JPRS L/9923

20 August 1981

Japan Report

(FOUO 49/81)

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APPROVED FOR RELEASE: 2007/02/09: CIA-RDP82-00850R000400040035-5

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JAPAN REPORT

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CONTENTS

SCIENCE AND TECHNOLOGY

OIL DEVELOPMENT IN JAPAN REVIEWED

Tokyo DIAMOND'S INDUSTRIA in English Vol II No 7, Jul 81 pp 19-20

[Text]

Teikoku Oil Co., Esso Sekiyu Kaihatsu Co. and East Japan Oil Development Co. announced on May 19, 1981, their plan to jointly develop Joban offshore oil and gas fields on the Pacific coast, which they had been studying to exploit on a commercial basis. The project was originally undertaken jointly by Teikoku Oil and Esso Sekiyu Kaihatsu, which test-drilled nine wells in the area until 1974 and found the existence of natural gas. But the development of oil and gas was postponed because of the preference given to other areas under Esso's global strategy.

In 1978, East Japan Oil Development, a joint company of Toa Nenryo Kogyo and General Sekiyu, took over 15% of the shares belonging to Esso Sekiyu Kaihatsu which owned 50% of the total shares. Ever since, the three companies have been jointly studying the exploitation of oil and gas on a commercial basis.

Since they have agreed with Tokyo Electric Power on the supply of the main product, natural gas, to the Hirono Thermal Power Station, beginning in 1984, the oil and gas developers have decided to start the construction of production facilities. Under the plan, a platform will be constructed at a point 41 kilometers off the coast of Fukushima Prefecture, from which natural gas will be sent to the Hirono Thermal Power Station through a pipeline. The recoverable reserves are estimated at 3,500~5,500 million cubic meters.

The decision to develop the natural gas fields is in line with the changes in the oil supply situation in the world. With the sharp rises in oil prices, development projects have become more profitable than before. Japan depends on imports for most of its oil needs. Oil has been sustaining Japan's economic development. But domestically-produced oil accounts for only 0.2% of the demand. Not only sharp increases in oil prices but also an unstable supply pose a serious problem for Japan.

In Japan, the ratio of oil used for industrial purposes to the total is much higher than in other industrially advanced countries. Although Japanese industries have been coping with the situation by reducing oil consumption, it has become an urgent matter to develop oil resources in Japan itself.

Oil development with Japanese funds has been undertaken abroad but there are risks which might be brought about by political instability. Therefore, oil development in Japan and waters around the country has been activated rapidly. The main energy resource being developed in Japan is natural gas. The annual production is about three million kiloliters in crude oil equivalent. About 80% of the total is produced on land but attention is being paid to waters around the country, especially to the continental shelf, since oil resources on land have already been totally surveyed.

At present, the only oil and gas fields in waters around Japan are the Aga offshore fields of Niigata Prefecture on the Japan Sea coast. This project is being undertaken jointly by a subsidiary of Japan Petroleum Exploration, Japex Offshore Co., and Idemitsu Oil Development Co., a subsidiary of Idemitsu Kosan. The oil and gas fields were discovered in 1972 and production began in 1976.

Furthermore. New Japan Sea Exploration, a subsidiary of Idemitsu Oil Development, found oil in the North Aga offshore concession, an area a little north of the Aga offshore fields, after digging two test wells in 1973. The company conducted detailed physical prospecting there, began drilling a third test well in March, 1981, and successfully struck oil in May. The test well, which is at the water-depth of 90 m, was dug 2,200 m into the seabed, where six oil bearing formations were discovered. And 1,500-2,500 barrels of crude oil were obtained daily from the lowest formation. At present, the company is conducting tests on upper formations and plans to dig a fourth well in autumn to survey the spread of the oil formations. The North Aga offshore fields, which yield mostly crude oil, are attracting the attention of industrial circles as having the possibility of becoming Japan's largest oil fields.

The sedimentary basin in waters near Japan, where oil and natural gas can be prospected, is known to total about 370,000 square kilometers, or as large as the land area of Japan. And the areas for prospecting spread widely on the continental shelf down to the water-depth of 200 meters and on continental slopes 200 meters to 2,000 meters deep. According to a survey by the Japan National Oil Corp., recoverable reserves in waters around Japan total about 1,304 million kiloliters (in crude oil equivalent), while the reserves on land are 200 million kiloliters. Development of the resources in the sea is deemed to be more promising.

The Japanese Government, which started the fifth five-year domestic oil and gas development project, beginning in April, 1980, intends to find 6 million kiloliters of reserves on land and 96 million kiloliters in waters in the five-year period. And the Government plans to produce 2.3 million kiloliters on land and 5.7 million kiloliters in waters, or a total of 8 million kiloliters in fiscal 1985. The Government is to test-drill wells on continental slopes deep in the sea for the first time.

Test drilling based on the 1978 Japan-South Korea agreement on the development of continental shelf is also to start this year. Oil development in waters around Japan is quickly gaining momentum.

CSO: 4120/291

SCIENCE AND TECHNOLOGY

MACHINE INDUSTRY STATUS, PROSPECTS REVIEWED

Tokyo DIAMOND'S INDUSTRIA in English Vol 11 No 7, Jul 81 pp 9-14

[Text]

Steady Growth

Reflecting the unclear business outlook, small-sized enterprises lack incentives in equipment investment. An increasing number of them are delaying the time of planned investment or reducing the size of investment. Some government officials foresee that this trend will continue through the first half of 1981 but they are not optimistic about the situation in the following half-year period.

However, there are some exceptions. Many medium-sized manufacturers are eager for labor saving, energy conservation and research and development, and most of them are planning on investments ranging from ¥500 million to ¥1,000 million. This trend, in fact, is even more conspicuous among big businesses. The Government estimates that plant and equipment investments in the private sector in fiscal 1981 (April, 1981 ~ March, 1982) will increase over the previous year by 7.3% in real terms and 10.7% in nominal terms. Business quarters think this outlook is too bullish. But a majority of business executives believe that the growth rate will be 5% or so. In other words, they have a fairly strong desire for equipment investment.

Investment plans by big manufacturers are centered on technological development, the development of new products, energy conservation and labor saving, while some manufacturers in the electric appliance, automobile, steel and petrochemical industries plan to expand their production facilities.

This provides a bright business outlook for machinery manufacturers. According to the Japan Machinery Federation, the production of general machines, including machine tools, in fiscal 1980 totaled ¥11,807,537 million (including some approximations) and exports totaled ¥3,700,699 million. They represented increases of 6.4% and 20%, respectively, over the previous year. Business growth in fiscal 1981 is expected to be even faster than the 1980 performance. The total output for fiscal 1981 is estimated at ¥12,450,129 million, up 5.4%, and exports at ¥3,987,000 million, up 8.1%.

Construction machines hold a large portion of the output. Their total output is estimated at ¥1,293,400 million (up 7.7%), refrigeration machines at ¥1,132,000 million (up 3.1%) and chemical machines at

¥1,032,900 million (up 7.3%). Among high growth products are printing and book binding machines (output: ¥176,900 million, up 14.6%), packaging machines (¥214,500 million, up 12%), hydraulic equipment (¥220,000 million, up 11.1%) and secondary metal working machines (¥210,000 million, up 10.5%). The top earner in exports is office automation machines (¥604,700 million, up 11.1%), followed by construction machines (¥541,900 million, up 14.4%), internal combustion engines (¥448,000 million, up 9.4%), chemical machines (¥380,900 million, up 6.3%), metal machining tools (¥290,000 million, up 7.4%) and textile machines (¥193,400 million, up 5%).

High growth products in exports are hydraulic equipment (¥8,500 million, up 21.4%), printing and book binding machines (¥57,000 million, up 15.4%), construction machines (¥541,900 million, up 14.4%), mining machines (¥29,200 million, up 12.3%), pumps, blowers and compressors (¥102,900 million, up 11%) and packaging machines (¥19,500 million, up 13.1%).

Behind the business prospects are the facts that big manufacturers are continuing investment to cut energy consumption, save labor and raise productivity and that many firms are also spending money to shift the fuel from oil to other sources, control pollution and raise safety standards in their plant operations. In export business, the Japan Machinery Federation holds a view that machinery exports will increase at a fairly fast pace, despite some trade frictions with importing countries, because Japanese machines have become competitive.

Continuing Equipment Investment

In early 1981, Yokohama Shipyard & Engine Works of Mitsubishi Heavy Industries adjacent to Yokohama Port was closed down, putting an end to its 90-year history of operations to a chagrin of many Yokohama citizens. The company says that its site is too small for the current operation. It also turned unsuitable for a heavy industry, because houses and stores were built too close to the site in the postwar era. The shipyard's workers are now busy building a new plant on a 330,000-square-meter site at the southern end of Yokohama. It is scheduled to go into business in April, 1983, as the Kanazawa Plant of Yokohama Shipyard & Engine Works to manufacture boilers, diesel engines and other types of heavy machinery. Mitsubishi is reportedly sinking about ¥20,000 million in the new plant – the biggest investment in a single plant by the company.

