated in December 1979 and packet switching service in July 1980 as advanced data communication services for digital transmission and switching. In the circuit switching service, a circuit is set up for each communication, as in the case of the telephone network, and communication is made between two terminals at the same rate of speed. The multiplex time-division signals are transmitted over a digital transmission route. Since digital signals are switched without conversion, high reliability can be secured. In case of the packet switching service, data is

not directly transmitted and received between the sender and receiver, but is first divided into single packets of 256 octets (1 octet = 8 bits). After they are once stored in the switching equipment as packets with address information, they are transferred through the switched network and sent to the addressee. Each time a packet is transferred, error control is conducted, resulting in very high transmission quality. Furthermore, the packet switching system allows communication between terminals with different rates of speed, and thereby permits flexible system configuration.

Visual Communication Services

Visual communication services now under development are facsimile, CAPTAINS, VRS and video conference services.

Facsimile service has rapidly come into wide use in Japan where complicated kanji characters form the basis of writing since transmission of the kanji is possible and because no full-time operator is needed for this service as is required for telex service, this system has become widely used. At present, Japan ranks second in the world – the United States is first – in facsimile-transmitting equipment in use with a number that now exceeds 100,000. From the viewpoint of popularization of facsimile, NTT has promoted the development of a subscriber facsimile communication system, incorporating easy-to-use, inexpensive and compact facsimile equipment with a network having diverse service functions suitable for facsimile communications such as multiple address communication and automatic reception. This system is expected to be put into service very soon.

The development of an interactive visual information system is now in progress in technically advanced countries. This system enables a user to obtain whatever information he wants from the large volume of information stored whenever and however much he wants as visual information through his access to visual information centers from his terminal combining a regular TV set with a pushbutton telephone set. In Japan, the system called CAPTAINS has been under joint experiments since December 1979 by the Ministry of Posts and Telecommunications and NTT.

Furthermore, NTT began experiments on VRS in January 1979 in the center of Tokyo, for the time being on an inhouse VRS system serving some 100 terminals as the test subjects. This system, differing from CAPTAINS based on character and pattern information, is capable of handling instantaneously color pictures, information in motion and sounds, in addition to character and pattern information. At present, experiments are being conducted by adding a new digital-type information file and expanding the functions of the system.

Finally, the video conference system, which can connect two conference rooms located at a distance from each other by video and audio, enables its users to see the conferees in another conference room on a TV screen, and to participate in a video conference as if they were in the same room. NTT has been conducting since 1976 a monitor test on the video conference service offered for public use between Tokyo and Osaka. Furthermore, NTT has developed a low-cost video conference system which can be installed in a user's building or on his premise. This system has been undergoing tests since March 1978 between Tokyo and Osaka with satisfactory results.

Basic Technologies to Support Services

We are promoting the development of various basic technologies in order to support the previously mentioned services, to add sophisticated functions and to meet the ever-increasing needs for new services.

LSI Technology: LSI is expected to contribute not only to computers but also to other telecommunications equipment such as switching equipment, transmission equipment and terminal equipment as very important elements to support the future telecommunications systems. LSI made of a large number of interconnected fine elements has shown rapid improvement. The number of elements we can put on a chip has been doubled each year, thanks to the improvement in fine element processing techniques such as the electron beam exposure technique. At present, a 64 Kbit/chip

RAM (random access memory) containing tens of thousands of memory elements on a silicon chip of several mm. square is being introduced into information processing equipment in the DIPS 11/5 series. Furthermore, we have developed a 256 Kbit/chip MOS memory, the highest integration in the world, which contains some 580,000 elements on a silicon chip some 6 mm. square, and successfully confirmed its performance.

Digital Technology: The rapid development of LSI technology in recent years has brought about drastic changes in circuit systems, mounting, equipment constitution and software technologies, and has had a great impact on transmission and switching systems. Furthermore, it was LSI technology that made the digital system possible, replacing the traditional analog system. The digital system translates every signal into a combination of "1" and "0" pulses, and a pulse train is multiplexed on a time division basis for transmission and switching.

NTT is vigorously promoting the development and introduction of digital transmission and switching systems. Digital transmission systems which have already been introduced into commercial use are the DC-100M System (1,440 voice channels/system) applicable to medium and short distance routes over coaxial cable, the DC-400M System (5,760 voice channels/system) having the largest transmission capacity in the world as a digital transmission system and applicable to long distance routes, and the 20 GHz Band Radio PCM System (20L-PI System having a capacity of 5,760 voice channels/system) applicable to long distance transmission routes up to 2,500 kilometers. Furthermore, for a digital radio transmission system, we are promoting the development of 5 GHz Band Digital Radio System (transmission capacity of 200 Mb/s/sys) through the improvement of utilization efficiency of frequencies by using the 16QAM modulation system, thanks to the development of multilevel modulation and demodulation technology.

As to digital switching systems, we are promoting the development of digital switching equipment which forms message channels with electronic components such as LSIs, differing from the ones of the existing switching equipment, and converts the pulse train of digital signals passed through a transmission route, changing the positional relationship in terms of time and space for every message unit. Digitalization of switching equipment will be undertaken starting with interoffice switching equipment and followed by local switching equipment.

Software Techonology: With the progress of electronization of equipment due to the advance of electronic technology, software is expected to become the nucleus of all technologies, while at the same time the volume of software and its importance are increasing rapidly. Since an enormous amount of expenditure is needed for the development of software, and its preparation is labor-intensive viewed from the international point of view, it is a challenge to improve software programming productivity.

To meet this challenge, and to promote reduction in software development costs, productivity improvement such as curtailment of the development period, quality improvement such as reliability, flexibility and capability, and improvement in maintenance, we are striving to adopt software development techniques, and to develop equipment to automatically produce software products and high level language capability to facilitate programming and maintenance.

Optical Fiber Communications Technology: The optical fiber communications system uses optical fibers as its transmission line, and transmits information over lightwaves. We have developed completely OH free VAD optical fiber system of less than 0.5 db/km with longer wavelengths ranging from 1.2μm to 1.7μm by refining the optical fiber manufacturing method (VAD method) which was developed by the joint efforts of Ibaraki Electrical Communication Laboratory and three electric wire manufacturers in 1976, and by adopting a high-degree purification method by which impurities in the fiber can be reduced to less than one ppb (one billionth). This has removed some restrictions on optical fiber communications, made a wavelength division multiplexing system possible, and

taken a great step toward the development of lightwave communications.

The first field trial of a lightwave communications system was conducted in 1978, centering on a 48-core multi-mode optical fiber cable over a distance of approximately 20 kilometers between the Karagasaki Controlling Radio Relay Station and the Hamacho Telephone Office in Tokyo. Subsequently, the second field trial was carried out over an 18 kilometer distance in Kawasaki in 1980 with satisfactory results. Commercial testing is scheduled to start this year.

Satellite Communications Technology: Satellite communications has the capability of transmitting high-quality information to any place on earth, irrespective of geographical features, providing signals over a wide area, as compared with the existing communications lines. In December 1977, "Sakura," a medium-capacity geostationary communications satellite for experimental use, was launched from Japan to undertake various experiments.

NTT is now developing demand-assigned time division multiple access equipment capable of improving the utilization efficiency of communications satellite channels by severalfold, and a lightweight (some 2.2 tons) 30/20 GHz band small earth station that can be installed on a rooftop, aiming at the development of the communications satellite II (CS-2) which is scheduled to be launched in 1982. For the time being, CS-2 will be used for public communications circuits with the purposes of providing reliable communications at times of emergencies, setting up communications lines with isolated islands and remote areas, and setting up additional circuits at ordinary times.

Establishment of an Integrated Digital Network

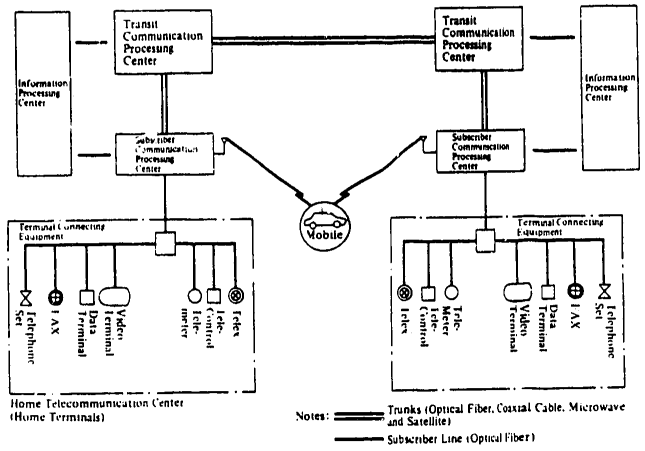
Telecommunication services have been provided so far by separate and independent networks such as the telephone network for telephone service, the telex network and the telegraph switching network. In recent years, however, computers have come to be used widely in every field of our social and economic activities. As a result, the volume of digital information has increased, while at the same time semi-conductor components technology such as LSI or digital signal processing technology has shown remarkable progress. It has become practical to transmit in a digital form not only data signals but video signals such as facsimile which is analog information in itself and even telephone signals. Consequently, it is now possible to establish an integrated services digital network (ISDN) aiming at a telecommunications network capable of providing convenient, easy-to-use and diverse telecommunications services economically and efficiently through integration of individual digital networks at the final stage. Prior to that, individual digital networks suitable for data communications and facsimile communication must be constructed and the telephone network also must be digitalized.

For the above reasons, NTT is steadily promoting digitalization of individual networks such as the digital data network and the public facsimile communication network, aiming at creating an integrated system.

Conclusion

For NTT, whose business has entered into a more creative area along with the progress of the so-called information society, there can be no obvious indicators of future developments as we could count on before, and it seems that the smooth technological developments as we have progressively achieved in the past can no longer be expected in the future. However, we accept this as a challenge. It is our intention to make further efforts to meet the expectations of the nation through our vigorous research and development activities so as to provide new and improved services economically and efficiently by merging new ideas with new technologies. ◘

Conceptual Diagram of a Future Telecommunications Network



CSO: 4120

SCIENCE AND TECHNOLOGY

NEW HEAT PUMP SYSTEM TO ACHIEVE GREAT ENERGY SAVINGS DESCRIBED

Tokyo BUSINESS JAPAN in English Vol 26, No 4 Apr 81 pp 91-94

[Article by Takehiko Shimura, Technical Official, Office for Promoting the Moonlight Project, Agency of Industrial Science & Technology]

[Text]

JAPAN'S energy consumption amounted to some 390 million kiloliters calculated in terms of oil in fiscal 1975. If Japan is to achieve sound economic growth, its energy consumption in 1985 is expected to reach as much as 740 million kiloliters in terms of oil even though great effort is exerted to save on energy consumption. The nation's oil imports are estimated to total 510 million kiloliters. It is evident that in case the import of such a huge volume of oil becomes difficult, not only the alternative use of coal, natural gas, nuclear energy and hydraulic power but also the development of such new energy sources as solar energy, geothermal energy, wind power and wave power will be needed. Improvement in the performance of machinery and equipment in the consumption of such primary energies does not lead to the expanded effective use of primary energies as compared to the development of pioneering technologies, but when compared to the efforts required, such improvements in machinery and equipment will generate effective results and can be achieved in a comparatively short period of time. The effort should not be made light of.

In the Moonlight Project, in order to improve the power generating efficiency and contribute to the promotion of thermal power generation with coal, three large-scale projects are being promoted, including the development of MHD (magnetohydrodynamic) power generation, and the development of new systems for storing power generated with cells.

Along with these projects, another large-scale project to develop new technologies to save energy consumption is under way. This research and development is aimed at developing new systems to utilize waste heat. Emphasis is placed in this project on the effective recycling of restored waste energy exhausted in the form of heat in order to enhance the general efficiency of primary energies utilized in machinery and facilities.

In fiscal 1975, of the nation's total energy consumption, the steel industry assumed 18.0%, the energy division including the power industry 32.2%, the transport industry 15.4%, the agriculture, forestry and fishery division 2.5%, and the general public 23.5%. As seen above, the steel industry and all the mining and manufacturing divisions including the energy division assumed the largest part of the nation's energy consumption. Furthermore, some 48% of energy consumed in these divisions is discharged as waste heat, regardless of actual utilization, into the atmosphere, rivers and the sea. In many cases, such waste heat generates pollution in various forms. Even though recovered, such waste

heat is low-grade energy in most cases and has been recycled for cost reasons. Conventional difficulties in utilizing waste heat must be overcome by developing new technologies to utilize it.

Based on this concept, the research and development of a new technical system to utilize waste heat was started in fiscal 1976 as a quasi-large-scale project for the purpose of developing technologies to recover and utilize waste heat from factories including steel mills. Along with the initiation in fiscal 1978 of the Moonlight Project that is intended to develop new technologies to cut energy consumption in general, the former project was included in the program and more strenuous efforts have been exerted to promote research and development. This project is expected to be concluded in fiscal 1981, we would like to introduce in this article a new heat pump system which has been developed to recover heat from warm waste water with a temperature from 30° to 60°C.