Mitsui Engineering & Shipbuilding, which parallels Mitsubishi Heavy Industries in shipbuilding, is now expanding business in overland machinery. Its plant and equipment investments in fiscal 1981 are estimated at about ¥12,000 million. More than half of it is to be spent for the construction of the Ohita Plant in Ohita Prefecture, Kyushu. Construction work began in October, 1980, and is scheduled to be completed in October this year. It is expected to manufacture bridges, sluices, tanks, oil drilling rigs and the like.

Fujitsu Fanuc, a subsidiary of Fujitsu (a top ranking computer maker in Japan), is known as a maker of precision machine tool systems. This company recently built a new plant equipped with FMS (flexible manufacturing system) on the outskirts of Mt. Fuji (in Yamanashi Prefecture) at a cost of ¥8,000 million. This computerized manufacturing system automatically controls machining centers, industrial robots and conveyor systems and it requires no skilled factory workers for manufacturing. With a few men on duty, the system can run the factory 24 hours a day. Several other machine makers are reportedly studying plans to adopt FMS by investing ¥1,000 million ~ ¥3,000 million.

The machine industry is anticipating very much of equipment investment for research and development. According to a survey on 118 large- and medium-sized manufacturers by the *Nihon Keizai*, Japan's biggest economic daily, the ratio of R & D investment to the total investment in fiscal 1980 stood at 6.3%, and the like figure for fiscal 1981 is estimated at 8.1%. To cite a few examples, Komatsu Ltd., a leading construction machinery maker, plans to invest ¥5,100 million in R & D projects in fiscal 1981. This represents a 59.4% increase over fiscal 1980. Similarly, Mitsui Engineering & Shipbuilding plans to invest ¥3,000 million, up 24.4%, and Toyoda Automatic Loom Works ¥1,000 million, up 37%.

The contents of R & D projects differ with manufacturers, but many of them are projects in new fields, such as the development of equipment for ocean development by a construction machinery maker. This means that it is difficult to foresee exactly who is trying to do what. Thus it is difficult for machine makers to make a proper long- or medium-term business outlook. The situation also suggests that competition among machine makers will intensify in coming years.

International Cooperation

Japanese machinery manufacturers have traditionally attached importance to plant and equipment investment and spared no efforts to renew production facilities and promote research and development.

During the period of more than 10 years from 1960 to the early 1970s, the Japanese economy achieved rapid growth. However, more than half of Japanese machines used for the economic expansion was manufactured by using industrial know-how imported mainly from the United States and Europe. As though correcting this situation, Japanese manufacturers have constantly spared part of their earnings during the past 10 years to assimilate foreign technologies or develop expertise of their own, especially new production technologies. As a result of their efforts, an increasing number of manufacturers are switching their contracts with foreign manufacturers to cross-license formulas or concluding new contracts to export Japanese technologies to their foreign partners.

A spokesman for Kato Works, the top maker of big truck cranes, said that his company's products have no risks of hit or miss and are strong and durable. He said that an IC-applied automatic control device ensures their safety operations. He attributed a sharp rise in exports of Kato's products in the recent few years to their high-quality standards, which, he added, owe very much to advancement in production technology.

To be sure, the stable quality of Japanese products is a feat of their production technologies. Especially in recent years, "mechatronics" (a combination of mechanical technology and electronics) that saw a rapid advance in Japan has been sending out products well accepted overseas.

Reflecting these realities, an increasing number of machine manufacturers in Europe and the United States are approaching Japanese makers asking for supply of products or for joint development or joint production. Their inquiries vary, some for the supply of assembly units they cannot make with their techniques and others for the supply of such specific parts. Recently, Kobe Steel received an inquiry for the 230-ton rotor shaft of the world's largest generator

(1,300,000 kW) to be installed at an nuclear power plant in France. In Japan there are only Kobe Steel, Sumitomo Metal Industries, Japan Steel Works and one other firm that have giant presses to make the product.

In another case, Toyo-sha, a medium-sized agricultural machine producer, received an offer from an internationally-known American company of farm machines for an OEM export of 4,000 small farm machines a year. JGC Corp., a leading plant construction and engineering firm of Japan, concluded a long-term business tie-up arrangement to take part in international bids "continuously" for the construction of liquefied natural gas plants with a U.S. firm. Shin Meiwa Industry will soon begin supplying arc-welding robots to a French firm under an OEM formula. Fujitsu Fanuc will also supply robots for machine tools to a West German firm under the same formula. Meanwhile, Kobe Steel recently acquired 10% of the shares of an American construction company to join its world business strategy. Kobe has been producing machines for many years under a license agreement with the said U.S. company.

These are only a few of the recent examples of technical cooperation between Japanese manufacturers and their counterparts abroad. In the future, the number of cases will increase further in which Japanese manufacturers will cooperate with machine producers in other countries by providing them with Japanese technology or using Japanese facilities. The time is coming for Japan to return to its former "teachers" for what it has learned.

Industrial Robots

As mentioned above, the Japanese machine industry has achieved spectacular advances in technology, particularly in "mechatronics." One of its achievements is an industrial robot. According to the Japan Industrial Robot Association, the employment of industrial robots in Japan rose steeply in 1980; their production totaled 21,000 units, worth ¥60,000 million. The production is estimated to rise to ¥300,000 million in value in 1985.

The industrial robot was used on the production line in Japan a decade or so ago. Its demand was very low in early years. Its output stood at ¥26,000 million in 1977 and at ¥27,000 million in 1978. But the production jumped to ¥42,400 million in 1979. It is only in the past year or two that the production showed big growth. The number of industrial robots being used in Japan today is estimated at about 75,000 units, nearly 70% of the world's total. Most of the industrial robots are working in the manufacturing industry. The biggest user is the auto industry which accounts for 38% of the total in value, followed by the electric equipment industry with 18%, the synthetic resin industry with 11%, the metal product industry with 8%, the steel industry with 4%, the machine tool industry with 3% and other industries with 18%.

Behind the rapid spread of industrial robots are various conceivable factors. For example, young workers are increasingly shying away from work on the assembly line and dangerous jobs. The industrial robot is an effective means to reduce labor costs. The robot's performance has so advanced recently that it can perform various jobs. Many robots take the place of simple manual work of man. And the number of computer-controlled robots for precision work is also increasing. Another factor contributing to the fast spread of robots is that Japanese labor unions are not opposed to the introduction of industrial robots as strongly as those in the U.S. and Europe.

The use of robots will continue to increase in such fields of work as machining, welding, painting and press. It is also likely that new robots will be developed for such jobs as (1) assembling many different types of products in small quantities, (2) material handling and machining, (3) cast finishing, (4) interior painting and finish painting of automobiles. Such industrial robots will probably be in practical use in the 1980s.

Thus, robot production is considered to be a promising business in the machine industry, and many manufacturers – about 130 in all – have entered this field of industry. Japan's top robot maker, Kawasaki Heavy Industries, is likely to turn out 600 robots for welding or painting operations within 1981 and 1,200 more units in 1982 under a technical tie-up arrangement with Unimation Inc. of the U.S. With the "robot fever" sweeping Japan, some one began calling the robot a "steel color," a term *vis-a-vis* white color and blue color. The steel color may probably oust many of blue color workers from factories in Japan before long.

Machine Tools

In March every year the Japan Machine Tool Builders' Association publishes a business outlook – demand and production – for the new fiscal year beginning on April 1. It is prepared on the basis of the projections of the association's 68 member firms. It is reported the assessment of business in this fiscal year was widely divided to an unprecedented degree. This means that the association committees could not make a proper projection of new orders for machine tools unanimously.

The business outlook of the auto industry – a major user of machine tools – is not very bright. Car exports are expected to slow down due to trade frictions with importing countries, while domestic demand is likely to stagnate this year. Meanwhile, small- and medium-sized manufacturers are curbing equipment investments, although big businesses are not so bad. These are negative factors the machine tool industry must not overlook. On the other hand, demand for NC (numerical control) machines is persistently strong both at home and abroad. Encouraged by recovering orders, shipbuilders are showing moves toward equipment investment. After all, however, the conservative opinion warning against over-expectations of the favorable developments dominated the association members.

In this year's projection, new orders are estimated at ¥620,000 million, down 2% from the previous year. The annual output is expected to reach ¥780,000 million, up 8%, since manufacturers are estimated to have an average of six months of work in their backlogs. In view of recent trade frictions, estimates for imports and exports are "political" ones. Exports are set at ¥290,000 million, up 4%, and imports ¥45,000 million, up 15%. Domestic demand is estimated at ¥535,000 million, up 12%.

The business prosperity the machine tool industry has enjoyed for the past few years is obviously coming to a waning phase. Demand rose sharply during the past years. New orders received in fiscal 1980 totaled ¥631,700 million, a 29% increase over the previous year. Production was up 36% at ¥720,000 million. One of the reasons for the growth was a sharp increase in demand for NC machine tools. Orders for NC machines accounted for 51.5% of the total orders received in fiscal 1980. Most of the NC machine orders are of lathes and machining centers. Their outputs in 1980 were 12,000 units (up 55% over 1979) and 5,200 units (up 75%), respectively.

Demand for NC machines will continue to increase in the future, but the growth rate will probably be moderate, compared with the past few years. Particularly, as to NC lathes, many industry observers say that demand has generally been filled. Machining centers still have potentials for expansion. But most prospective markets are located overseas. So, optimism is not warranted. A general manager of one of Japan's major producers of machining centers says, "Prospects are bright until the first half of fiscal 1982. But we cannot tell you if the demand continues to rise or decline thereafter."

It also seems to be clear that NC machines will make the main stream of Japan's machine tools in the future. The increase in exports owes to brisk orders for NC machines. Especially medium- and small-sized NC machines of Japan have won high reputations overseas. Electronic components employed in the machines, such as microcomputers and sensors, are largely responsible for the credit. The so-called "mechatronics" will provide a prime power for the development and advancement of future machine tools. This may also be applied to other types of machinery.

Future Outlook

Last December the Japan Machinery Federation published a business outlook projecting the production, demand and exports of general machines, electric machines, transportation equipment and other types of machinery in fiscal 1985.

This estimate was prepared on the basis of the Japanese Government's new seven-year economic-social program, which is intended to "balance the ratios of exports and imports and establish an economic growth pattern counting on domestic demand." The estimate, therefore, has a political tinge but still suggests a medium-term projection of the nation's machine industry.

The federation estimates that the output of all machinery in fiscal 1985 will total ¥56,311,400 million in value. This represents an average annual increase of 6.3%. In the breakdown, the output of general machinery is estimated at ¥14,874,700 million, which indicates that the annual growth rate is 5.8% on the average. The total domestic demand for all kinds of machinery in 1985 is set at ¥35,147,000 million (growth rate: 6.1%), and that for general machinery at ¥10,761,900 million (5.7%). Total exports are estimated to reach ¥21,164,400 million and those of general machinery ¥4,112,800 million. Their average annual growth rates are 6.7% and 6.1%, respectively. The growth rate of electric machinery is estimated at 8.7% to total ¥6,826,000 million, and the growth rates of other types of machinery are set below the average.

Exports of general machinery to the United States and Europe are growing continuously, and some of them might cause trade frictions in the near future as in the case of car exports. The share of Japanese machinery on the Southeast Asian market is quite high. For example, almost all the construction machines used in the area are Japanese products. Naturally, the necessity of overseas production by Japanese makers will grow in the future. Demands for "orderly exports" may also arise in importing countries. The machine industry will have to stop massive exports and study the possibility of developing the domestic market. In the light of the industries' moves toward energy conservation and development of substitute energy sources for oil, machine makers have to step up efforts to develop labor-saving equipment, pollution control equipment, large-scale construction machines and equipment for development of energy resources. At the same time, it is important to develop high value-added products.

In fact, many machine makers are studying ways to expand business tie-ups with electronic equipment manufacturers to develop software for their products, as well as strengthen their own research and development divisions. While stepping up technical cooperation with foreign manufacturers, they are also studying ways or plans for overseas production, including "knock-down production." This is a new phenomenon that has arisen in the 1980s – an indication of manufacturers' strong determination to survive the difficult era.

CSO: 4120/291

SCIENCE AND TECHNOLOGY

JAPAN, U.S. COMPETE OVER IC MARKET SHARE

Tokyo NIKKAN KOGYO SHIMBUN in Japanese 9, 11, 12, 13, 17 Jun 81

[9 Jun 81 p 8]

[Text] Japan's IC industry is comparable to being in a situation in which it is one of the contestants in a semiconductor confrontation between Silicon Valley and Silicon Island. The relationship between these two contestants has been extremely tranquil during the past year, but the demand for lowering IC import duties erupted at the time of Prime Minister Suzuki's visit to the United States, and the heat from this friction still has not subsided. On the other hand, because Japan has taken over 70 percent of the 64K market in an overwhelming show of strength, there is a complete reversal of the situation of 3 years ago, at the time of the "spy incident involving Japanese industry," in that Japan is considered to be the decisive victor to the extent that it is rumored that some voices are being raised on the American side to "study the ways of the more powerful Japan." This is why it was decided to survey the frontline of the Japanese IC industry and to look into the most recent situation and the changes on both sides.

Intense Enticement Activities

There is in the Japanese archipelago today an epidemic of IC fever. This fever has also struck every country in the world. Self-governing units, power companies, and mass communications related governmental organs throughout the country are engaged in a hectic race for "an IC plant in its town." It is an almost daily occurrence that semiconductor manufacturers such as Nippon Electric and its main plants in the northern Kyushu district are being enticed to relocate, and it is not necessarily a mistake to engage in such give-and-take efforts.

The scene is the reception room of Nippon Electric Company's main office. The visitors are the executives of a certain prefecture who are asking this company to locate there. The party answering this delegation is the so-called "top man" of Japan's semiconductor industry, Vice President Jungi Ouchi of this company.

Prefectural delegation: Our prefecture has good water available, and there is ample labor to the extent that there is a considerable overflow of labor from the prefecture. The prospective plant site is but 30 minutes from an airfield. Why not locate an IC plant in our prefecture?

Mr Ouchi: This company plans during the course of this year to expand the former processing line in Yamagata Prefecture, in addition to which it will construct an assembly plant in Akita. At the same time, selective buying is under way for a second plant in the United States, and we have started in on a comprehensive LSI plant in Scotland. We will make a study of your prefecture, but we do not have the leeway to make a move right now.

Similar sessions are experienced by the "supreme mentor" of Hitachi Limited's Semiconductor Industry Department, director Hiromu Asano, almost daily. The situation is the same at Tokyo Shibaura Electric and Matsushita Electronics Industry. Whether in submission to such fierce onslaughts or whether a balance was found between gains and losses, Mitsubishi Electric has decided to locate a plant in Ehime Prefecture.

This type of visitation rush also applies to Kyushu Electric and Toshiba's Oita IC plant, and these people say that for the past year or 2 they have been exposed to a continual series of "please hear our offer for you to locate in our area" enticements. Visiting groups are "coming down to the extent we almost hate to see them come."

A breakdown of these visiting groups shows that there is a predominance of local self-governing bodies, commercial and industrial groups, and power companies (the IC industry utilizes air conditioning and furnaces, so it uses large amount of electric power; indicative of the huge consumption of power, Kyushu Nichiden is said to pay 130 million yen a month in power charges to Kyushu Electric) from Chugoku, Chubu, Shikoku, and Hokkaido, where there is little in the form of IC industries.

The reasons local self-governing bodies are putting on so much pressure in their inducement efforts include: 1) IC acts as the food for industry, as it is known that IC is associated with the growth of the iron and steel industry and other basic industries, and the opening of new plants has a very great domino effect on industry; 2) this is a nonpolluting and advanced industry; 3) it is of a suitable scale to absorb excess labor capacity. Added to this has been the overlap with the most recent technopolis concept to spur this movement further.

Sales Double in 3 Years

Now, listening to the situation as seen by the semiconductor industry, we hear the following story: "This business will be in sad straits if sales double every 4 years, as is the case with the computer industry, and we expect sales to double in 3 years. This is why any company which does not construct new plants, even though it says it will not produce very much, will be in a poor production situation one day." (Director Hiromu Asano of Hitachi Limited) Where Nippon Electric is concerned, it is eagerly constructing new plants every year, and its annual outlay for new facilities is assuming gigantic proportions, as attested by this year's investment of 35 billion yen.

According to director Asano, the items Hitachi looks for when it seeks to locate a new plant are: 1) Is there a site which has idle in-plant space? 2) Is there a Hitachi group member with such a location? 3) Is there a site in an area where the technopolis concept is strong? Even though all of Japan would like to get into this industry, the company's situation must always be uppermost in mind. Unlike the situation with Silicon Valley, even should Japan succeed in centralizing its IC industry, the problem of the "supply of chemicals and gas will be the ultimate limiting factor," and there is not much advantage in such concentration. On the other hand, dispersion of the industry will facilitate assurance of manpower, which is a limiting item particularly with respect to manpower for equipment maintenance and improvement. These are the reasons for dispersing the industry throughout the country.

Nippon Electric's expansion in Yamagata Prefecture, parallel to its expansion in Kyushu, is one phase of such a program. Mitsubishi also feels that concentrating its plant facilities in Kyushu may be risky, and that it would be better to be located in four or five areas throughout the country. Its recent move into Shikoku to set up its "virgin IC site" reflects this position.

Viewed from this viewpoint, there is concurrence between the inducement groups and the IC industry groups that their basic line of thought is to convert the Japanese islands into a Silicon Island (this may be put more accurately as Silicon Archipelago). If this comes to pass, the entire archipelago will develop IC fever. When Nippon Electric announced the construction of its assembly plant in Akita, the contract was signed at the prestigious Distinguished Visitors Reception Room at the prefectural building. The governor himself addressed the news group on the history of this development. Local papers carried banner headlines the next day, taking more than half of the front page to cover the event. In fact, all of the country's papers gave this item top billing from the social movement front (prefectural press), and there was lavish welcome for this occasion.