Heat from warm waste water with a temperature from 30° to 60°C is plentiful but of low grade, and has rarely been utilized. But if such heat is used as a heat source for a heat pump to generate hot water or steam, it becomes highly useful. Conventional heat pumps, however, have been able to generate hot water with a temperature of only 60°C or so. If it becomes possible to efficiently generate hot water with a temperature from 70° to 90°C or brine with a temperature lower than -10°C for making ice from such low-grade heat, regional air-conditioning can be materialized almost without requiring additional energy from some other source. But, as mentioned above, conventional technologies have been generally unable to generate warm water with a temperature of more than 50°C or cold water colder than 0°C. In this project, therefore, research and development have been conducted to work out a compression-type high temperature heat pump system to generate processed hot water with a temperature from 100° to 160°C utilizing heat recovered from low-temperature waste water. Another one is an absorption-type heat pump system that is designed to generate refrigeration utilizing warm waste water as a heat source. These studies have been entrusted to private research organizations.

Compression-Type Heat Pump System

As shown in Diagram 1, the compression-type heat pump system is designed to generate process hot water with a temperature from 100° to 160°C utilizing heat from low-temperature waste water. The system envisions new-type vaporizing equipment adopting the principle of flush vaporization and designed to vaporize a heat medium with a low boiling point by means of the heat of warm waste water (30 to 60°C). The vaporized heat media is compressed in the screw compressor whose rotor is sealed with a heat medium. The temperature of the heat medium is raised through this process. The temperature is further raised through the high-temperature generator, adopting the principle of the absorption-type in studies conducted thus far that high-temperature water from 100° to 160°C. Designs of all elements of the machine were started in fiscal 1977 and various technical problems have been studied by repeating trial manufacture and operation of related machines and equipment. Studies were finished in the first half of fiscal 1979. Methods to control the system as assembled as a heat pump have been studied. In fiscal 1980, a pilot plant combining all the components was manufactured. It has been confirmed in studies conducted thus far that high-temperature water from 100° to 160°C can be gained from warm waste water with a temperature of 60°C. The pilot plant manufactured (450,000 kcal/hr) is one-twentieth in size as compared with an actual plant and its screw compressor is driven by a diesel engine.

Absorption-Type Heat Pump System

Three types of heat pumps are included in the absorption-type heat pump system. The first one uses warm waste water as a heat source but needs a high temperature exterior heat source for driving the pump. The second pump needs no energy to drive itself but needs cooling water. The third one is an ice making cycling machine that is designed to generate cold water for cooling and brine for ice making from hot water and cold water generated by the second-

type absorption heat pump. The development of all these machines is being promoted. Another stage of this development will be to work out a plant for heating and cooling through general systematization of these machines. Diagram 2 indicates the principle of the heat pump.

Basic experiments were started in fiscal 1977 and trial manufacture of each part has been repeated. As for the first-type absorption heat pump, studies were completed in fiscal 1979 and this new type heat pump is now commercially produced as an alternative for ordinary boilers. Concerning the second-type heat pump, a pilot plant (120,000 kcal/hr) was constructed in fiscal 1980 and is being remodeled to improve its efficiency. As for the ice making cycling machine also, it has been found that brine of less than -12°C can be realized by using warm waste water of 60°C as a heat source. Now a pilot plant is being remodeled to more thoroughly test the process. These pilot plants are one-thirtieth in size as compared with actual plants.

If abundant low-temperature warm waste water can be recycled in the form of hot water or cold water through the above methods, oil consumption can be reduced to 3/5 as compared to conventional methods using boilers, ice making machines, etc. In addition, the average depreciation period of these heat pumps has been found to be one year or so. In this respect also, efforts are being made to put them to practical use in the shortest possible time. ■

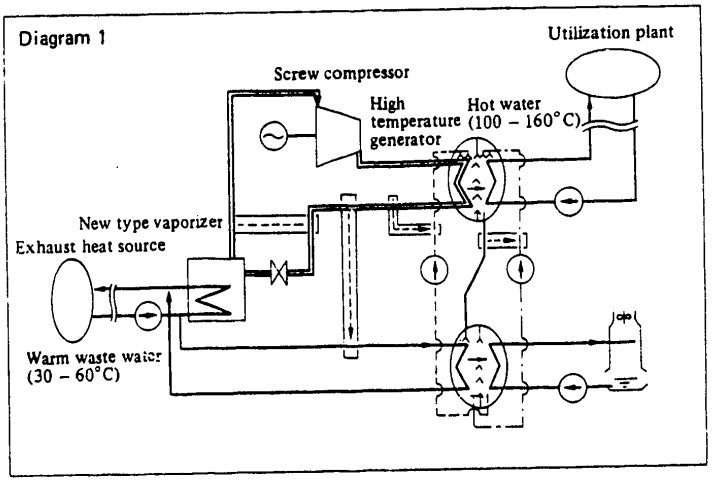
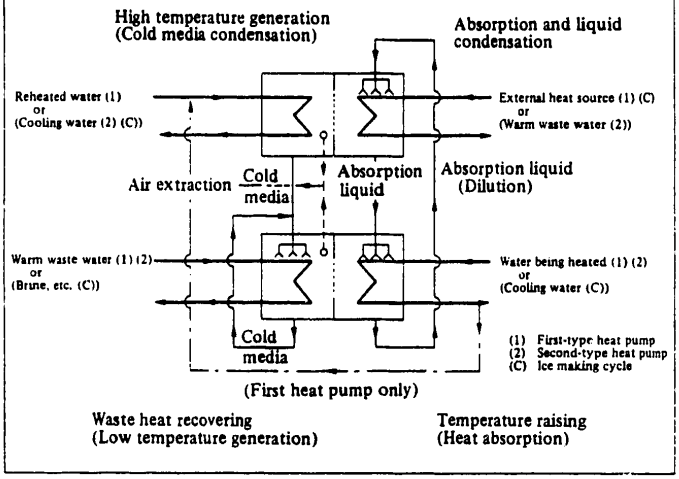


Diagram 2



CSO: 4120

SCIENCE AND TECHNOLOGY

AIRCRAFT INDUSTRY DEVELOPMENT INCREASES

Helicopter Industry

Tokyo NIKKEI SANGYO SHIMBUN in Japanese 8 Jan 81 p 7

[Text] In the Japanese aircraft industry where there is always a lot of talk about both commercial and military planes, the policy of boosting the helicopter sector has surfaced as an issue. Although recently the helicopter industry is introducing new model projects almost yearly, the three makers--Kawasaki Heavy Industries, Mitsubishi Heavy Industries, and Fuji Heavy Industries--still lack strength to get out of the present license production based on imported technology and start cultivating the market on their own. At last, the Kawasaki Heavy Industries is beginning to make it on its own through international joint development; however, it seems that before a "helicopter with the [Japanese national flag of] Rising Sun" can "take off" on a full scale, there will be many problems in terms of both personnel and money.

Production Would Be Fxpansion-Based

The Defense Agency plans to procure in large quantities the armed ground attack support helicopter, "AH1S," which will be used by the Ground Self Defense Force as of 1982. The AH1S, developed by America's Bell Helicopter, is equipped with missles (4 on each side) and 70 mm rockets on its slim 0.9 m-wide body; it is capable of attacking tank forces at low altitudes, skimming just above the ground level. The Ground Self Defense Force has imported one in 1979 and another in 1980, and is testing them; they plan to have a total of about 50 craft ready for battle in the future. In case of quantity procurement, it is likely that a domestic manufacturer would produce them on license basis and that would most likely be Fuji Heavy Industries.

For the past 2 years, Mitsubishi Heavy Industries has been producing ASW [antisubmarine warfare] helicopters, the "HSS2B." This model is an improved version of the "HSS2" developed by Sikorsky Corporation of the United States and produced by Mitsubishi Heavy Industries on license; the improvement by Mitsubishi includes its ability to be carried on ships and better ASW equipment. According to the Defense Agency's mid-term operations estimate, which constitute its equipment budget plan, 51 craft will be purchased by fiscal 1984 and it is expected that the HSS2B "is the model for which there will be the heaviest demand in the helicopter industry in the future" (according to an industry spokesman).

Also, Kawaskai Heavy Industries has, since the latter half of last year, begun mass-production of "BK117," a multi-purpose helicopter which is a product of joint development with West Germany's MBB [Messerschmitt-Bölkow-Blohm]. By the end of last year the two companies received orders totaling some 120 craft. Kawasaki Heavy Industries is emphasizing this model as its new mainstay for future commercial demands. Although these three companies are moving in three different directions, at a glance, it would appear that the Japanese helicopter industry is steadily moving toward improved technology and increased production.

Not Good Enough for the World Market

The actual state of the industry, however, is so weak that "judging from the present situation, it will take more than 10 years before Japan's comprehensive forces of technology and sales can compete in the world market," (according to Kozo Hirata, managing director, the Society of Japanese Aerospace Industry Association). "To begin with we are decidedly too short of eingeers to take a leap in the future," (says Kenji Ikeda, managing director, Mitsubishi Heavy Industries). Even Kawasaki Heavy Industries, which has the best record in terms of both the number of models produced and production volumes, says that, "Of the 600 technicians working on aircraft body, the helicopter personnel numbers only 150; therefore we cannot help but priortize research and development" (says Moto Yoshiwaka, director, Rotary Wing Aircraft Sales Dept., Aircraft Division).

Each company is engaged in many long-term projects which require a great number of engineers. These include the new YX (YXX, the next term commercial aircraft), MTX (next term intermediate-level training jet), STOL (short take-off and landing) research craft, and CCV (reflex improvement aircraft). Consequently, even if a company wants to transfer engineers from the fixed wing division, it cannot do so because of shortage in engineers in that division. In addition, because "among the aircraft, the helicopter is most mechanically involved, there are that many more difficult technologies to consider, such as those involving vibration, automatic stabilizer, etc" (according to Atsushi Kasai, managing director and director of the Aircraft Division, Fuji Heavy Industries). This further aggravates the shortage of engineers.

In terms of finance, too, it cannot be said that the industry is on a sound footing. At present, the total annual production of helicopters by the three companies is valued at a mere 28 billion yen (just 10 percent of the entire aircraft industry). It is said that the development of a new helicopter would cost at least 10 billion yen, and furthermore that "both in terms of technology and sales, the risks are high," (according to Toshiro Murai, director, Aircraft Dept., Mitsubishi Heavy Industries). A company cannot simply increase the amount of development investment. In this respect, Kawasaki Heavy Industries' development of BK117 is seen by the industry sources as a "valiant undertaking."

Consequently, the present position of the respective manfacturers is that of "waiting for the development and production of military aircraft whose demand prospect is certain." From the mid-1950's to the mid-1960's the Defense Agency made plans for domestic development of a new helicopter called HX. The plans went as far as the basic design stage, but eventually fell through. According to the manufacturer involved in the development, the experience was bitter: "While the Maritime Self Defense Force requested large models, the Ground Self Defense Force wanted smaller craft. The differences were never adjusted, and the project was discontinued."

A Time to Consider Promotion Measures

The aircraft industry has, in passenger aircraft and engine divisions, improved its strength through accumulation of experience in sub-contract production for leading foreign manufacturers. However, in the helicopter division, it has been mostly the case in which "although several subcontract offers were made, they had to be turned down because what could be gained in terms of both profit and technology was minimal," (according to Mitsubishi Heavy Industries). The talk, also, of Fuji Heavy Industries doing subcontract production of the rear section of Bell's newest 214ST, in progress since last fall, has been suspended. The executives in charge of aircraft production of manufacturers find that [helicopters] are "not as tempting as combat aircraft or passenger planes," (according to managing director, Ikeda).

The industry's top manufacturer, Kawasaki Heavy Industries, has set a goal increasing its production of helicopters from 60 billion yen between 1975-1979 to 100 billion yen between 1980-1984. Fuji Heavy Industries plans to increase its production from 24.4 billion yen to 32 billion yen during the same period. In comparison, however, with world standards these figures are insignificant. For example, Bell's annual helicopter sales is said to exceed 900 million dollars.

Thus far, most of the helicopters flying in Japan were developed by foreign manufacturers. Helicopters for industrial operations, such as ones for spraying insecticides, conducting land surveys, and for new reporting are mostly built by Bell and Aerospatiale (France); and last year, Russian-made craft were imported and are in use now. Many expect Kawasaki Heavy Industries' BK117 to increase its share in the Japanese market in the future; however, it would appear that a time has come in which Japan must review the industry's present status and consider helicopter promotion measures.

Industry's Joint Ventures

Tokyo NIKKEI SANGYO SHIMBUN in Japanese 27 Jan 81 p 1

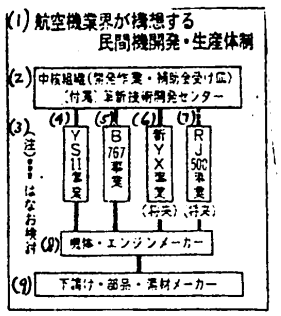
[Text] Beginning this fall, the Japanese aircraft industry expects to have its various commercial aircraft projects organized under a single "core unit." The three major aircraft manufacturers --Mitsubishi Heavy Industries, Kawasaki Heavy Industries, and Fuji Heavy Industries--have been studying the formation of the "core unit" since last fall. To date, it is strongly felt that the functions of the "core unit" would consist of (1) serving as a recipient of government subsidies, while principally involved in developing and conducting research in [aircraft] technology; and (2) the projects responsible for profit-making operations, such as mass-production and "after-sales services," as in the case of the Japan-U.S.-Italy joint development of the Boeing 767 passenger aircraft, will be consolidated under a "business division" of the "core unit." Although what is needed now is compromise of requirements between the aircraft body manufacturers and Ishikawajima-Harima Heavy Industries, the manufacturer of engines, the aircraft industry now entering a period of internationalization will be at once moving in a direction of complete restructuring.