Communist Sphere Also Shows Interest

A recent trend at the Kyushu IC plants has been the influx of foreign visitors. For example, semiconductor manufacturers and consumers, buyers, and important government people from the United States and Europe have been continually visiting Toshiba's Oita plant. Visitors from communist countries are also appearing. When this reporter visited this plant the latter part of May, he was told that visitors from two East European countries had come the week before and Soviet high officials would be coming by that week.

In this manner, even the so-called main adversary in the semiconductor area, the United States, has had its semiconductor industry coming to view the situation on Kyushu, which has become famous as the semiconductor island. It is said that this trend happened after the Washington seminar (sponsored by the Japanese Electronic Equipment Association), at which time the superior quality of Japan-made IC was broadcast to the world. It was here that the Japanese industry demonstrated its close control over product quality through quality assurance and demonstrated its better quality over the American product. This was why the thought arose among the Americans that if the product was that good, a look at the Japanese IC plants was warranted. One visit was sufficient to impress the visitors of the beauty of the quality control program, and this information was relayed to the Valley, with the result that visitors from that area now make a beeline for Kyushu on their arrival in Japan. FORTUNE magazine, in an issue 2 or 3 years ago, stated, "The Japanese industry has spies in Silicon Valley." Compared to that situation, Japan's position surely has changed.

[11 Jun 81 p 14]

[Text] Nine Semiconductor Companies are the Strongholds

During the past 5 years, Kyushu began to become regarded as the "Silicon Island" counterpart to the "Silicon Valley" of the United States. It was about 11 years ago, in 1970, that semiconductor plants began to be located in Kyushu in sizable numbers, and this was when the Kumamoto No 2 plant of Mitsubishi Electric, Kyushu Nippon Electric, and Tokyo Shibaura Electric's Oita plant all initiated operations at about the same time.

The following is a brief history of the semiconductor industry in Kyushu.

December 1966	Toshiba's Kyushu plant
July 1967	Mitsubishi's Kumamoto No 1 plant
March 1969	Matsushita Electric at Kagoshima
March 1970	Mitsubishi's Kumamoto No 2 plant
April 1970	Kyushu Nippon Electric
July 1970	Toshiba's Oita plant
November 1973	Nippon TI Hinode plant
May 1974	Sony's Kokubun Semiconductor
October 1976	Nippon Gakki's Kagoshima plant
August 1981	Miyazaki Oki Electric

Although there are some assembly plants, the nine major companies with the exception of Hitachi Limited, Sharp, and Sanyo Electric have production centers in Kyushu. In addition, the IC industry based on Kyushu has been recording the high average annual growth rate of 40 percent, which accounts for 40 percent of the entire country's production and for about 25 percent in money value.

There Are No Other Suitable Sites for IC

We asked Masao Suzuki, director of Nippon Electric Kyushu, Morihisa Nakane, manager of Mitsubishi's Kumamoto plant, and Akihiro Fujii, manager of Toshiba's Oita plant, why the IC industry located in Kyushu. They all gave as the primary reason: "Above all, there was an abundance of good-quality labor." This was followed by "there is good water" and "airfields are nearby, making for ready communication." As long as these conditions can be satisfied, it is expected that Kyushu will continue to remain a large IC production base.

Director Suzuki of Kyushu Nippon Electric had this to add, "It was I who stated that Kyushu is blessed with the three conditions necessary for the IC industry: manpower, water, and airports. However, this statement is but a catch phrase. I cannot say whether everyone jumped on the bandwagon or was forced on, but when

I look at the situation in which this explanation is spouted as gospel truth, I have recently begun to reconsider my position." He added, "If one examines the three conditions suitable for IC more carefully, he will find that any place in the Japanese archipelago will fulfill these conditions. Kyushu is not the only site."

Director Suzuki's views may probably be regarded as holding true at the present time, for surely the Tohoku district or Shikoku would satisfy these three conditions (in like manner, the entire archipelago constitutes IC fever).

Take, for example, "good quality and abundant labor." The educational level is the same no matter where one goes in Japan, and there is essentially no difference between districts. The level is high compared to the United States. The ability to pick up leading technology industries quickly and even have the capacity to improve and further develop the technology is present in workers throughout Japan, no matter whether the worker comes from a good school or from Iwate.

Kyushu is not particularly blessed with labor. Looking at the new influx of workers from the middle schools and upper secondary schools during JFY 1980, there were 88,700 from Kyushu, while the Tohoku district with not much industry had 94,200. In addition, there were 40,000 in Chugoku, 23,600 in Shikoku, and 17,000 in Hokuriku. In this manner, all these districts have the capability of absorbing an industry such as an IC plant which hires between 1,000 and 2,000 workers per plant.

Accidentally a Producer of Distilled Spirits

Should one look all over Japan, he would find very few places where the quality of water is so poor that it cannot satisfy the condition of "water being of good quality and abundant." Practically every district can supply the volume of water required by an IC industry. "The practice in the past was to select a site where the water was pure and low in salt content. On the other hand, water and construction control has been improved to the point that any water is suitable as long as it is low in silica. The site can be along the coast of Oita, as was seen above. The distilled spirits of Kyushu are of good quality. While it has been said that a site that is good for manufacturing distilled spirits is also suitable for IC production as well, there is no real scientific basis for this. Water used in IC production is rather poor in quality" (Mikiro Safuji, manager of the production department of Toshiba's Oita plant).

Toshiba's Oita plant takes water from the Ono River which flows through the city, and this water is filtered and used as tapwater. This water is converted to pure water, from which superpure water is prepared by an ion permeation method. Superpure water is a very important item in the IC industry; it is used to wash wafers and prepare chemical solutions. This is why this plant has a large water treatment facility, and large and small pipes distribute this water around the plant. This situation is the same at Kyushu Nippon Electric and Mitsubishi Kumamoto. As long as this type of complete water treatment facility is available, it makes no difference where one is located. The fact that Hitachi continues to operate its

Musashi plant as a center for super LSI development, despite its acknowledged water limitations, is the result of the development of this water treatment technology and drying technology.

"The proximity of an airport providing convenient transportation" was given as the reason for the decision of Oki Electric to select the town of Seibu, in Miyazaki Prefecture, which is only 15 minutes by automobile to the Miyazaki airport through Nitta-shi in Oita Prefecture, and this has become very famous. It is true that air transportation is a vital cog for the IC industry.

A ton of "IC" is worth 300 million yen, and this amount can be put in two containers for air transport. The shipping cost is 250,000 yen--a piddling sum compared to the value of the product. By timing the arrival of the package at the airport no later than 5 p.m., this plane can meet the plane which leaves Kumamoto airport at 7:40 p.m. and arrives at Haneda by 9:30 p.m. that same evening. There is no difference in cost or time from a product shipped from the Sagamigahara office. It can almost be said that "this is the Kumamoto city ward of Tokyo," said director Suzuki of Kyushu Nippon Electric in citing the merits of air transport.

Critical Air Industry

The situation differs, however, in the case of Mitsubishi Kumamoto. Should air delivery be planned from Mitsubishi's new plant at Itami, there is no suitable plane toward the Kansai area from Kumamoto in the evening, and there is no difference in time between air transport and truck transport from the Itami plant.

Toshiba Oita ships everything by air transport. It takes more than 2 hours to get to Oita airport by automobile (it is convenient for Nippon TI at Hinode), but this illustrates the extent to which air transport is utilized. It is not only the prefectures of Kyushu which have airports. Fujitsu's decision to locate in Iwate Prefecture, Nippon Electric's venture into Akita, and Mitsubishi's in Saijo were determined by the proximity of airports. Here again, Kyushu has no superiority.

Everyone said that the selection of Miyazaki by Oki Electric Industry was natural. Miyazaki probably is the only place left in Kyushu which would fulfill the three conditions. In addition, the reason given for Nippon Electric's decision to build an IC strongpoint in Yamagata parallel to Kyushu Nippon Electric was that "Kyushu has reached saturation in the labor situation." (Director Tomihiro Matsumura) There is already the feeling that Oki Electric's new plant may be the last new large-scale IC plant in Kyushu for a while, and it is expected that there will be a shift to the super-LSI age, in which plants will be renovated and provided with new capabilities. This move is expected to be accompanied by greater development of IC-related industries and electromechanical industries.

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Major IC Related Industries Locating in Kyushu

1 県名	2 企業名	3 所在地	4 操業開始	5 製品・工程	6 従業員数	7 系列等
福岡県 8	東芝北九州工場 9	10 北九州市	41.12	ダイオード、IC一貫 11	1,300	
	三菱福岡製作所 12	13 福岡市	52.12	IC組み立て 14	50	
	九州ミツミ 15	16 飯塚市	44.10	IC組み立て 14	550	ミツミ電機（東京） 17
	直方東芝エレクトロニクス 18	直方市 19	45.3	ダイオード、LED組み立て 20	300	東芝北九州 21
	三井工作所直方 22	19 直方市	44.8	リードフレーム製造 23		
	福岡日本電気 24	25 柳川市	54.10	IC組み立て、検査 26	250	九州日電 27
28	豊前東芝エレクトロニクス	豊前市 29	48.1	IC、LED組み立て 30	350	東芝北九州 21
31 佐賀県	佐賀エレクトロニクス 32	三田川町 33	41.4	IC、トランジスタ組み立て 34	440	新日本無線 35
	九州電子金属 36	37 江北町	48.8	シリコンウエハー、単結晶 38	520	大阪チタニウム 39
40 熊本県	九州日本電気 41	42 熊本市	45.4	IC一貫 43	2,000	
	湯浅製作所 44	42 熊本市	55.7	メンテナンス、メンテナンス機器製造 45	10	九州日電 46
	三菱熊本第一工場 47	42 熊本市	42.7	IC一貫 48	450	
	三菱熊本第二工場 49	42 熊本市	45.3	IC一貫 48	350	
	熊本凸版 50	51 玉名市	54.6	回路設計、フォトマスク 52	100	凸版印刷 53
	南西電機 54	55 泗水町	55.10	IC組み立て、検査 56		
	九州日誠電機 58	59 矢部町	55.11	IC組み立て 60	300（最終）	九州日電 57
61 大分県	日本テキサスインスツルメント日出工場 62	日出町 63	48.11	IC一貫 64	1,000（非公表）	65
	東芝大分工場 66	67 大分市	45.7	IC一貫 64	1,400	
74 宮崎県	宮崎沖電気 68	69 清武町	56.8	超LSI一貫 70	1,000（最終）	71
	九州小松電子 72	69 清武町	48.11	シリコンウエハー、単結晶 73		
75 鹿児島県	ソニー国分セミコンダクター 76	国分市 77	[illegible]5.5	IC一貫 78	570	
	日本楽器鹿児島工場 79	栗野町 80	51.10	IC一貫 78	280	
	鹿児島富士通 81	82 入来町	53.10	IC組み立て、検査 83	320	
	鹿児島松下電子 84	85 伊集院町	44.3	トランジスタ、ダイオード 86	623	
	鹿児島日本電気 87	88 出水市	44.9	けい光表示管、LED 89	950	
	京都セラミック・国分 90	国分市 91	47.10	ICパッケージ、電子部品 93	1,300	
	京都セラミック・川内 94	川内市 95	44.7	ICパッケージ 96	1,500	
	鹿児島東芝エレクトロニクス 97	98 隼人町	54.12	セラミック基板、トランジスタ組み立て 99	150	

100 従業員数などは55年7月現在（大分県調べ）

Key:

1. Prefecture
2. Industry
3. Location
4. Start of operation
5. Product, process
6. Number of workers
7. Affiliation
8. Fukuoka Prefecture
9. Toshiba North Kyushu plant
10. Kita Kyushu-shi
11. Diodes, IC
12. Mitsubishi Fukuoka Seisakusho
13. Fukuoka-shi
14. IC assembly
15. Kyushu Mitsumi
16. Iizuka-shi
17. Mitsumi Electric (Tokyo)
18. Nogata Toshiba Electronics
19. Magata-shi
20. Diode, LED assembly
21. Toshiba Kita Kyushu
22. Mitsui Kosakusho, Magata
23. Lead-frame production
24. Fukuoka Nippon Electric
25. Yanagigawa-shi
26. IC assembly, inspection
27. Kyushu Nichiden
28. Buzen-Toshiba Electronics
29. Buzen-shi
30. IC, LED assembly
31. Saga Prefecture
32. Saga Electronics
33. Mitagawa-shi
34. IC, transistor assembly
35. Shin Nippon Musen
36. Kyushu Denshi Kinzoku
37. Ekita-machi
38. Silicon wafer single crystals
39. Osaka Titanium
40. Kumamoto Prefecture
41. Kyushu Nippon Electric Yuasa Seisakusho
42. Kumamoto-shi
43. IC complete
44. Kyushu Nippon Electric Yuasa Seisakusho

[Key continued on following page]

45. Maintenance, maintenance-related equipment manufacture
46. Kyushu Nichiden
47. Mitsubishi Kumamoto No 1 plant
48. IC complete
49. Mitsubishi Kumamoto No 2 plant
50. Kumamoto Toppan
51. Tamana-shi
52. Circuit design, fat mask
53. Toppan Insatsu
54. Nansei Denki
55. Shimizu-machi
56. IC assembly, inspection
57. Kyushu Nichiden (final)
58. Kyushu Nisshi Denki
59. Yabu-machi
60. IC assembly
61. Oita Prefecture
62. Japan Texas Instrument Hinode plant
63. Hinode-machi
64. IC complete
65. (Unannounced)
66. Toshiba Oita plant
67. Oita-shi
68. Miyazaki Oki Denki
69. Seibu-machi
70. Super LSI complete
71. (Final)
72. Kyushu Komatsu Denki
73. Silicon wafer single crystal
74. Miyazaki Prefecture
75. Kagoshima Prefecture
76. Sony Kokubun Semiconductor
77. Kokubun-shi
78. IC complete
79. Nippon Gakki Kagoshima plant
80. Kurino-machi
81. Kagoshima Fujitsu
82. Nyurai-machi
83. IC assembly, inspection
84. Kagoshima Matsushita Denshi
85. Ishuin-machi
86. Transistor, diode
87. Kagoshima Nippon Denki
88. Idemizu-shi
89. Fluorescent display tube, LED
90. Tobu Ceramics, Kokubun
91. Kokubun-shi
92. [number not used in key]
93. IC package, electronic parts
94. Tobu Ceramics, Kouchi
95. Kouchi-shi
96. IC package
97. Kagoshima Toshiba Electronics
98. Hayato-machi
99. Ceramic base plate, transistor assembly
100. Number of workers from survey of July 1980 (by Oita Prefecture)

[12 Jun 81 p 12]

[Text] Sudden Increase in Exports From 1979

In 1979, Japanese-produced IC really began to invade the American market. The American economy made a sharp recovery from the recession of 1974-75, and industrial production volume increased sharply. To be sure, this increased production was even more noteworthy in the glamorous electronic industry, and the manufacturers in Silicon Valley were in the enviable position that they almost could not keep pace with the orders from consumers. At the same time, this was just about the period when there was shift from 4K IC memory to 16K, and the Valley's production system had not yet caught up with this change. Because of this production insufficiency, manufacturers in the Valley were all putting capital into plant investments, and this factor, compounded with the lack of sufficient IC, placed consumers in these straits.

Upon seeing this situation, Japanese manufacturers exported samples to companies such as Hewlett-Packard, DEC, and Univac, and demonstrated that these products exceeded the American products in quality and were favorable both as to availability and cost. This was how exports of Japanese-made IC to the United States began. The share of the American market captured by the Japanese rose to 40 percent.

Nippon Electric Will Build No 2 Plant

Nippon Electric was one of the first to enter into exports of IC to the United States, but when Japan's share of the American market began to exceed 40 percent, the American Semiconductor Industry Association (SIA), which draws its membership mainly from Silicon Valley, slowly began to mount anti-Japanese criticism which Nippon Electric was quick to realize the implications of, and so in 1978 it bought into one of the important specialty makers of the Valley, "Electronic Allies," and started production in the United States. In addition, this company is presently trying to procure a second production plan in the United States. "This will be an integrated plant covering everything from software processes to assembly, and it will be truly an NEC mode plant. The choice has almost been finalized. We probably will be able to initiate production next year. We expect to use this plant solely for 64K production" (Hirobei Nagabune, president of NEC Electronics USA).

Toshiba Has Monthly Production of 2 Million Units

In April of last year, Toshiba purchased Marmon Integrated Circuits, which had been owned by Japanese-Americans, and set up its own onsite production plant, "Toshiba Semiconductor." At the same time, Toshiba enlarged this plant and put considerable funding into the facility. It is said that several billion yen was directed to this project. This new facility is said to include a completely automated assembly line which is Toshiba's pride and joy, and its production capacity is 2 million units per month.

With these moves, "we have assured ourselves a status of being one of the mainstay manufacturers in the United States. We will convert this plant into a local-type organ as quickly as possible. We want to set up a business structure which will be managed by an American as president" (Kenji Takahashi, president of Toshiba Semiconductor).

Operations Initially Will Be in the Red

A unique Japanese-related industry present in the Valley is Excer. It is a daughter company of resistor manufacturer Toyo Dengu, which was started 10 years ago, about the time Intel made its entry. "We had predicted that the semiconductor age will take over," said Kenichiro Sato, president of Toyo Dengu, "and we decided that if we were to make a start, Silicon Valley would be the place." On the other hand, unlike large industries with abundant capital, this company had but limited funds, and it was difficult to advance a large sum at any given time. When this business first started, operations were under the control of an American president, but this company's business policies could not be implemented, and the business operated in the red. As a result, president Sato personally took over direct management 3 years ago, after which the situation finally stabilized.