At present, the commercial plane divisions of the aircraft industry, with the exception of cases of individually developing a new plane, have separate contact points, even for the joint development of new models in which the entire industry participates as a whole. For the YS11 passenger aircraft, there is Nihon Aeroplane Manufacturing Co. (headquarters, Tokyo; presently involved only in after-sales services of spare parts); for the development of the Boeing 767, there is the Civilian Transport Plane Development Association; and for the Japan-Britain joint development of the RJ500 jet engine, there is the Jet Engine Technology Research Association.

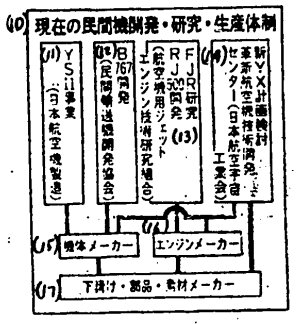
On top of this, since a study is now being made of the new YX (YXX, the next term commercial aircraft) Development Project, another contact point would be needed in the future. There is a fear that such a complex industrial structure would lead to decentralization of the industry's strength and contribute negatively to the development of the industry. Because of this, last summer, the Aircraft Division of the Aircraft and Machine Industry Council made an interim report on the formation of an integrated organization and the industry began its study of the feasibility of such an organization.

On the other hand, the Ministry of International Trade and Industry, by the end of last year, solidified its position to dissolve the Nippon Aeroplane Manufacturing Co. which had been established by 50/50 investment of the government and the aircraft industry. With this, the industry began to accelerate its examination of a new core organization. As a result, to date, the industry has decided upon a basic policy that the "core unit" would be a corporation, either as a joint stock corporation or an incorporated body, that would conduct research and development of large commercial aircraft projects, and absorb the New Aircraft Technology Development Center, which currently comes under the Japan Aeronautical and Space Industry Association. The YS11 and those profit-making projects, by virtue of mass-production (such as, the Boeing 767), "will be placed within a division of the core unit," (according to an executive of the industry).

However, an attempt to make ["the core unit"] an organization capable of encompassing both the production of aircraft bodies and engines is encountering some differences of opinion between Ishikawajima-Harima and the rest of the industry. The former insists that, "there is no such case of joint production anywhere in the world. Since the engine is sold to many aircraft body manfacturers, the engine division should be independent." Because of this, it is expected that the RJ500 project may not be incorporated into the "core unit" and that the industry will be "two-tiered," consisting of the aircraft body and engine divisions; however, the aircraft industry plans to determine its course by this summer, with reference to the council report. By fall, it hopes to establish the core unit.



1. Commercial Aircraft Development and Production Structure Devised by Aircraft Industry
2. Core Unit (development operation and recipient of subsidies) (Affiliation) New Technology Development Center
3. (Note)--under examination
4. YS11 Project
5. B767 Project
6. New YXX Project (future)
7. RJ500 Project (future)
8. Aircraft Body - Engine Manufacturers
9. Subcontractors, Parts, Material Manufacturers



10. Present Commericial Aircraft Development, Research and Production Structure
11. YS11 Project (Nihon Aeroplane Manufacturing Co.)
12. B767 Development (Commercial Transport Plane Development Association)
13. FJR Research
    RJ 500 Development
    (Jet Engine Technology Research Association)
14. New YX Project Study
    Japan Aeronautical and Space Industry Association
15. Aircraft Body Manufacturers
16. Engine Manufacturers
17. Subcontractors; Parts, Material Manufacturers

Fanjet STOL

Tokyo NIKKEI SANGYO SHIMBUN in Japanese 30 Jan 81 p 19

[Text] The development of the first Japanese fanjet STOL (short take-off and landing), promoted by the Science and Technology Agency and the National Aerospace Laboratory, is approaching a high point. Hailed as a jet most suited to Japanese airport conditions which require short runways and low noise levels, its research and development has been conducted since fiscal 1977 through joint efforts of domestic aircraft manufacturers. Last year the manufacturers began working on the major portions of the craft, such as the development of a domestic jet engine and manufacturing of the body; it is expected that if everything goes as planned, the craft will be completed during fiscal 1983 and the first test flights will begin. The Science and Technology Agency, which has been promoting the project, wants to develop the STOL as a successor to the "YS11," the major domestic air transport now becoming obsolescent. In the immediate future, [the Agency] will make all efforts to develop its major equipment and instruments.

To Be Completed in 1983

Although the demand for air transportation in Japan is increasing every year, expansion and construction of new airports are becoming a problem; furthermore, due to noise problems the use of airports is being regulated severely. The fanjet STOL is a new model whose development is being promoted with domestic technologies as a carrier suited for these heavily regulated air transport conditions. Since the development of the commercial STOL craft has been thus far limited to two cases worldwide, one by NASA and the other by U.S.-Canada joint venture, it constitutes a challenge to the entire field of new aircraft development.

The STOL is unique in that its fanjet engines are mounted above and forward of the front wings. When large flaps are lowered during take-off and landing, the exhaust gas from the engines flows downward along the upper surfaces of the front wings and flaps; this creates a large uplift force and allows the craft to take off and land within a short distance.

The present intermediate-short distance jet transports require 1,500-2,000 m runways, but the fanjet requires only about half that distance or 800 m. Also, since the engines are mounted on the front wings and the craft can take off and land at a steep angle (normally, entry angle is at 3°, but for STOL it is 8-10°), another advantage of the fanjet lies in the reduction in the size of noise affected areas surrounding the airports by as much as 1/10 of those areas affected by conventional jets.

For this reason, it is expected that local airports with 1,200 m-class runways which could heretofore accomodate only the YS11's will be able to handle craft with greater transport capabilities and this would contribute to large reductions in airport consolidation expenses.

The STOL now under development is 30.3 m long and can accomodate 100-150 passengers, equivalent to the capacities of the conventional B737 and DC9; it weighs 45 tons. A revised version of the domestic jet transport C-1 is used for the body and four FJR710 fanjet engines, developed under the "large-scale project" of MITI's Agency of Industrial Science and Technology will be used.

Japan has accumulated experience in research and development of such aircrafts as the commercial transport YS11, military C-1, STOL hydroplane PS1 and of fanjet engines by the Agency of Industrial Science and Technology. The present development [of the STOL aircraft] is conducted on the basis of these experiences and domestic technologies. Five aircraft manufacturers, Kawaski Heavy Industries, Mitsubishi Heavy Industries, Fuji Heavy Industries, Shin Meiwa Industry, and Japan Aircraft, are engaged in the development of the STOL body; three companies, Ishikawajima-Harima Heavy Industries, Mitsubishi Heavy Industries, and Kawasaki Heavy Industries, are participating in the development of the egine.

The development [of the STOL] started in fiscal 1977 and basic designs were completed between fiscal 1977 and 1978; the manufacturing of the powerful lift-off system began in fiscal 1979. Based on these, as of the current fiscal year, work has begun for the manufacturing of such major parts as the body, control systems, and the FJR engines.

The total cost for the development of the STOL craft has been estimated at about 20 billion yen; 4.385 billion yen has already been appropriated in the government budget proposal for fiscal 1981. It is expected that the prospect for a continuous and steady development of the craft is good. The Science and Technology Agency wants to complete the entire project within fiscal 1983, continue test flights through 1985, and thereby verify the technology of the STOL.

Aircraft Parts Manufacturers

Tokyo NIKKEI SANGYO SHIMBUN in Japanese 30 Jan 81 p 7

[Text] The machine parts manufacturers are rapidly converging on the aircraft industry which is considered a promising growth industry of the next generation. This is because while aircraft parts such as bearings and rodends have been heretofore mostly exported to the United States and European markets, domestic demand for them has increased with [the scheduled production of] the next term major combat plane

"F15" and the newest medium-class passenger aircraft "Boeing 767;" the latter being developed jointly by Japan, the United States and Italy. Furthermore, because the specifications of the aircraft industry require far more accurate and precise processing than that required by ordinary industries, the parts manufacturers can expect a "bonus" in the form of greatly improved technological standards.

Tokyo Screw Manufacturing Co, the leading screw manufacturer, will expand its production facilities for aircraft screws by investing about 1.3 billion yen during the coming 2 years. This equipment investment will be targeted for surface processing, heat processing, and machine processing facilities. This step was taken in order to cope with the changes in demand situation of the F15 and the next term sub-detector P3C, both of which will move from test-production to delivery stage.

In conjunction with this, the percentage of aircraft screw sales in the total sales of the said company is expected to rise from 25 percent (about 3.2 billion yen) in the September 1980 period to 30 percent (about 4.2 billion yen) in the September 1981 period. As its sales to the Defense Agency increase so would the stability of its management. According to president Takami Takahashi (concurrently, chairman of Tokyo Screw) of Japan Miniature Bearing Co., Ltd. which is the parent company of Tokyo Screw: "We would like to reinforce the facilities at Tokyo Screw in the future. This would be supported by the entire minature bearing group."

At the same time, Japan Miniature Bearing itself will strengthen and expand its product line for the aircraft industry. This company produces, mostly for exports, miniature bearings, rodend bearings, and micron gears for aircraft; however, its policy is to channel these products to the domestic market as soon as the market becomes active.

On the other hand, the precision ball screw industry has also concluded that, "After this spring when every company in the industry would have completed its program of equipment reinforcement for the time being, there is the danger that the supply and demand balance with respect to the major screw user, i.e., the machine tool industry, might break," (according to president Takatoshi Kondo, Tsubakimoto Seiko). Based on this view every company is now rushing to open up new markets. Under this situation, one of the new markets which the leaders of the industry, Nippon Seiko K.K. and Tsubakimoto Seiko, are eyeing is the aircraft industry.

The reason for this is that precision ball screws are used in aircraft bodies and are indispensable for high performance machine tools which process aircraft bodies and their major parts. Consequently, it is regarded that when domestic production (including license production) of combat, surveillance and passenger planes increases, "there will be demand [for screws] that would be greater than the increased amount [brought on by the domestic aircraft production]," (says president Kondo).

In addition, although these are not parts manufacturers, Mitsubishi Heavy Industries and Kawasaki Heavy Industries are emphasizing the development of servo (super precision oil pressure) valves. Furthermore, in the area of bearings too, NTN Tokyo Bearing Co., Ltd. is promoting expansion of sales of aircraft bearings; it would seem that for some time to come the machine parts industry will continue to converge on the aircraft industry.

New Commercial Aircraft

Tokyo NIKKEI SANGYO SHIMBUN in Japanese 3 Feb 81 p 8

[Text] The selection process of overseas partners for joint development of the new YX (YXX next-term commercial aircrafts) is approaching a decisive stage. The possibility of a joint venture with Airbus Industry of France and West Germany is slim. The consensus of the Japanese aircraft industry is that "a joint development will most likely take place with America's Boeing and Holland's Fokker", (according to Kiyoshi Yotsumoto, chairman, Kawasaki Heavy Industries). The attitude of Boeing, expected to play a central role in the joint venture, is one of extreme caution. It is said that Boeing's "real intention" is one of "keeping its interest unpublicized," (says a representative of aircraft industry) so as to avoid competition with other crafts which Boeing aims to sell. The Japanese aircraft industry wants to select its partner before the beginning of the fiscal 1981, the year for which subsidies for preliminary designing have already been approved. The success of the negotiations would appear to depend considerably on the internal affairs of Boeing.

On 20 January, Iwao Shibuya (managing director, Fuji Heavy Industries), chairman of the YXX Special Committee of the Society of Japanese Aeronautical and Space Contractors, and Kenji Uchino, vice-director of Commercial Aircraft Development Association visited the Boeing headquarters and exchanged opinions with Boeing representatives. Originally, Kenji Ikeda, managing director of Mitsubishi Heavy Industries and Satoaki Yamada, managing director of Kawasaki Heavy Industries were to accompany the two officials so that "full-scale negotiations" could be held. Since, however, "Boeing was unprepared for a full-scale talk" (according to managing director Ikeda), the delegation was limited to the two officials named above who in fact made up the advanced party.

"Subcontract Coloring" To Be Washed Away

"All we did was to explain Japan's position to Boeing" (said managing director Shibuya); this was the official announcement concerning the talks. As for the YXX development, the Japanese industry is soldifying its basic policy consisting, among others, of (1) at the stage of the determination of [mutual] intent, Japan will participate in all business areas, including basic designing, detailed designing, manufacturing, and sales; (2) Japan will be responsible for sales in specified districts. This is because the industry aims at washing away the "subcontract" coloring which now permeates the YX project that is developing the Boeing 767.

The negotiations are focused on sales network. According to a proposal submitted by Fokker, Boeing will be responsible for the United States market, Fokker the European market, and Japan the Asian market. For Boeing which has always dealt with markets worldwide, it is strongly felt that the restriction of the market applicable only to this joint development model is unacceptable; at the end of last year [Boeing] submitted its own version of sales and production systems based heavily on its previous records. The present visit to Boeing was made because "if Japan remained silent [Boeing] may take it as Japan's consent" (said managing director, Shibuya, Fuji Heavy Industries). It is, however, unlikely that a single meeting would lead immediately to resolution of opinions.

Besides, Boeing is now busy trying to develop and sell its 767 (210 seats) and 757 (180 seats). It is also conducting a study in demand for the 737-300 (130 seats), a revised model of Boeing 737; the final decision to develop or drop this model is expected to be made between this March and May.

So Long as Conditions Fluctuate...

Since the YXX project aims at development of 140~150 seat class aircraft, it would not directly compete with the existing plans. However, it is natural for Boeing to feel that if it were to reveal the new plan it would affect the buyers of the Boeing 757. In so far as demand situation after the latter half of 1980, when the YXXs are scheduled to appear, remains uncertain, there will continue to be too much fluctuation in conditions surrounding the project to allow for any determination of concrete proposals regarding development schedule, the size of the aircraft, etc. Under these circumstances, the real feeling of Boeing seems to be one of "letting the present plans settle down a bit before committing itself to 'next' [series of projects]."

The Japanese industry's policy concerning the present development plan is to obtain a tentative agreement by the end of March. Since Fokker officials will visit Boeing before they arrive in Japan on the 4th, the two parties will discuss the strategy of Boeing. Since Japan's partner [Boeing] is the world's largest passenger plane manufacturer, it is unlikely that things will progress according to Japan's wishes; on the other hand, if Japan keeps on making compromises, the basic policy of the YXX development would fail.

Independent Research Is Important

The Japanese [aircraft] industry is faced with these conditions. Although managing director Shibuya of Fuji Heavy Industries says that "Since Boeing is well aware of Japan's situation such as the budget system, there are no problems," it is doubtful whether talks among the three parties including Fokker will be resolved smoothly.... Among the aircraft industry sources, there are those who are beginning to voice the view that "the present situation would last for another 2 or 3 months. Japan cannot cope unless it can catch the post-mid 1980 market trends and conduct independent research."

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SCIENCE AND TECHNOLOGY

DIRECT STEP-ON WAFER MACHINE TO BE FOCUS OF SUPER LSI WAR

Tokyo NIKKAN KOGYO SHIMBUN in Japanese 26-28, 30 Jan, 2-4, 6 Feb 81

[26 Jan 81 p 11]

[Text] When the subject of super LSI comes up, electron beam exposure immediately comes to mind. Now, despite the fact that mass production of 64 K units considered to be the gateway to super LSI has begun, there is no talk of the use of electron beams other than in the production of masks. This is because light exposure optical technology, which in the past was thought to have approached its limit, has undergone sudden development and most recently has become capable of making circuitry of the order of 1 micron, while the turn of electron beam technology had not yet come around. This is why we looked into light exposure optical technology = activities in wafer-stepper which is presently the topic of discussion in the semiconductor industry.

1 Micron Order Is Possible

"Japan, which bested the United States in the 16 K, was expected to increase its margin of superiority even more in the matter of 64 K units, which are much more difficult to produce, and there was the possibility that this situation would relight the flames of the Japanese-American semiconductor battle once more, but the situation is just the reverse. American industries such as TI and Mostec already possess production capabilities for the 64 K in the form of the "indicator" that is the stepper which they acquired early in the game. One of these companies is said to have 20 such units already on hand. In contrast, the Japanese companies have steppers on order but these are limited to only two-three units at best, and the situation is far inferior. To be sure, 64 K can be produced without steppers...." (official of a certain semiconductor maker)

The semiconductor makers made their initial super LSI by the exposure techniques of each company, but the next product (actual production of 64 K and 256 K) will be produced by steppers, according to a consensus of company officials which was arrived at very recently, and it appears that it will be this fall before the capability will be acquired" (man in charge of steppers for a certain company).

"The top production facilities for producing semiconductors in the eighties will probably be sputtering and etching facilities" (official of equipment makers other than steppers).

"The present units are only good for 256 K, but units aimed at 1-0.7 micron line width have appeared, and once the 1-micron level can be assured, a 1 [illegible]-bit super LSI should become possible. It should be possible to go to light exposure by 1990 at this rate" (section chief in production of one of the maker's production technology section).

American Influence Introduced Large Volume

The above reflects the most recent situation in the semiconductor industry. Now, what is this so-called stepper, which does not use electron beam engraving (mask forming is used) but uses optical technology to mass produce super LSI and which already controls the semiconductor contest with the Japanese?

This technology was first developed and announced by the GCA Company of the United States and the product was called DSW (direct step-on wafer) or wafer stepper, and it is now called wafer-stepper. It is called a one-tenth reduction projected light exposure facility in Japan. Explaining this facility in simple terminology, unlike the method of one-step transfer from a photo mask with mask aliner, as was the practice in the past, the circuit pattern of 10-fold enlargement on a mask original plate reticle is projected through a lens directly on a wafer at 1/10 reduction to effect the transfer, and this operation is repeated (step and repeat) to expose the entire wafer surface. Near ultraviolet light is used for the light source, and the so-called 3-micron barrier of the past has been overcome by a wide margin, to about 1-micron width. At the same time, the facility is suited to mass production, unlike the electron beam system.

When the GCA Company announced this development in the fall of 1977, there was sudden attention: there was a stampede of orders, and the New York TIMES introduced this facility. The American semidonductor market, which had been badly hit in the quality and mass production technology related to 16 K production to the extent that more than 40 percent of the American market had been taken over by the Japanese, decided that the only way it could recoup itself in the next race for the 64 K LSI was the early introduction of steppers, and they all placed orders. It is said that the leading industries such as TI, Motorola, and Mostec have 20-30 units apiece.

256 K Will Actually Be Produced

The Super LSI Technology Research Group in Japan directed attention to this direction at an early date. The GCA Company "first demonstrated this machine to Japanese users" (assistant director in charge of research and development). A couple of these units were brought to the Super LSI Research Group in 1978, and four units were brought in in 1979. The research results coming from this group included development of the reduction projection transfer device "VL-SR2" and the 256 KDRAM of NJIS which a year before had drawn worldwide attention. To date a total of 34 GSW units have been acquired by Japanese companies, which have evaluated this unit, and reportedly the conclusion was reached recently to go to the stepper for production of 64 K LSI and on.

Top Business Secrecy

Now, when we inquire of the makers about items relating to the stepper, their faces change color and they say: "We have no comments to make on that subject." "The top knowhow in the business" will be required hereafter where the stepper is concerned, and this is not something that can be realized overnight. A single unit costs 200 million yen, and mass production requires several dozen such units. As a result, several billion yen will be required once the decision to "go" is made. If trouble should occur after introduction and the units are not usable for mass production, "a business responsibility which could not be rectified even by suicide" will result. There is every reason to insure that no mistakes are made. This is the agonizing final decision. If a rival should now say, "if they go for it, so will we" and simply tags along, that rival is in trouble. This strategy is not one which can be treated lightly. When a certain maker announced the start of production of 64 K LSI, there was the rumor "exposure technology is the future," and the attitude of the various companies toward the stepper intensified immediately, according to a certain story. The semiconductor industry has become very psychotic about the stepper.

Now, it is said that once the number of stepper units a company has acquired or has ordered becomes known, then the intentions of that company regarding semiconductor strategy will be revealed because the treatment capacity and layover properties of the stepper are well known. It may be said that the number of stepper units is the top secret for any company. The selling outfit can say: "we sold a total of so many units, but we absolutely cannot discuss sales to any individual plant," it emphasizes.

In any event, at present there is a rush for orders and receipts are delayed, so that the distribution during the course of this year is the controlling force in the business. The stepper is presently the strategic item on the market.

[27 Jan 81 p 12]

[Text] Successive New Introductions

While it is too much for the present stepper, if improvements should be introduced so that a 1-megabit super LSI memory (a dynamic RAM will have 1 million transistors and the same number of condensers, for a total of more than 2 million units) became capable of mass production, the stepper would most likely control the 1980's as the light exposure device for "mass production" of super LSI. If this should happen, a vast demand and market would open up.

Recently, many new businesses have entered this area to engage in this line. These are all world famous names. Looking over these names, in the United States there is the GCA Company, followed by the aircraft parts maker RTE Company (formerly Electromask Co) and the Optometrics Company (subsidiary of the large automobile parts and semiconductor device maker, the Eaton Company); in Europe the Sensor Company (Lichtenstein), Thomson CSF Company (France), and the Phillips Company (Holland); and in Japan Nippon Kogaku, Hitachi Limited, and Canon which have announced developments or have announced entry.

At the present time, GCA is unquestionably the leader, and as of the end of last year it had introduced 150 units, of which 34 were purchased by Japanese makers. This year it expects to produce about 200 units, of which 45 will be shipped to Japan according to Sumitomo Corporation, which is the Japanese representative.

While GCA is having the field to itself, the situation of the late comers is that of just about getting to the production stage or setting up the system for production. In Japan, Hitachi has delivered several units, which is about the only record thus far, and most of the companies are in the demonstration or seminar stage. These companies say: "The actual competition will start this year, and the high water mark will be 2 years hence."

Desirable Sales Rights

To be sure, the stepper battles involve not only the makers but have also enfolded those companies which have participated in importing semiconductor devices in the past. If a semiconductor industry were to go into stepper introduction, it would have to purchase several dozen high-priced units costing 200 million yen apiece, and the handling costs would become very large. This is why the trade companies are looking toward import representation rights even where there is none; this fight for acquisition is said to have caused fierce battles and maneuvers, and the situation is reportedly continuing.

Such being the case, what is the demand and the market for steppers? According to Sumitomo Corporation, which is the representative for the GCA Company, this situation can be deduced from the sales situation of a one-to-one projection exposure device which the prosperous Perkin Elmer Company is in. The products of the Perkin Elmer Company first appeared 5 years ago, its sales have topped 500 units for the last 2-3 years, and this pace is expected to continue another 2 years. When a product becomes a mainstream item in this manner, sales can be expected to increase for about 7 years, and production can rise to as high as 500 units per year.

At the outset most of the companies engaged in producing 64 K product were using patterns formed from 3-micron-line width, and these steppers could compete one to one. As more experience was gained in production and the line widths could be narrowed eventually to an improved stopgap level, a line width of 2 microns will enable production of 64 K units, a 256 K product will make one the sole producer, and demand will be expected to rise up to a high water mark in 1987 as judged from the industry logic. It is said that five or six steppers are required to produce 100,000 units or more of 64 K per month. Since it is said that the more aggressive companies will introduce 50-100 steppers, the world's industries will order a considerable number.

GCA Alone Will Produce 3,000 Units

According to the American survey company, the Data Quest Company, the number of steppers installed throughout the world is expected to total more than 1,000 units in 1982, increasing thereafter to 3,000 units in 1983 and 4,000 units in 1984. GCA has a more conservative estimate of 1,700-1,800 units in 1983. This company plans to produce 150 units in 1980, 200 units in 1981, 300 units in 1982, and

350 units in 1983, and it should have a total production of more than 1,000 by the end of 1983. It plans to increase production to more than 500 units per year thereafter, so this company is expected to have produced 3,000 units by the end of 1987. Since this will be augmented by production from other companies, a unit price of 200 million yen would be equivalent to a market scale of 1 trillion yen.

Between 260 and 300 steppers are thought necessary for Japan by 1983, while the total by 1987 is expected to come close to 800 units, according to Sumitomo Corporation. Nippon Kogaku is more optimistic and predicts demand for as much as 1,000 units over the next 5 years and a total market of 1,500-2,000 units.

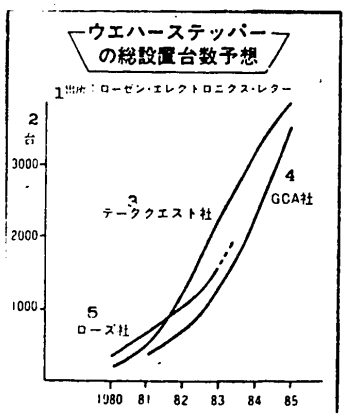
One-to-One Facility Counterattack

To be sure, it is not necessarily the case that the stepper market will develop as predicted. It is said that Perkin Elmer will soon market a "one-to-one exposure device Model 500 which can be used with a 5-inch wafer with resolution of 1 micron" (business director N.C. Macdonald). Since a one to one is a total surface exposure mode, it is only natural that its throughput (handling volume) will be greater than that of the divided exposure mode stepper. If this happens, the future of the stepper will see some great changes. Kenmatsu Semiconductor, which serves as representative for Perkin Elmer, actually predicts that the stepper will not see too great expansion.

Counter to this situation, the stepper proponents claim "the Model 500 is a dream machine" (Vice President G. Les Eaton). "Can they resolve problems such as precision of superposition warpage and defects (layovers)?" (assistant research and development director G.L. Liesser). A semiconductor engineer said: "I do not believe 1 micron engraving is possible by one-to-one technique, but this is a claim by the most reliable optical maker in the world. The actual situation is that one cannot state positively what the future holds for the exposure device."

In any event, it appears that the semiconductor industry in preparing for the age of the super LSI is going to shift from the use of electron beams to some sort of optical technology for the pattern exposure which is the heart of the production line.