Way of Life for Medium and Small Industries

The feature of this company however, is that in the eyes of the American people it functions as a completely American business. It is said that some of the workers do not even know that this is a Japanese industry. At the same time, this company differs from other Japanese industries in its business policy. Where the other Japanese companies are engaged in making standard IC memories, this company specializes in semicustom (gate alley) and custom-made IC production. "This is the only way we can operate effectively with our limited funds" (president Sato). This company has adopted the small-volume production of various different units which is a feature of Japanese medium and small industries.

Other companies which have established sales outlets in the Valley are Hitachi Limited, Fujitsu, Mitsubishi Electric, and Tokyo Sanyo. Fujitsu has a separate company with production facilities in San Diego, where it carries out IC assembly. The Fujitsu America sales company was originally the sales window for computers to Amdahl. Last fall Hitachi shifted its Hitachi American semiconductor industry section from Chicago to the Valley, while this spring Mitsubishi shifted its semiconductor industry department of Mitsubishi Electronics from Los Angeles to the Valley, and its semiconductor sales headquarters was established there. Oki Electric has its sales company, Oki Semiconductor, which has begun sales in the United States of memories and microprocessors. In addition, Sanyo Semiconductor, which is the sales company for Tokyo Sanyo, has also established business offices.

In this manner, nearly all of the large Japanese semiconductor manufacturers have set foot in the Valley by one means or another and are actively conducting business. As these activities become more and more prominent, manufacturers in the Valley, centered on SIA, are becoming increasingly more wary and are complaining about the plight of the Valley to the federal government (San Francisco Communications Department).

[13 Jun 81 p 8]

[Text] Mass Production Is Japan's Forte

Why has the Japanese IC industry become so powerful? When this question was posed to any of the top men of Japan's semiconductor industries, no one said that this was accomplished through developmental strength or overall technological strength. "American industry is naturally superior in research and development, and there is very little here that Japan can point to with pride. However, the Americans are lacking in mass production expertise, while, conversely, the Japanese are very good" (Ouchi, vice president of Nippon Electric). This explanation of the characteristic feature of the Japanese semiconductor industry is one that has been around for some time. At the least, it is said that the Japanese are superior in mass production technology and have really surpassed the world in the matter of memory.

Director Suzuki of Kyushu Electric made the following analysis of Japan's outstanding record in the matter of mass production.

The first point is the difference in the line of thought regarding inventions. In the United States a brilliant invention on the part of an individual wins him great admiration, and he may become, first of all, very wealthy. As demonstrated by the example of President Noyes of the American company Intel, who used the money earned by his invention to found this company, it is the practice in the United States to recognize individual efforts. In contrast, many of Japan's inventions are the product of salary men; for example, even a very outstanding invention reverts back to the industry, and there may be at most an award of roughly 50,000 yen from the company president. Fundamentally speaking, cooperative effort is respected more than individual efforts, and it is the philosophy that inventions and new technology are the products of ideas thought out and worked out by a large group. This is why there is from the outset more thought directed at technology related to mass production in plants, and the development of mass production technology is a natural result.

High Quality of Labor

The second point is the very high educational level of the operators. "This is something we have really learned to appreciate, coming to Kumamoto from Tokyo," the talk goes. Kyushu Nippon Electric received the 1979 Deming award. Its QC (quality control) program is very famous, but it now exercises SQC (statistical quality control). This is a method in which studies are made on how to converge quality scatter, and it involves fairly high-level mathematical elements in its application. In this work, girls just out of higher middle school sit side by side with the more experienced hands and develop the theory behind this quality control system. This is something which is unthinkable in the United States, and when Americans see the product made by these girls, they say in astonishment, "This is something only specialists can produce, and certainly this high-level work is not the work of young girls."

Manager Nakane of the Mitsubishi Kumamoto plant also believes that this high standard of labor is Japan's strongpoint. Ever since the Meiji Era, Japan has resolved to overtake the Western world, and the national character that was developed by this process was such that when one did any work assigned to him, he could at best register but 80 points, and this was insufficient to overtake the Western world. In order to overtake, one had to take it upon himself to improve his work and aim for the high mark of 90 or 95 points, according to the desire that was subconsciously instilled in him. It is this awareness to search for job-connected problems of which the technologists had not been aware, the so-called QC, which is the strength that has sustained the small group activities, according to one analysis.

On top of this high educational level is the in-plant training which follows, and this makes the quality of Japanese labor that much better. In the first place, the IC industry is an equipment-using industry. The equipment involves the application of physics, chemistry, and optics-type academic knowledge, on top of which the equipment of this industry is advancing and becoming more complex with great fervor. The price runs into the very high order of 100 million yen per unit. The operators at these plants who operate this equipment and machinery must thoroughly understand the principles upon which the units operate, and if they are to survive in the IC industry of the future they must be able to service and repair the equipment without needing to call in special technicians, according to statements made by the top brass of Hitachi's Musashi plant. This is why this company believes that "education is the one main weapon." In 1975 it established an educational center with the status of a semiconductor production department at its Musashi plant (higher vocational school training), where workers are given a year's course in knowledge and technical handling of semiconductors covering the whole system before they are sent to their jobs. This training instills a feeling of belonging. The number trained thus far has come to more than 250, and this represents a potent strategic weapon of this company. When the reporter visited this training department, several workers were sitting on the floor of a clean room feverishly working, and the picture of the high level of Japanese labor become even more apparent.

In contrast to this situation, it is said that the quality of the Western worker is such that high school graduates can only be taught by breaking down 500 IC units into 10-unit lots, demonstrating the lower level of competence. Furthermore, they do not remove their shoes upon entering a clean room. They bring in handbags, and they require coffee time. When required to wear uniforms, they demand extra pay. This different behavior resulting from different cultural standards is reflected in the manner of behavior in the production of IC units. This large difference in worker levels must certainly be reflected in the quality of the products they produce.

Knowhow Numbering in the Thousands

The diffusion process, which is a basic process in IC production, involves baking in a furnace, making IC products resemble ceramic products. This process involves considerable knowhow, such as where to place the temperature measurement gages or what angle to set the items to be fired. Where an etching process is involved, the situation is similar to one used in producing photographic plates, and this too involves various knowhow. Furthermore, micron-order dimensions are used, and "dust, scars, and contamination" must be avoided to the utmost. This is why the wafers are handled with forceps, and even this handling must be minimized in order to reduce chances of fouling up the wafers. Here again, knowhow stands out prominently.

It is said that a study was conducted by Kyushu Nippon Electric to see just how many times during the diffusion process a wafer was handled by forceps, and the number turned out to be 97. Such a large number of handlings certainly was not conducive to the high turnover rate required to produce micron products, and so efforts went into studying how to introduce automation and thereby eliminate the use of forceps altogether--whereupon, it is said, a line requiring but three forceps operations was developed. This knowhow is the sole property of Kyushu Nippon Electric. Since ordinary paper is a source of dust, all writing materials such as process charts are made of plastic paper. Since the use of forceps to remove the etched wafers from the etching bath will cause changes in the bath composition, the bath is expanded on the inside to lower the liquid level and facilitate removal. This again is knowhow. It is only through the capabilities provided by the hundreds or even thousands of knowhow items intrinsic to this company that high turnover rate and quality can be anticipated. Mitsubishi, Hitachi, and Toshiba all have their own private stores of knowhow. In fact, mass production technology is an assembly of these accumulations of knowhow that were achieved by group effort and are the joint property of a large number of people; it is impossible to designate any single individual as being responsible for any particular invention. It can be said that Japan's mass production technology has been able to surpass that of the United States only because of this Japanese approach to mass production technology.

On the other hand, the following opinion was expressed at Hitachi Musashi.

"Does Japan not lean too heavily on the superiority of its technologists? And just as with the Zero fighter tactics of World War II, Japan is depending on its technology to the utmost. Quality control is such a course. On the other hand, the American approach, as exemplified by Grumman, is to employ dunces and idiots to man simple machines, making unnecessary highly trained technologists to counter the Japanese approach. The present situation is akin to Pearl Harbor. We have but won the initial skirmish of the war."

[17 Jun 81 p 12]

[Text] New Plants Gambling on the Company's Future

Opening ceremonies were held on 30 May for Oki Electric's new plant at Seibumachi, in Miyazaki Prefecture. On this occasion, Masac Miyake, president of Oki Electric Industry, said, "I am full of gratitude that we have been able to observe this opening ceremony today. This plant site was selected from more than several dozen prospective sites all over the country. Just as the name Seibu implies, this is a site blessed with pure water and clean air, and sunlight and wind conditions are good. There is also abundant manpower, and we are fortunate in locating in such wonderful surroundings. We intend eventually to produce 3 million units of 64K super LSI per month at this new plant. After an initial test period, we hope to be in full production by the end of August." In this manner he addressed the start of this new super LSI plant, on which the future fortunes of this company are risked.