Predicted Total Wafer Stepper Units



Key: 1. source: Rosen Electronics Letter
2. units
3. Data Quest Co
4. GCA Company
4. Rose Company

[28 Jan 81 p 12]

[Text] The Once Booming EB

"Aiming at super LSI development, Super LSI Joint Laboratory succeeds in electron beam engraving" (15 March 1978 issue of paper A).

"Super LSI will become practical as Toshiba succeeds in developing production equipment for engraving circuits with electron beam" (18 July 1978 issue of paper S).

"Joint Laboratory works on super LSI engraving device development with capability of 0.5-micron design" (16 May 1979 issue of paper A).

"Super L Laboratory works in innovative electron beam device capable of producing 1-megabit semiconductor" (14 February 1980 issue of paper A).

As reflected by these items in various newspapers, the last 5 years up to very recently can be said to have been the age of a boom in electron beam (EB) exposure devices for the production of super LSI. About the time the Itek Company in the United States received the patent from Bell Laboratory to market EB devices (IBM and TI had already been using self-developed units) the Super LSI Technology Research Group in Japan was organized, and this group placed emphasis on EB devices from the outset, with three laboratories out of six being dedicated to EB-related studies. These efforts were rewarded by the development of three types of EB equipment, including the variable shape beam type electron beam engraving device.

As news of EB development of this group and related industrial efforts was being broadcast, the concept that "super LSI is production with an electron beam" gradually became a "national consensus." The thought that EB can operate in the "submicron region" kept people frozen to the scientific sense of awareness without questioning the practical aspects. This situation was abetted by the advanced nature of the IC industry along with the rapid growth of this industrial sector, and it was only after 2-3 years that the impression was created that EB and mass production of super LSI are synonymous. The semiconductor companies all introduced EB units one after the other, and there was the growing impression that "the age of the electron beam is just around the corner" despite the proviso that this was for "mask formation use."

Certainly, during this super LSI research period there was the feeling among researchers and technologists that super LSI could only be produced with EB. "The light exposure technology of the past was limited by the physical limitations of the wavelength of the light used and submicron level work is impossible" was the view expressed. Actually, there was the following announcement by this group (29 May 1977) which stated: "The photo lithography of the past using ultraviolet light is capable of drawing ordinary LSI patterns of minimum 3-micron-line width.

This value is several tens of times the wavelength of the ultraviolet light used in its production process, and it is difficult to make patterns accurately below this level due to light interference and diffraction. This is why it probably will become absolutely necessary to use electron beams or x-rays of much shorter wavelength to create the find patterns required by super LSI."

Now, why was light exposure thought to have limitations?

Light Is "Limitation of Equipment"

For about the last 10 years, IC production has relied on a contact method by which the mask and wafer are placed in intimate contact and exposed, and this was the technology employed in the production of 16 K memories and microns. Because of the close contact, patterns could be transferred with good contrast, and logic dictated that submicron level work was possible. On the other hand, the mask and wafer were in contact constantly, and this was a source of defects which was further augmented by poor precision together with the incidence of damage to the expensive mask. The proximity (spaced) method was developed which placed a slight gap between the mask and wafer, but now the resolving power was limited to 4 microns by the diffraction of light (light was not propagated according to the slit width but expanded in diffuse manner). This effect was compounded with poor precision, and the actual minimum line width was of the order of 5 microns.

The one-to-one projection mode exposure device which next appeared on the stage utilizes the mirror principle to project the pattern of the mask on the wafer as a narrow image, there is need to scan the mask and wafer separated by several tens of centimeters in a synchronous manner in order to realize full surface pattern formation, and the precision of this scanning mechanism presented difficulties. That is why it was claimed that the minimum dimension possible was 3 microns despite the resolving power being 2 microns.

In this way, the 3 microns which represented the "limitation of light" actually was the "limitation of the equipment" incorporating the optical system, the precision machinery, and the electronics, and this limit was considered to be roughly 10 times the wavelength of the light used for all practical purposes. It may be said that this certainly was not a physical limitation of the wavelength of light (0.4 micron).

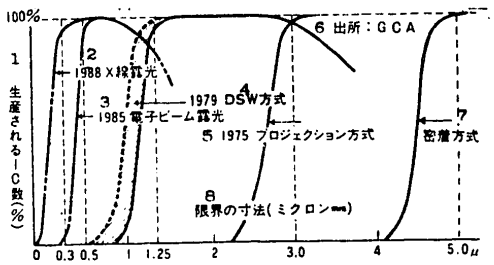
It was the stepper (the one-to-one device which uses near ultraviolet light of short wavelength is one such item) which broke through this limitation of equipment to bring the system closer to the limitation imposed by the wavelength of light. This device has filled the wide gap existing between EB and one-to-one equipment. At the same time, it has had the effect of pushing back EB development until the day that the submicron region becomes necessary.

120 Billion Yen Required

Certainly, EB has the following major attributes: 1) it enables ready duplication of submicron dimensions, 2) it can directly transfer patterns to wafers, and 3) a short time elapses from research and development to commercialization. Now, what happens when EB is put on the production line? The direct engraving capability of

EB is three plates per hour, which is only one-tenth the speed of the GCA stepper. Assuming that 10 steppers make up a 64 K production line and further assuming that a year's production will involve 20 steppers, replacing these with EB will necessitate 200 EB, with each EB costing 600 million yen for a total of 120 billion yen, and the economics goes completely off balance. At the present rate, it may be after 1985 before EB's turn comes around.

Trends in Lithography Equipment by Minimum Dimensions



Key:
1. number of IC produced (%)
2. 1988 x line exposure
3. 1985 electron beam exposure
4. 1979 DSW mode
5. 1975 projection mode
6. source: GCA
7. close adhesion mode
8. limiting dimensions (micron mm)

[30 Jan 81 p 10]

[Text] High Resolving Power with Reduction

When IC chips with fine patterns are being produced, light exposure technology of the past was said to have been beset with the three problems of 1) how to form the fine pattern = resolving power, 2) how many layers of patterns to be developed at the specified site = position adjustment, and 3) how to handle fine dust particles = defect countermeasure. "How to overcome these problems was the technological subject," explained principal investigator Meiko Takanashi, who was in charge of development of the one-tenth reduction exposure device at the Central Research Laboratory of Hitachi Limited.

The resolving power is determined by the numerical aperture (NA) and the exposed area of the wafer. The numerical aperture has the relationship

$$NA = 1/ 2F(1 + N)$$ (F = lens aperture, N = reduction ratio)

and a large numerical aperture is associated with high resolution. The numerical aperture can be made larger by increasing the reduction ratio. Even when a reduction of none-twientieth (0.05) is effected, the mask becomes larger while there is no change between one-tenth and the N value so one-tenth is suitable. For example, the numerical aperture for the GSW is 0.28. In contrast, the N value for the one to one is 1, and the numerical aperture cannot be made greater than 0.2, as a result of which it is inferior to the one-tenth reduction facility

by two times. "The world's industries including this company have deemed the stepper to be more advantageous than the one to one. This is the only reason we are rushing to produce this unit, and this is the logic we are following" (Takanashi).

Submicron Level Possible

The resolving power will also improve by lowering the wavelength. The theoretical line width for practical purposes is calculated from the following relationship between wavelength and numerical aperture: $S = \lambda (1 + N)F$ (W in microns). According to this equation, line width can be made smaller by making wavelength, reduction ratio, and F number smaller. By introducing the limiting values of these different quantities, the limiting line width is 0.445 microns. In this way, the one-tenth reduction exposure method theoretically can bring the resolution down to the wavelength of light or, in other words, to the submicron level.

The wafers are gradually being made of a larger diameter in order to improve the IC production efficiency and are reaching the 5-6 inch diameter size. As the exposed area becomes this large, it becomes difficult to focus the pattern over the entire area, and the pattern is distorted: "Combining a large area with fine finishing dimensions is difficult" (Vice President Lisser of GCA). This situation can be rectified by dividing the total area into subdivisions of workable size for the exposures, and a reduced exposure effect can be exploited.

Mechanical Precision Is Foundation

Even when high resolution is attained, it is necessary to keep this as close as possible to the theoretical stage. "Just how to develop at the desired position" is the alinement problem, the solution of which is the number one difficulty in light exposure, and this was the barrier. "This problem was conquered by a mechanical mode" (Lisser) through the stepper.

A wafer resembles a potato chip and will expand or shrink with various thermal processes and even return to its original state. The glass of the mask will also expand. A 100 mm diameter silicon piece will expand 0.3 micron per degree Celsius while the mask will expand 1 micron. As a result, there is overall distortion in the pattern and a blanket exposure will result in great difficulty in absorbing the error, and the precision can be of the order of $\pm$ 1 micron. In contrast, the stepper makes exposures of the order of 10 mm square, so that even if the wafer should deform or return to initial shape, the development can be made individually according to the situation at hand, making position alinement that much more advantageous. It is said that the precision of this alinement is of the order of 10-20 percent, and this is an improvement of up to 0.25 micron for a minimum dimension of 1.25 micron.

In order to stop exactly at the desired position, it is necessary first of all to detect the position by submicron units, and a laser beam capable of measurement to 0.05 micron is used for this purpose. A shortcoming of the stepper is the slow treatment speed of the step and repeat mode, and this can be partly compensated by reduction in exposure time and an XY stage with high-speed movement. On the other hand, position alinement requires superfine movements of submicron level,

and stops must be made within 0.3-0.4 second. A technology which satisfies these two conditions is required. This has been attained by the combination of mechanical finishing technology with craftsmanship-like precision and servo mechanisms, and this is the area where each company prides itself.

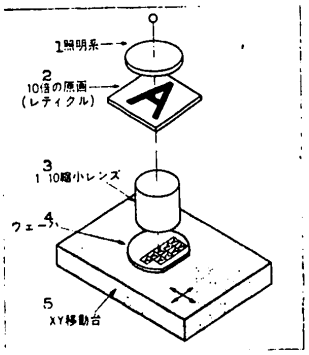
Dust Particles Form No Image

The photomasks used at present are not perfect and suffer from chrome pinholes and peeling as well as adhesion of dust particles. Dust particles of 1 micron will pass through the filter, and the particles which stick to the mask accumulate sharply with time. They are then directly transferred to the wafer. If the line width is less than the 1-micron level, a 1-micron particle can become the source of a fatal flaw. Since as much as 10 masks can be stacked against one another, the presence of defects in each layer will greatly reduce the total defect-free area through the 10 layers, and the layover becomes extremely poor.

The reticule used in the stepper is the original plate, and the pattern can be 10 times as large. The use of a clean room eliminates dust particles large enough to cause fatal defects in circuit patterns with this margin. For example, if even a 5-micron particle adheres, it is reduced to 0.5 micron on transfer. A 1-micron dust particle, which is a lethal defect in the one-to-one mode, is transferred as an 0.1-micron defect by the stepper, and it is actually not developed on the wafer. This is why there is a decided improvement in the layover effect.

In addition, monochromatic light needs to be used to avoid light interference, high degree illumination sources need to be devised to reduce exposure time, an automatic focusing unit which incorporates dynamic range into its focusing depth, and establishment of alinement techniques with precision of 0.2 micron are some of the technologies which the stepper has incorporated. In any event, the foundation for high resolution and precision is mechanical precision, and it was this technology in the various areas of detection, measurement, and precision mechanical finishing which made it possible to break through "the 3-micron light barrier."

Conceptual Diagram of One-Tenth Reduction Projection Exposure Device



Key: 1. illumination thread
2. 10 X magnification of original (reticule)
3. one-tenth reduction lens
4. wafer
5. XY movable base

[2 Feb 81 p 15]

[Text] "5A1" Classification

The GCA Company (president and manager, M. Greenberg), which is the pioneer of the stepper, has compiled a good record to date and intends to produce more than 3,000 steppers by 1987 and grab more than 80 percent of the market by that time. Its main plant is located in the city of Bedford, Massachusetts, and its sales for 1980 totaled 160 million dollars. Now, 60 percent of this business was in semiconductor devices while the rest was accounted for by vacuum furnaces and laboratory measurement equipment. This is one of the few over 100-million-dollar businesses from the ranks of the innumerable medium and small makers of the semiconductor industry. The famous industrial credit survey of the United States, the "Dun Report," has given this company one of its few "5A1" ratings, which is the highest classification with respect to the business status of an organization.

Its industrial scale is increasing, as attested by the construction of a plant last spring at Chelsford in Massachusetts and very recently a new GSW (name of stepper made by this company) plant an Andover also in the same state, and its building area is now 10 times what it was 3 years ago. At present it produces 16 steppers per month, which is expected to be increased to 25-30 units by the end of the year. Its work force has increased five times over the 160 of 3 years ago, of which 300 are said to be development personnel.

Studies Initiated From 10 Years Ago

We interviewed the vice president in charge of GCA technological development, Lisser, when he visited Japan a short while ago, with regard to the development of the stepper.

What Is the History of GSW Development?

Lisser: GCA has been manufacturing a photo mask production facility called a step and repeat camera for more than 20 years. The application of this unit to the direct exposure of wafers and break through the limitation of light exposure was being considered more than 10 years ago. We actually produced a facility for pattern exposure on quartz, and the mask production facility "3969" on which development was started in 1973 was designed with GSW in mind. There was no need for this facility at that time, but along about 1975, there was a strong request from IC makers that rather than electron beam exposure, "we would like to see a start made on fine engraving using the light exposure technology of the past," and development of GSW was initiated. The first model was demonstrated on 6 October 1977.

Have You Broken Through the Vanguard of Development?

Lisser: We cannot say that we are the first. There is also the Woltratic Caspar Thomson CSF which has been announced. We have no patent. It may be said that this facility is a product of the needs of the time.

Rival Makers are Continually Appearing

Lisser: The facilities put out by other companies still have not demonstrated their basic capabilities and design. This is particularly the case with the capability when a number of units have to be matched for production in which it has to be demonstrated that there are no individual traits and deviations between units. The reason there is high demand for GCA units is its high reliability, low variability between units, and the ready adaptibility to mass production.

Performance Seems To Suffer at First Glance

Because it is the first maker in the field, "GSW when compared with models put out by makers appearing later seems to suffer in comparison at first glance based on the catalog performance," said a representative of Sumitomo Corporation. Certainly, when compared to the 1-micron resolving power and submicron position alinement capability of 0.2-0.1 micron claimed by some of the other companies, the resolving power of 1.25 micron and total position alinement precision of 0.35 micron of the GSW gives a feeling of considerable inferiority. On the other hand, "the semiconductor makers claim that GSW is the most reliable," according to Sumitomo Corporation's strong statement. The steppers in Japan are all GSW except for those produced domestically and the single RTE unit. It is intended for use in mass production lines. According to an official of a certain semiconductor maker, "the essence lies in whether the performance as originally intended can be fulfilled on the production line," indicating his awareness of the situation.

A number of reasons come to mind why great reliability is attached to the GSW, but it eventually boils down to this company's more than 20 years' experience with the photorepeater and the matching performance between machines which the researchers refer to as no deviation. In other words, the technological strength which has pursued mechanical precision to give the XY stage to extreme precision in performance.

Polishing at NASA

This company has been developing instruments for analysis of astronomical photographs, in the course of which it has been developing measurement instruments for NASA. It turned to use the precision fabrication technology it developed in this area to the production of semiconductors in the micro area and announced the use of the photorepeater in the early sixties. In this manner, it has always been in the forefront of precision fabrication technology. It uses a special cast product developed by NASA for the XY stage main body, and it is claimed that this material has stability for over 15 years.

The XY stage, which works in conjunction with a laser measurement system, is a three-layer construction consisting of two layers of coarse movement stages over which floats a fine movement stage supported on a plate spring in which the final positioning is made by operating this fine movement stage with a linear motor. This unit has very high mechanical precision, and it is said to equal anything the precision fabrication makers of Japan, reputedly the best in the world, can offer. About a year ago, a certain maker had been planning to introduce the stepper and inquired of Sumitomo Corporation the construction of the GSW and caught a glimpse

of the XY stage, whereupon he exclaimed, "surely, nothing to match this unit is possible," according to a story that made the rounds.

Improvements to the Second Generation

This company's forte lies in the equipment which has been demonstrated through actual performance, to which has been incorporated various improvements as per requests from the users. For example, the replacement exchange of the wafer alinement and wafer handling reticule which was formerly done by hand is now automated and is now linked with the wafer transporting device. In addition, the resolving power has been lowered to less than 1 micron and alinement precision to 0.2 micron in the second-generation units. These are said to be optional items, and the most recent units are said to include a field retrofit policy.

The problem is delivery time. "We are presently able to guarantee delivery no earlier than the end of 1982 on orders received now, but we are making every attempt to assure the Japanese their share of units. Once production can be increased to 25 units per month with the completion of the new plants, there should be adequate capability to meet any sudden increase in orders after 1982," said Sumitomo Corporation. "In comparison, the capacity of rival makers is less than 10 units per month. Can they handle these increasing orders with such production?" is the cutting retort.

[3 Feb 81 p 12]

[Text] We Do Not Get Excited or Panic

There are five American and European makers competing with the GCA Company which at present is the sole producer of steppers, and these companies are Optometrics, RTE Semicon (formerly Electromask Company), Thomson CSF, Phillips, and Sensor. Among these companies Optometrics has initiated sales activity in Japan through Ito and Company, RTE Semicon through Dai Nippon Printing, and Thomson CSF through Japan Kameda. These three companies have yet to deliver their first units to semiconductor makers. These companies maintain that "the stepper battle has just begun. Our turn will come after 1982. We have the high capability 'second-generation' units, and we will be in time for the decisive conflict." This is the common view, and they say: "We will not get excited or panic."

Resolving Power of 0.8 Micron

The catalog performance of the Optometrics Company stepper is considerable. Its resolving power is claimed to be 0.8 micron, placing it in the submicron level. Its position alinement is claimed to be 0.1 micron level super precision. Its treatment capability is claimed to be 50 wafers per hour, and this is also very fast. The positioning of the reticule and stand is performed automatically. Furthermore, it is a compact unit, and there is no need for a temperature controlled room among its many features. In other words, it is a so-called model "second-generation" stepper. A certain official of the Ito Company set out to sell this catalog item to a potential customer about a year ago which was a time when awareness of the stepper was not much advanced so that the party he was making his sales pitch to did not give him undivided attention but said: "This

does not seem to be a saleable item." As the summer wore on, there was a change to an attitude of complete attention, and the customer said, "if this performance can be realized, we would like to purchase it right away," in a complete reversal of attitude.

Ito Company has since received an order from that company and was about to present a demonstration last fall when the first trouble with this unit was experienced in the United States, so that the O Company was tied up in correcting this malfunction, and no unit has as yet been shipped to Japan, according to reports. "Since it is a precision instrument, we expect some troubles at the outset. We are not worried. There has been some feedback from the market, and once these troubles are all cleared up, it would be of advantage to possess this unit." This is the attitude of Ito, and the first demonstration model is expected in the summer.

Ito Company expects that the three large makers will need at least 60 units each if the market it envisions should materialize, for a total of 180 units. This will be followed by 14 other potential customers who are expected to need an average of 30 units each or a total of 420 units. Added to the above will be 100 units purchased by foreign capital. In this manner, this company thinks that a total of 700 units or so will be needed to fulfill domestic demand. Since this is a quantity which GCA alone will probably not be able to handle, there is still considerable time for entry by other parties.

Use of the TLL Mode

RTE Semicon also has a proven record in the area of photorepeaters, and it entered stepper development relatively early, in 1979. It has already sent a demonstration model to Dai Nippon Printing. The product of this company has resolving power of 1 micron (0.5 micron at best), and it uses the same through the lens (TTL) mode for alinement as Optometrics which can be used with each die, and the precision is the very high value of 0.2 micron. The unit is completely automated, and there is no need for adjustments or preliminary preparatory operations. There is also a dust finding mechanism for the reticule.

RTE Semicon has the advantage that its representative in Japan is Dai Nippon Printing. Dai Nippon Printing has more than 20 years experience in the production of photomasks, which is said to be the most difficult process in the semiconductor production procedure, and it has the technological strength that it supplied nearly all the makers with these photomasks, so that this company can provide overwhelming technological support.

The RTE Semicon product has already been used by RCA and Fairchild and has a number of outstanding orders. It has a plant in Woodland Hill, a suburb of Los Angeles, which has been expanded to a monthly production of 10 units and is soon expected to be increased, according to present plans. Accompanying this expansion will be a large reduction in waiting period, and this situation has prompted its entry into the Japanese market. It plans to make a vigorous assault on the market with its special compact "Model 800 SLR."

Units Assuring 0.7 Micron Appearing

Thomson CSF announced its photorepeater and stepper combined facility in 1975, and Japan Kameka Enterprise says "this company was probably the first in stepper development." A practical stepper was developed in 1977, but it was mainly used for in-plant purposes and there were some problems with the speed and other items. That is why the decision was made in 1979 to develop a next generation unit based on a new design concept, and this program was announced last fall. The first unit of this new model rolled off the line this spring, demonstrations are scheduled starting in June, and sales are expected to be initiated next spring.

This new facility will be marketed with emphasis on 1) increasing treatment volume, 2) improving precision, and 3) diversifying use, as its three main features. The units to be marketed will include the two types for usual LSI use (1-2 microns) (one-fifth and one-tenth reduction) and submicron use and large size use (for magnetic valves and CCD use), for a total of four types.

Among these units the one to which semiconductor makers have been giving the greatest attention is that for submicron use. It guarantees minimum line width of 0.7 micron and is said to be capable of even going to 0.5-micron-line width by pulling out all stops. This is because a lens of the very high numerical aperture of (index of resolving power) 0.45 is used. It also has fast treatment speed, and as a general use instrument it can handle 80 4-inch wafers per hour (40 wafers per hour by position alinement at each die) and 40 wafers per hour (20 per die) in submicron use. This fast production speed is said to be the result of a double diffraction mode in which alinement signals are generated simultaneously from two sites. The problem with this high performance is what the eventual price will be.

Development of this facility has been carried out under the semiconductor group in this company's central laboratory, and the actual production and sales will be entirely handled by its subsidiary, Kameka. Kameka Company will expand its plant in the city of Paris to three times its present capacity by this fall, and its present manpower of 60 is expected to be increased several fold in this burning display of its interest in stepper production. Stepper production at this plant is primarily intended for in-plant use, but it also plans to market some units in line with the French Government's plan to foster its electronics industry.

[4 Feb 81 p 12]

[Text] Greatest Interest Shown at Exhibition

At last November's Seikai semiconductor show, an assembly of specialists of the semiconductor and related industries for this semiconductor producing facilities exhibition, the item which drew the greatest attention and the greatest number of visitors was the reduction exposure device "NSR-1010G" made by Nippon Kogaku, as everyone who was there will agree. The precision work group in charge of this company's stepper at this exhibition said: "We gained great confidence." First of all, the visitors all flocked around this facility, rating the unit as very promising in accolades from external as well as internal sources. Second, it is

difficult to obtain and operate a stepper, which is a highly precise instrument in the ranks of semiconductor production equipment and which requires the use of a special temperature-controlled room, yet this unit when installed in this exhibition hall with its atrocious conditions still operated an opening day even though it had only been installed the day before. "That is because it has a mechanism which operates instantly, and we gained a great deal of confidence in its technology," said the party in charge.

You Are Small

This company has long supplied the GCA Company with lens for the photorepeater, so it is not exactly a stranger to steppers. When members of this company visited GCA in matters pertaining to the lens, they said: "We may become a competitor in the future, but we would like to see your plant," whereupon GCA replied in a rather carefree manner: "You are small; sure you can see the plant." Now, as this company struggled under adverse conditions until it was able to produce its own steppers, it also possessed the lens-making capability which has been the bottleneck in mass production, and it now is a potential competitor which GCA cannot disregard. During the course of the exhibition, GCA made several trips to the Nikon corner to survey the enemy's situation (this show is famous for looking over the competitor's situation and searching for representatives) and measure the throughput of the stepper with a stopwatch in one hand and a tape recorder in the other. It is said that this episode reflected the Japanese-American competition in these production units.

It was about 4 years ago when this company investigated its entry into the stepper field. By chance there was an inquiry from the Super LSI Technology Research Group, and the net result was that this company undertook actual production under the guidance of the group which was attained in 2 and 1/2 years, and delivery was made. "At that time, we were not well acquainted with semiconductor processes, and we felt as though we had a large elephant by the tail," said the party in charge. Since delivery, there has been no evaluation or feedback from the group, but this experience was the basis for the self-development of the NSR-1010G" through the company's independent technology and on suggestions from and discussion with semiconductor maker technologists.

Use of Clear Lens

Because this company is a lens maker, the outstanding feature of this facility is the very clear lens which is used, and it is said that new technologies were developed in the areas of material, polishing, and axial setting. Since the lens is so clear, the aperture can be the very large value of 0.35, as a result of which the high resolution of 1 micron is possible. In addition, 1) the illumination system is brighter, as a result of which the exposure time can be shortened and the fast throughput of 60 4-inch wafers per hour can be realized; 2) a high-speed precision XY stage using an interference scheme is employed, making for good stability and reproducibility; and 3) alinement precision is 0.25 micron while the off axis mode is used in position alinement. At the same time, a TTL mode can be exercised by the use of two units when there is need for alinement at each die.

This company announced this development in February of last year, and as there were no domestically produced steppers at that time, it received tremendous reaction and encouragement from the semiconductor companies. The reasons for this great acceptance included 1) the price was a low 135 million yen; 2) there was no language barrier, and aftercare is simpler with a domestically produced item; and 3) the fast delivery date. In addition, it is said that there were people from all the semiconductor makers (25 companies and 50 businesses) taking notes at the seminar held last fall. All the companies participated in operating this facility and evaluated it for actual resolution, alinement, and throughput, which they rated very highly. No matter how cheap it may be, this is a high priced item which costs 1.5 billion yen for 10 units, thereby necessitating a prompt decision and responsibility, so the parties in charge at the various companies are extremely discrete.

On the other hand, there is a need to obtain steppers faster than other companies and beat them to the draw if any company is going to win out in the production of 64 K and the succeeding super LSI, and the distress of the semiconductor industry is easy to understand. To be sure, Nikon is always said to force the issue by saying: "Please do not divulge any order plans."