The United States has been greatly delayed in mass production of 64K due to low turnaround and design changes and is in the position of "going both left and right." In contrast, three of the Japanese companies have already started mass production, and the other three companies have adopted a policy of soon entering the mass production race. These companies have been conducting preproduction runs on the order of 100,000 to 200,000 units per month at their development plants located in the Tokyo environs. However these companies are planning to shift their main operations to plants with the latest equipment. This will be either at their main plants or in completely new plants where production will eventually be aimed at the million-units-per-month level. Nippon Electric has its No 6 Diffusion Line of Kyushu Nippon Electric; Hitachi has a plant at Musashi and another at Kofu; Toshiba has its Oita No 4 Clean Room; Mitsubishi has its Kumamoto C Plant; Oki Electric has its Miyazaki Oki; and Fujitsu has a plant at Iwate. The construction phase has all been completed, and the sites have entered the test operation stage and are now counting the seconds prior to the word "go" to start mass production in earnest.

"Top Secret" Strategy

Each company is keeping its 64K production plans "top secret" so as not to disclose its strategy to other companies if at all possible. "Gag rules" have been issued. At the same time, vainly flashing its production plans by public announcement may spur the still-delayed American industry to greater efforts and rekindle the semiconductor conflict. Should this come to pass, it may be that the prized IC which had been so carefully developed may wind up in some questionable situation.

It is said that Kyushu Nippon Electric has at its No 6 Diffusion Line "knowhow that has not even been shown to NEC workers," but already it is in the "stage of full operation and mass production of 64K at the plant site is in the state of complete takeoff." (Director Suzuki)

The register becomes positive in super LSI of micron-line width, light exposure methods or etching methods are different, and some completely different items of equipment are necessary. As a result, completely different equipment becomes necessary on the one hand, while the associated technology becomes increasingly more difficult to develop on the other. Testers who could test a 16K in 1 second without much effort require 8 seconds for a 64K. This is slowly necessitating the development of new facilities.

What is even more important is just how to maintain the highly clean state and protect against defects caused by dust. The No 6 Diffusion Line is housed in a three-story building in which the second floor is assigned to power chambers which produce clean air and supply the first floor clean rooms with air conditioning at exactly 22°C and completely dust free at the rate of 400 exchanges per hour.

This reporter was able to visit the C Building for 64K use at Mitsubishi's Kumamoto plant. Building C is a three-story affair constructed of reinforced steel, and it is said to be higher than an ordinary five-story building. The first floor is an open construction with just posts, and is intended for future development. The third floor is used for inspection processes, while the second floor is assigned to clean rooms for the wafer process. When seen from the observation aisles, the photoregister, etching, CVD, and diffusion processes were partitioned into separate clean rooms. The photoregister room, illuminated by yellow light, was ventilated with clean air which swept down from the ceiling and through the steel lattice floor in a total front-downflow mode. This air is class 100 (less than 100 bits of dust larger than 0.5 micron in size per cubic foot) or less in dust-free nature. This can go down to zero as long as humans do not enter, and it is said that there are restrictions on the number of people permitted, and no going between the rooms is allowed, just as with the No 5

Diffusion Line of Kyushu Nippon Electric. Two series of photoregisters centered in projection-mode aligners were seen within one of these chambers. It was said that there would be five series if all had been installed. An exposure device-stepper for super LSI use in a temperature-conditioned room was seen to the other side. The stepper is slower than the projection mode, but it can engrave 1-2 micron level patterns and is used for circuits in which extremely high precision is required.

One Floor of Air Conditioned Chambers

After inspecting the second floor of the Nakane plant, we descended a flight of stairs and opened the door to the lower floor. I thought I would be entering the first floor, but the left side was taken up by offices and locker rooms, while the right side was a wall. Upon opening a door on the wall side, I entered a duct room. There were ducts of all sizes running horizontally and vertically. There is space enough for one floor extending up to the ceiling. This is to be expected, because the next room is an office (while above is a diffusion furnace). It became clearly evident why the height of this three-story building was equal to that of an ordinary five-story building. Light came from the ceiling between steel lattices. The clean rooms are above. "We had some difficult experiences in plants in the past, in that there was no space to run ducts, and so this building was constructed with margin for future height alterations. Super LSI production at a high-turnaround rate is not possible unless one is willing to spend the money to build these clean rooms," said Kimio Sato, manager of the Semiconductor Industry Department.

0.2 Micron Dust Particles Also a Problem

The Toshiba Oita No 4 Clean Room is expected to start test runs this month, but construction was still going in one section of the plant when this reporter visited, so I had no opportunity to view the inside of this place. It is said that here again, an entire floor will be ventilated by a downflow mode. In direct contrast to Kyushu Nippon Electric, the entire first floor will be the airconditioning section and the second floor will be the clean room. The degree of cleanliness will be class 10, or the same as the present dust-free chambers.

Manager Fujii of this plant said that if there are N processes involved in the turnaround time of IC, then the turnaround time for each process will have to be raised to the Nth power, and unless each process is brought around to the best level as far as turnaround time is concerned, the overall turnaround time cannot be improved. As a result, not only the policies of the IC manufacturers but the requirements of the mask and wafer manufacturers need to be considered, and these are creating monumental problems.

In addition, dust particles less than 0.5 micron had been considered harmless in the past, but it is said that the dawn of the 64K era has made it necessary to eliminate dust particles down to 0.2 micron. To be sure, when one views a circuit in a planar light, the settling of a 0.5-micron dust particle on a circuit 2-3 microns wide is not of defect proportions. On the other hand, when a three-dimensional view is considered, the oxide film of a 64K gate is about

0.025 micron thick, and an electric field strength of 5V per power source is applied which is four times that of a 16K, so that the presence of even an 0.2-micron dust particle spells disaster.

In any event, it became evident that every company is calling upon all the know-how it has accumulated over the years, together with the employment of the utmost care in the production of the 64K units.

2267
CSO: 4105/182

APPROVED FOR RELEASE: 2007/02/09: CIA-RDP82-00850R000400040035-5

SCIENCE AND TECHNOLOGY

JAPAN PLANS TO DEVELOP NUCLEAR FUEL CYCLE

Tokyo NIKKEI SANGYO SHIMBUN in Japanese 9, 10, 12, 17, 18 Jun 81

[9 Jun 81 p 12]

[Text] Nuclear power has now become Japan's energy pillar. Since Japan's first nuclear powerplant initiated operation 15 years ago at Tokaimura, in Ibaraki Prefecture, the number of operating nuclear powerplants has increased to 22, with total output of 10.55 million kw, generating more than 10 percent of Japan's total power demand. In order for this growth to continue, and also in order to make nuclear power generation a stable energy resource, the assurance of uranium ore, which is the source of the uranium needed to fuel these powerplants, has to be maintained, along with the assurance of effective utilization of this fuel and proper management of the waste that is generated--all of which comprises the so-called nuclear fuel cycle. Japan has trod various paths in its direction toward this fuel cycle and is now about to take the giant step toward fulfillment of this fuel cycle from the preparative stages. Japan's nuclear power development, which has relied so long on dependence on foreign sources, is about to enter a turnaround position.

Steadily Advancing Strategy Formulation

The Nuclear Energy Subsection (chairman, Genso Nagamatsu) of the Advisory Committee for Energy, which is the inquiry organ for the Ministry of International Trade and Industry, drew up the policy for Japan's future nuclear power development in May and reported its contents to the ministry. This policy, in other words, may be termed the direction setter for nuclear power development, and the path which Japan is to follow from here on has been defined very clearly.

The point which is most strongly emphasized is disengagement from dependence on foreign sources, and it clearly states that the time has come for Japan to engage in developing uranium resources and uranium enrichment in an independent manner. Since the long-term assurance of uranium resources is a premise for long-term assurance of nuclear power development, the all-out development of a resource policy is a must if the projected goals are to be realized. This report states that more than half of new uranium mineral resources will have to be from sources that we discover and develop by one means or another.

The report further states clearly the direction to take in uranium enrichment, heretofore dependent entirely on foreign sources. The Power Reactor and Nuclear Fuel Development Corporation is presently operating a pilot plant, to be followed by the construction of a 200-250 ton SWU (separation operation unit) prototype plant, slated for completion during the middle of the 1985 period, which is expected to produce between 417 and 518 tons of 3-percent enriched uranium per year. In addition, a 3,000-ton SWU per year commercial plant capable of producing about 700 tons of 3-percent enriched uranium per year is planned for operation by the year 2000, and it is planned to provide at least 30 percent of the enriched uranium demand in Japan from these sources.

The formulation of a nuclear power development strategy with the concept of establishing an independent fuel cycle is also being promoted by the Atomic Energy Commission. This commission is presently revising its long-term plans for nuclear power development and hopes to have the final plans by October. This revised plan will take in uranium enrichment, new types of reactors, and waste management to cover the entire range of nuclear power activities, but it is also expected to emphasize the establishment of an independent fuel cycle, as recommended by the Nuclear Energy Subsection of the Advisory Committee for Energy.

From Blueprints to Execution

This establishment of our own nuclear fuel cycle is not just another plan that is drawn up on blueprints, and some facets of the overall plan have already been initiated. For example, a fast breeder reactor, a second generation atomic pile which uses as fuel plutonium recovered from spent fuel and which produces more new fuel as it burns, and which will be the prototype for an embryonic power reactor, is soon to begin construction.