There are presently orders for 5 units, and several large companies are considering orders at the 10-unit level. It is said that practically every company has orders for a single unit. In view of this favorable sales picture, this company is planning increased production of steppers at its Oi plant, and production is already several units per month. There are plans for more future expansion, but the present situation is said to be one in which delivery can be made within a year.

Confidence in Its Participation

This company has had one or two experiences in the past in producing mask aliners where the semiconductor production deivces area is concerned, but it quickly withdrew from such production, and this stepper represents the first real shot this company has fired in this area. This facility has been the central axis for retrieving lost ground in the area of semiconductor production equipment. At the same time, it later announced its automated reticule defect finder and light wave interference coordinate measurement device, which are being systematized as associated equipment in the strategy this company is pursuing to develop this semiconductor production facility as the first post camera candidate. To this end this company hopes to "capture at least half the share of the Japanese market and more specifically sell a total of 500 units."

[6 Feb 81 p 16]

[Text] Hitachi in Quick Decision To Enter

Hitachi Limited was the next to follow Nippon Kogaku in domestic production of steppers. This company announced the development of its one-tenth reduction projection exposure facility in May of last year and immediately entered into production. It has already received orders for more than five units for use both in its plant and for external use, and it is to be noted that this company has led Nikon in actual delivery.

The stepper of this company can transfer superfine circuit patterns of 1-micron-line width on silicon wafers with position alinement precision of 0.2 micron, and it has an automatic correction of positional errors by fine movement correction of the reticule in the new positioning scheme which is employed.

There is, however, a problem in the area of sales of the stepper produced by this company in that it will be handled by the measurement equipment business group (sales will be handled by Hitachi Sangyo) and there is the question of how well this business can be integrated in with the other semiconductor efforts, according to industrial sources. Where rival makers are concerned, a purchase of the Hitachi stepper will result in the key step of the semiconductor process, pattern exposure, being controlled by Hitachi and incurring the possibility that their business strategy may be controlled from the outside. This fear may stand in the way of sales. Thus any sales will be limited to companies which do not compete to any great degree with Hitachi. At the same time, the maintenance control is initially a very important item for this type of equipment, necessitating the dispatch of service people along with the product, so that a sudden expansion in sales is difficult. This is why the present sales plan is fairly restrained, with sales of 8 units in 1980, 20 units in 1981, and 30 units in 1982 being planned at the present time.

Pathfinder in Reduction Exposure

In addition, some problems have cropped up in the product which has appeared on the market, and it is said that a modified version is now being quickly developed. Furthermore, the activities at the Musashi plant which is the stronghold of this company's semiconductor activities are said to be at fever pitch in efforts to come out on top in the race for the 64 K, and how to maintain both programs is a major problem. When these problems are licked, it is thought that this company will be in a good position to confront GCA.

Canon has greater experience in semiconductor production equipment than its rival, Nippon Kogaku. It developed this country's first mask aliner "PPC-1" in 1970 and succeeded in noncontact development through equal magnification projection, followed by development of the proximity (gap) mode aliner in 1973 and the world's first use of a continuous ultraviolet light source in 1978. It introduced a one-half facility in the area of step and repeat mode reduction exposure in 1973, followed by a one-fourth facility in 1975, indicating its pioneering role.

At the present time, this company has bested the American companies K and S, Caspar, and Cobilt to top the world in sales of the close adhesion (in sense of proximity) mode. While it is sometimes said that the contact mode has seen its time, the actual situation is not so, with orders increasing each year, and sales are taking place automatically without any business activity. A Canon official said at last fall's semiconductor exhibition: "While everybody is talking about the stepper and gathering at the other company's (Nikon) exhibit, what is seeing actual sales now is the contact mode PLA-500, and we have already sold 300 units over the past 3 years. The reason people pass by our display is because everyone knows what our unit can do."

The semiconductor strategy of Canon is one of "take over the market by appearing later on the scene with the best product," as demonstrated by its success with the contact mode. In this guise its present target is said to be to be invasion of the field of mirror type projection devices on which Perkin Elmer presently has a stranglehold, and it developed a facility for use with 5-inch wafers, which Perkin Elmer has not yet marketed, 2 years ago and invaded the market last year. This facility has resolution of 1.5 micron, and a line width of 1 micron can be realized with a continuous ultraviolet source for the production of super LSI. A number of orders are said to have been received, and production is reported to be proceeding smoothly.

The stepper is presently under development, and it is said that the latest version of one-fifth or one-tenth reduction exposure with laser beam auto alinement mechanism is expected to appear in the market in 1982.

Canon believes that the Japanese influence of Nikon and Canon will take over in the end in the two areas of the mirror mode and the stepper mode. They base this conclusion on these two Japanese makers being optical equipment makers with the capability of producing lenses while most of the Western makers with the exception of Perkin Elmer use a Zeiss lens, as a result of which they are not able to match the Japanese products. At the same time, there are limitations to Zeiss' lens production capacity, and this is expected to become the bottleneck in mass production. Then there is the delivery time. The Western industries must pick up orders for delivery from now to the end of next year or they will be lost. There is the possibility of better instruments appearing in the interim. This is a point where the Japanese industries are said to be in a better position because of the faster and more reliable delivery date.

Perkin Elmer Is Still the Greatest Concern

Now, what concerns the various stepper makers is not so much rival stepper makers as the Perkin Elmer Company. Kanematsu Semiconductor which represents Perkin Elmer in Japan says: "In the first place, attention was directed at the stepper because of the appearance of the 5-inch wafer, which made a radical change in the situation. The large semiconductor industry began moving toward a 5-inch wafer, intending to get into the 64 K and higher area in which they rejected the Perkin Elmer mirror mode because it is a 4-inch affair. They thought that a 5-inch mirror would be difficult to achieve so they went to the stepper. Now, if Perkin Elmer succeeds in coming out with a mirror mode which can be used with 5-inch wafers and has a resolution of 1 micron (using continuous ultraviolet light), this unit will be superior to the stepper both in throughput and price. This is why the rival companies are claiming that this 5-inch instrument cannot be produced."

The sled for the wafer, which is a problem point in the mirror mode, is said to be rectifiable by using a number of rod-like vacuum checks on the stage to hold the wafer down by vacuum, thereby holding the wafer in a horizontal manner and relieving the problem.

Now, if the wafer size were increased to 6 inches or more, the lens and mirrors would have to be so large that the conditions would become too taxing. It is said that Perkin Elmer is putting considerable funds into research into the x-ray and

electron beam exposure devices in preparation for such a situation. It is said that the stepper is also under consideration. An engineer of a certain semiconductor maker said: "Perkin Elmer is a lens maker so it will not limit itself to the mirror mode should the stepper be more promising and it would certainly go into the stepper." If this happens, it will be left to the few optical equipment makers of the world to come up with new steppers of independent design, and this is why Perkin Elmer is being highly regarded.

Industries Engaged in Wafer-Steppers

1 社名（国名）	2 開発	3 備　考	
4GCA (米国)	1977	住商が代理店、断然の実績、電子ビーム開発中	14
5RTEセミコン (米国)	1979	大日本印刷が代理店、コンパクト型を開発中	15
6オプティメトリックス (米国)	1980	伊藤忠が代理店、解像力0.8㍍のカタログ性能	16
7センサー (リヒテンシュタイン)	1980		
8日本光学（日本）	1980	0.35の大開口数レンズX線露光を研究中	17
9日立製作（日本）	1980	注目の装置分野参入電子ビームも販売	18
10フィリップス (オランダ)	1980	解像力1㍍、精度±0.1㍍、電子ビームも開発	19
11トムソンCSF (フランス)	1981	最高のカタログ性能を発表。電子ビームも開発	20
12キヤノン（日本）	1982	超小露光の草分け、コンタクト方式のトップ	21
13パーキンエルマー (米国)		ステッパー対抗の1対1新装置を開発中	22

Key:
1. company (country)
2. development
3. remarks
4. GCA (USA)
5. RTE Semicon (USA)
6. Optometrics (USA)
7. Sensor (Lichtenstein)
8. Nippon Kogaku (Japan)
9. Hitachi Limited (Japan)
10. Phillips (Holland)
11. Thomson CSF (France)
12. Canon (Japan)
13. Perkin Elmer (USA)
14. Sumitomo Corporation is representative, has a proven record, presently developing electron beam
15. Dai Nippon Printing is representative, developing compact model
16. Ito Company is representative, 0.6-micron resolution listed in catalog performance
17. researching x-ray exposure using 0.35 large numerical aperture lens
18. has entered the equipment race, also sells electron beam equipment
19. 1 micron resolution, ± 0.1 micron precision, also developing electron beam
20. has developed top catalog performance equipment, also developing electron beam
21. pioneer in reduction exposure, tops in contact mode
22. developing new one-to-one equipment to counter stepper

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CSO: 4105/137

SCIENCE AND TECHNOLOGY

ELECTRO-MECHANICAL MANUFACTURERS TO CUT IN-HOUSE IC AND LSI PRODUCTION

Tokyo JAPAN ECONOMIC JOURNAL in English Vol 19, No 950 14 Apr 81 p 9

[Text] Japanese producers of "electro-mechanical products" (such as video tape recorders, cameras and copying machines) have started holding down in-house production of integrated circuits and large-scale integrated circuits mainly because of snowballing development costs. ICs and LSIs constitute the core of electro-mechanical products.

Recently, several electronic components manufacturers have discarded in succession their earlier plans to mass produce semiconductors for their own use. Canon, Inc., a leading maker of cameras and copying machines, has decided on a policy of producing only very special semiconductors. Instead, they will procure ICs, LSIs and other semiconductors from specialized makers.

Development of new LSIs now cost several tens of billions of yen a year. This can be hardly met by a single producer of electro-mechanical products. Even specialized semiconductor producers are now trying to limit production items in order to save development investments.

Under the situation, possibility is very strong that a limited number of large makers with huge investment funds will control the semiconductor business in the future.

TDK Electronics Co., a Tokyo producer of magnetic tapes and ferrite products, had been aggressively tackling in-house production of semiconductors. It once set up a semiconductor manufacturing company jointly with Fairchild, but TDK-Fairchild Corp. was later liquidated. Recently, however, TDK has changed the policy and is now placing stress on development of application and peripheral technique rather than semiconductors themselves.

Alps Electric Co., a Tokyo producer of tuners, switches and volume controllers, has given up a plan to mass produce semiconductors.

Pioneer Electronic Corp., which plans to raise the ratio of in-house semiconductor production to 20 per cent in a few years from the present 7-8 per cent, will limit its in-house production to those whose designing and production can hardly be entrusted to other companies because of secrecy and other reasons.

Sony Corp. is now observing the principle to hold down consumption of semiconductors it produces for its own to around one-third of the total consumption.

Matsushita Electronics Corp. plans to hold its semiconductor-related plant and equipment expenditures in fiscal 1981 at the previous year's level of around ¥22 billion.

In sharp contrast, Nippon Electric Co. (NEC), Hitachi, Ltd., Fujitsu Limited and other major semiconductor makers are trying to further boost production. The combined total of plant and equipment investments of the 11 major Japanese semiconductor makers is estimated to reach ¥170 billion in fiscal 1981 on a construction base, up 50 per cent from the preceding year.

They hope to mass produce and mass market their semiconductors in order to recover the huge investments. The mounting "supply pressure" makes semiconductor users feel it costly to continue in-house production.

Another factor that discourages semiconductor users is the difficulty in securing technicians talented in the semiconductor field.

CSO: 4120

SCIENCE AND TECHNOLOGY

'JAPAN ECONOMIC JOURNAL' COMMENTS ON SHIPPING INDUSTRY

Tokyo JAPAN ECONOMIC JOURNAL in English Vol 19, No 950 14 Apr 81 p 10

[Editorial]

[Text]

The working panel of the government's council on rationalization of the shipping and shipbuilding industries has started study of future policies for ocean-going shipping on the basis of the proposal the council came out with in 1978, which, in essence, stressed maintenance and development of Japan's merchant fleet despite the decline of its international competitiveness. This proposal led to the implementation of a three-year program to help reinforce the nation's merchant fleet through subsidies and other preferential financial schemes.

As the three-year program is due to expire at the end of fiscal 1981 (next March 31), it is necessary to formulate a new long-range policy to strengthen the shipping industry after fiscal 1982. One thing that must be kept in mind is the increasingly severe international environment surrounding it. Conclusions of the study by the council are bound to have significant influences on the shape of the shipping industry in the future.

What is important to begin with is to reconfirm the necessity of maintaining and developing the Japanese merchant fleet. This is only natural from the standpoint that Japan is an insular country distant from America and Europe and poor in resources. Her survival depends on the import of foreign materials and fuels to manufacture goods to be sold abroad. The shipping industry has played a critical role in sustaining the development of the Japanese economy through economical and reliable movements of goods from abroad and to overseas markets. It indeed is one of the basic factors that has contributed to the rise of Japan as an economic power.

Another important aspect of the shipping industry is that it is a major source of foreign currency income. It is also significant from the viewpoint of national economic

security in that it ensures a stable supply of goods required for the nation's industry and life.

It is obvious, however, that maintenance and development of the merchant fleet presumes that the Japanese shipping industry retain international competitiveness. To this end, long-term, low-cost funds should be made available for the building of vessels for hauling key materials and goods. There seems to be a particular need to formulate adequate policies both in the building and operation of vessels to carry liquefied natural gas, liquefied petroleum gas and coal, which are rapidly growing in importance as substitutes for oil.

Measures for reinforcing the corporate stability of shipping companies are also up for review. The nature of the shipping business subjects companies to instability, as a high level of profits at one point can easily be wiped out later by a plunge of the market owing to external factors, such as changes in the international situation, or a slump, prolonged especially in this era of slowed economic growth worldwide. To cope with this, shipping companies should be allowed to accumulate internal reserves when they are enjoying good business.

All these measures to help the shipping industry gain in strength presuppose the efforts of both management and labor. There are many things that must be done to enhance Japanese shipping competitiveness, but of crucial importance is rationalization of the wage costs of the crews which are far higher than those in the shipping industries of developing countries. While negotiations on this question are already in progress between management and labor, the point is to modernize and make more reasonable the onboard working conditions, such as lowering the reserve crew ratio, among other things.

CSO: 4120

SCIENCE AND TECHNOLOGY

MITSUBISHI CHEMICAL TO PRODUCE CARBON FIBER OUT OF COAL

Tokyo JAPAN ECONOMIC JOURNAL in English Vol 19, No 950 14 Apr 81 p 12

[Text]

Mitsubishi Chemical Industries, Ltd. intends to commercialize its new carbon fiber technique featuring the use of coal as the raw material (rather than polyacrylonitrile, as choasen by Toray Industries, Inc. and other fiber producers) by 1982. The chemical concern is urging automobile makers to jointly develop specific applications for the coal-based carbon fibers.

The Mitsubishi know-how was developed as a spin-off of its needle coke production technique. (coke shaped in the form of needles is made from coal tar.) Its carbon production does not require fiber stretching as needed in the processes utilizing polyacrylonitrile. Besides the equipment simplification, MCI obtained test results indicating that carbon yields can be substantially improved over those produced by the conventional polyacrylonitrile baking technology.

Throughout 1981, MCI intends to carry out joint application studies with potential users, including automakers. Its commercialization plan will be formulated after the joint research, including study of plant capacity and determination of capital requirements, is completed. MCI consumes about 13 million tons of coal annually to produce coke, making its raw material position a favorable one.

CSO: 4120

SCIENCE AND TECHNOLOGY

WESTERN INTERESTS DRIVE TO GET GENE ENGINEERING PATENTS IN JAPAN

Tokyo JAPAN ECONOMIC JOURNAL in English Vol 19, No 940 14 Apr 81 p 13

[Text]

The Japanese Patent Office recently disclosed that a predominant 73 per cent of all gene engineering patent applications on its waiting list since the beginning of last year were filed by Western interests. Only the remaining 27 per cent were filed by Japanese equivalents, suggesting a danger of Western domination of gene engineering industrial ventures in Japan.

According to the office, a total of 29 applications for Japanese patents on gene engineering has been on file with the office since January 1,1980 Of the total, American applicants accounted for a majority of 15, West European 6 and Japanese only 8.

Japan's patent classification standard was revised on that date to set gene engineering apart as a newly-defined field of technology. This was in keeping with the international practice of patent granting.

Until the end of 1979, there had been similar applications related to gene engineering, but they have been widely scattered among the older classification categories as parts of other kinds of technology.

The office has unofficially figured that such older gene engineering patent applications probably totaled 13. The picture, however, seems to have been just as Western-dominated, with Japanese applicants holding only two cases, or 15 per cent of the total.

The disclosure, the Patent Office's first on gene engineering, was made in order to help the Japanese public understand the facts. The public seems to have become interested in the importance and potential of gene engineering since the patent classification revision.

Observers thought the patent imbalance spotlighted the fact that Western industrial and other researchers have been mounting a fierce gene engineering patent drive in Japan to head off Japanese competition. Without some really determined rollback efforts, almost all Japanese attempts at gene engineering would come up against a wall of locally established foreign patent rights, as a certain Japanese chemical company leader has put it, they said.

Gene engineering, including gene splicing, is rapidly developing into a revolutionary scientific and industrial technology encompassing medical, pharmaceutical, foodstuff, and many other areas, notably new energy development.

In the U.S., Stanford University was granted basic patent rights by the U.S. Patent Office at the end of last year for its pioneering gene splicing process developed by two scientists.

But no such patent has yet to be granted in Japan. Japanese patent authorities have recently continued to announce their own standards of screening such patents, sorting of ideas or processes and preparations, but keeping all applications pending. Various Western interests have called for it to start its screenings soon.

Gene Engineering Related Patent Applications Filed with Japanese Patent Office

(January, 1980-March, 1981)

	Cases
(U.S.)	
Upjohn Co.	9
Cetus Corp.	1
G.D. Searle & Co.	1
Harvard University	2
University of California	1
Stanford University	1
(France)	
Pasteur Institute	3
French Research Evaluation Bureau	1
(Antilles, the Netherlands)	
Biogen S.A.	1
(West Germany)	
Life Engineering Institute	1
(Japan)	
Ajinomoto Co.	3
Mitsubishi Chemical Industries, Ltd.	1
Sumitomo Chemical Co.	1
Noda Industrial Science Institute	2
Agency of Industrial Science & Technology, MITI	1

Source: Japanese Patent Office

CSO: 4120

SCIENCE AND TECHNOLOGY

SANYO ESTABLISHES WORLD RECORD WITH PHOTOVOLTAIC EFFICIENCY RATE

Tokyo JAPAN ECONOMIC JOURNAL in English Vol 19, No 950 14 Apr 81 p 13

[Text]

A new world record in light-to-electricity energy conversion rate of 6.91 per cent has been set by Sanyo Electric Co., in an experiment with solar cells of the amorphous silicon type.

According to the big Osaka electric-electronic appliance manufacturer, the highest photovoltaic efficiency rates known so far are the 6.1 per cent set by RCA Corp. of the U.S., and the 6.47 per cent by Fuji Electric Co. of Japan.

Sanyo Electric's new solar cell is of the same three-layer kind as that of Fuji Electric.

But Sanyo says it made each of the three layers — the p layer involving electron-short impurities, the i layer containing no impurities, and the n layer containing electron-redundant impurities — with a different reactor.

Besides, a process to produce the three different layers continuously has been developed, it says.

The cell produced on trial basis is only 2 millimeters square.

But the new production method can apply even to making big cells of 10 centimeters square. The photovoltaic efficiency, in the case of factory production, thus could be raised to about 5 per cent from only 3 per cent attained last year, the company says.

Use of one reactor to make each different layer ensures complete or, near-complete elimination of undesired impurities in making the layers, such as diborane in making the p layer and phosphine in producing the n layer.

Attainment of somewhere between 8 and 10 per cent is said necessary for commercially paying ventures to manufacture such solar cells.

CSO: 4120

SCIENCE AND TECHNOLOGY

FUJI DEVELOPS HIGH POWER TYPE SUN BATTERY

Tokyo JAPAN ECONOMIC JOURNAL in English Vol 19, No 950 14 Apr 81 p 13

[Text]

Fuji Electric Co. has developed a highly-efficient amorphous silicon solar cell. Its photovoltaic efficiency, which is the sunlight-to-electricity conversion rate, reaches as high as 6.47 per cent. This development was bared at a scientific symposium in Tokyo recently.

The amiorphous silicon solar cell has a single cell surface size of only 1.2 square centimeters, Fuji Electric said.

The new solar cell, on a stainless base board, has three layers of amorphous silicon filming — a p-type, involving electron-short impurities, a neutral type containing no impurities, and then an n-type containing electron-redundant impurities. It is topped with an electrically conductive transparent filming made of oxides of indium and tin.

The new p-i-n (p-n combination) structure has proved to be almost 1 per cent higher in photovoltaic efficiency than the company's own predecessor of 5.58 per cent developed last year.

CSO: 4120

SCIENCE AND TECHNOLOGY

UNIQUE SPECIES OF FUNGUS-PRODUCING CELLULASE IDENTIFIED

Tokyo JAPAN ECONOMIC JOURNAL in English Vol 19, No 950 14 Apr 81

[Text]

The Japanese Government's Fermentation Research Institute has identified a new species of fungus-producing cellulase, that has a stronger dissolution capacity than any known precedent.

Such a microbiological discovery has much to do with the modern new energy-creating biomass technology.

According to the institute at Yatabe Town, Tsukuba County, Ibaraki Prefecture, of the Agency of Industrial Science and Technology, the new filamentous fungus species it has named "Strain M-41," produces cellulase with such strong titer (potency to separate cellulose into glucose) as to surpass even the best developed by the U.S. Army research institute.

That American-developed cellulase, now commercially available in Japan, when tried on a 1 per cent chemical solution of cellulose, has turned 65 per cent of the cellulose content in the solution into glucose. But the cellulase derived from the new species of fungus has attained 70 per cent.

The cellulase coming from the new fungus has also proved so effective as to work even on a 20 per cent thick cellulose solution, turning the solution into a clear 12 per cent glucose solution in 48 hours.

A professor of agriculture at Miyazaki University, well known for his studies on such biomass developing technology, rated the new cellulase and the Japanese studies on such enzymes the most advanced in the world. But he also cited an energetic American research drive to catch up and called for new Japanese efforts to develop low-cost mass-production methods.

Observers said finding a really good kind of cellulase as well as its production source is becoming a worldwide race because the modern key biomass utilizing method of producing ethanol (ethyl alcohol) as a new kind of fuel, out of plants consists in fermenting the plants' starch or glucose contents. Cellulose making up half the body of almost every dried plant has so far been hard to turn into glucose efficiently because of its hardness.

CSO: 4120

SCIENCE AND TECHNOLOGY

ELECTROTECHNICAL LABORATORY FINDS NEW WAY TO MAKE AMORPHOUS SILICON

Tokyo JAPAN ECONOMIC JOURNAL in English Vol 19, No 950 14 Apr 81 p 13

[Text]

A new method of producing amorphous silicon for solar cells, recently developed by the Electrotechnical Laboratory, Agency of Industrial Science & Technology, has worked so well as to turn out product with an efficiency of 1,000 times conventional items.

Development of the new method thus could open a way for manufacture of amorphous silicon types of solar battery with much greater efficiency than heretofore, although it would still take some more time to enhance the photovoltaic efficiency of amorphous silicon to a high enough level for commercial production.

That level is said to be anywhere between 8 and 10 per cent, but the highest rate so far attained in Japan is less than 7 per cent in experiments and about 3 per cent in industrial trials.

According to the laboratory amorphous silicon divides into various types, such as p-type (electron-short), n-type (electron-redundant), and p-i-n type (combining the types p and n). P-type has been difficult to produce as a solar cell material because the necessary addition of boron as dorpant results in degeneration in quality.

The laboratory has solved this problem by preparing the raw material gas as a special mixture of hydrogen and silane (silicon hydride) at the rate of 30 parts to one, an exceptionally great content of hydrogen, with the addition of diborane, a sort of boron hydride, at a certain percentage, pressurizing the mixture to a level 20 times the best conventional production method, heating it to 300 degrees C. and releasing electric discharges between two poles placed four centimeters apart in the mixture at 80 watts, 16 times the best known method.

A p-type amorphous silicon sample thus created has proved to be 1,000 times as high in dark conductivity (a solar cell efficiency unit) as those made by the best conventional process. Besides, addition of boron has never caused the undesirable quality degeneration in the sample.

The laboratory's achievement is expected to draw attention of private businesses engaged in amorphous silicon cells.

CSO: 4120

SCIENCE AND TECHNOLOGY

PHOTO TYPESETTING ARABIC LETTER PLATE DEVELOPED

Tokyo JAPAN ECONOMIC JOURNAL in English Vol 19, No 950 14 Apr 81 p 14

[Text]

A Tokyo printing company has developed a cost-saving electronic photo typesetting letter plate for printing in Arabic that produces a major cut in type-setting work.

The new letter plate, according to the Middle East Printing Co., facilitates electronically-typeset letters for headlines of catalogues, pamphlets and magazines, the first of its kind in the world.

So far, it has been impossible to photocompose or type Arabic letters for headlines, titles etc. They, thus, have had to be manually written or transcribed by designers.

The company has made a design of such letters on its own and formed letter plates for typesetting with the following features:

—A plate can cover all necessary letters as one letter can be formed by combination with another.

—Typesetting is possible without separating letters, thus maintaining the unique style of Arabic, which, in principle, should be written manually.

Compared with instant lettering, the new plate can shorten the time required for typesetting to the onetenth with the cost being reduced to onefifth, the company said.

Printing firms in Arabic countries reportedly have no photo typesetter using such letters as they mostly adopt the instant formula. In Western countries, too, instant transcribing is common.

The Middle East oil-producing countries are a lucrative market for electric appliance, car, construction machinery and plant makers. To successfully sell such products in the region, they are required to prepare documents in Arabic. Manuals for various machines and equipment also should be written in Arabic.

Given this background, demand for printed matter in Arabic is increasing rapidly.

The Tokyo company intends to solicit orders through promotion of the new machine.

CSO: 4120 END