The construction plans for the 280,000-kw output reactor, named "Monju," which is this prototype, may suffer from the effects of the nuclear incident at the Tsuruga powerplant of the Japan Atomic Power Development Corporation, but there has been a rigorous safety check by the Science and Technology Agency, while the Power Reactor and Nuclear Fuel Development Corporation, which is the ramrod for this construction, has left no stone unturned to insure safety. The manufacturers are also paying close attention to the orders they are expected to fill. In another direction, the electric power industry is looking forward to the next step, which is the demonstration reactor, and it is making all preparations to this end.

Plans for constructing a commercial spent fuel reprocessing plant are also well under way. In line with the operation of the fuel reprocessing operation conducted by the Power Reactor and Nuclear Fuel Corporation in Tokaimura, the Japan-U.S. agreement of November 1977 placed an injunction on reprocessing operations in Japan, and since then there has been a clamp on any plans for a commercial reprocessing plant. On the other hand, the ascent of a pronuclear leader in the person of President Reagan has raised hopes that this ban will be lifted, and effort is being directed at plant site selection and development of equipment for the facility.

In addition, efforts are under way to develop a type of nuclear powerplant that has the principal role of nuclear power which is best suited to Japan, and this will involve getting away from advice from imported technicians and encouraging development solely by Japanese endeavors. The modification and standardization of nuclear power, which had been pushed mainly by the Ministry of International Trade and Industry, seem to have been shelved temporarily while the power industry and the manufacturers are directing full efforts toward development of reactors which are safe and efficient and are making provisions through proper modifications, to minimize human errors in case of emergencies.

The Changing Nuclear Power Industry

At the present time, any kind of nuclear power facility is faced with the very difficult problem of siting. When an incident occurs, such as that at the Tsuruga powerplant of the Japan Atomic Power Development Corporation, the uneasiness on the part of the nearby residents is concentrated, and the siting problem becomes even more difficult. On the other hand, when viewed from the standpoint of safety assurance of energy, nuclear power has become an indispensable item, and the establishment of our own nuclear fuel cycle has become urgent business. It seems that the nuclear power industry will change in appearance as this country advances toward this goal of self-sufficiency.

[10 Jun 81 p 15]

[Text] Uranium Prospecting

The establishment of one's own nuclear fuel cycle starts with the assurance of uranium ore. In order to insure that nuclear power will be a stable energy source, a certain degree of self-developed supply sources must become available to avoid complications due to price increases and export bans on the part of uranium ore-producing companies. Domestic uranium reserves are estimated at but 9,000 tons, and presently more than 3,000 tons of uranium are required to fuel the nation's reactors every year; thus, self-developed sufficiency will have to involve discovering ore in foreign countries and extracting the uranium ourselves.

Up to the present time, nearly all the assurance of uranium mineral supplies came from power companies purchasing the ore from foreign mining companies. Recently, however, there are indications of a shift from a uranium resources development stage to development and import in which Japan participates.

Joint Mining Company With France

For example, the Overseas Uranium Resources (main office, Tokyo; president, Yoshiaki Suzuki; capitalization, 5.4 billion yen) has been undertaking joint prospecting for uranium ore with the French Nuclear Power Agency in the African country of Niger since 1969 and already has discovered ore. A mining company, "Acta Mining," was established under joint ownership of this company, the French, and the Niger Government, and actual mining began in 1978. Annual production is presently 2,200 tons. Japan stands to gain about 40 percent of this total.

About 850 tons were mined during 1980, and this is presently being enriched in France. It is said that the enriched fuel will be shipped to Japan by the end of the year.

While this next situation is not a case in which Japan participated in the prospecting stage, there is a situation in which capital participation was entered into a mine under development in order to assure uranium resources. The four companies of Kansai Power, Kyushu Power, Shikoku Power, and C. Itoh and Company entered in capital participation for the "Ranger Uranium Mine" in Australia in September of last year, and they plan to import about 23,600 tons over a span of 15 years starting next year.

Among the steps taken to assure "self-developed resources," business participation in mines under development can take place only when one is blessed with the opportunity. In the case of the Australian project, it was possible only because the Australian Government released the stocks it owned. At the present time, the uranium market presents a depressed situation because of the siting problems being experienced by nuclear power around the world, and it is said that some uranium mining companies are becoming somewhat negligent. That is why there should be a number of chances to get in on such situations, but a windfall acquisition will not always do to assure uranium resources. There is a need for our own prospecting efforts.

When it comes to prospecting, the competition is fierce. Director Takaharu Okuno of the Foreign Survey Office of the Resource Department of the Power Reactor and Nuclear Fuel Development Corporation, relating his bitter experience, said, "There is an incident in which the hint of a uranium mine was obtained while prospecting in western Australia, and this information leaked out by chance. The very next day, mining companies associated with Exxon and British Petroleum applied for mining rights in the adjacent regions."

Compete With the Majors

Furthermore, a recent development in uranium resources is the eyecatching advance of the majors (oil capital) into the field. For example, it is said that Gulf, Exxon, and Getty type majors have all but cornered American uranium mines, and there are other activities throughout the world revolving about the major axis in exploring the world's crust.

In the midst of such a situation, probably about the only area where Japan has been able to develop uranium mines with private funds is the Afast region of Niger. Prospecting involves the search for uranium ore by manual groping, and until very recently it required 10 years from the time a vein is discovered until the mine is developed, involving great risk. This is why it is difficult for private business to develop this field, and almost all of Japan's developmental activities are in the hands of the Power Reactor and Nuclear Fuel Development Corporation. The prospecting areas are distributed in seven countries, including the United States, Canada, and the Republic of Mali in Africa; the total [prospecting] area is roughly 370,000 square kilometers, very nearly the area of Japan itself.

Since the prospecting must cover wide expanses with no roads and far from human habitation, the corporation is pushing the development and introduction of new instruments. These include apparatus which can be used for a quick analysis of borings, to enable a decision on the next strategic step, and a laser analyzer that can quickly detect any abnormal changes in uranium content of water collected from a boring.

On the other hand, a system to smoothly tie together the results of prospecting and mine development is also making progress. A group of 31 power companies, mining companies, and commercial companies and the Power Reactor and Nuclear Fuel Development Corporation comprise two government-related organs which make up the Uranium Resources Assurance Countermeasures Committee (committee chairman, Toshio Ito), which is gathering information on uranium resources and selecting promising projects. At the present time, "there are a number of sites which look favorable for mine development, but they all have very short veins and great depth, and thus are not suitable for mine development" (office manager Kyoji Mizumachi). This committee seems likely to stand at the central position in "self-developed resources" assurance.

Domestic Situation Faces a System Wall

Where domestic uranium resources development is concerned, an interested party stated that the "Power Reactor and Nuclear Fuel Development Corporation, which conducts prospecting, is restricted by government budget limitations and cannot conduct active prospecting very well. At the same time, it has little experience compared with the Western world outfits, and this is another weak point. On the other hand, where advances through private efforts are concerned, there are some subsidy funds such as the Metal Industry Work Group's awards for successful ventures, but when the mine development stage is involved, they cannot receive any help from the Development Bank unless they have assurance from the power companies that these power companies will purchase the uranium which is mined; this, together with the problem of price fluctuations, compounds the risks." This type of system needs to be reassessed if a stable plan for long-term "self-developed resources" assurance is to be realized.

[12 Jun 81 p 14]

[Text] Uranium Enrichment

"Japan's uranium enrichment technology seems to have been pointed at the right direction from the outset. Such being the case, in the event we enter commercial production, we should be able to hold our own in international competition" (one of the top research officials of a large electric power company). Uranium enrichment is treated as a top secret order of business by many countries, and they hate to allow technological information to leak out to foreign areas. It is in the midst of this situation that Japan, which worked independently on its own technology, has been able to come up with something that is very highly valued.

Ultimate Goal: 12 Tons per Year

The light water reactor, which is the nuclear powerplant most widely used at the present time, uses fuel in which "burnable fuel" in the form of uranium 235 is enriched to the level of about 3 percent. The uranium 235 content of natural uranium is but 0.7 percent. Uranium enrichment is the technology whereby natural uranium is the starting material in which the fraction of the "burnable" component is built up to 3 percent. There are a number of different methods for achieving this enrichment, including gaseous diffusion and gaseous centrifugation; the method selected by late arrival Japan was gaseous centrifugation. Uranium gas is introduced into a cylinder which is rotated at high speed, much like the spin dryer of a washing machine, and the difference in densities of the two types of uranium is exploited to achieve this enrichment.

The brunt of the development to date has been borne by the Power Reactor and Nuclear Fuel Development Corporation, and after a stage of basic research the study blossomed into a national project in 1972. After a series of small-scale experiments at a facility in Tokai, located in Ibaraki Prefecture, construction was started in the fall of 1977 on a pilot plant at Ningyo Toge, in Okayama Prefecture. Plans called for initiating operation in 1979 of the roughly 1,000 centrifugal units which are part of the so-called OP-1A unit, and a second unit, the OP-1B, with roughly 3,000 centrifuges and 1.5 times the performance, was installed and put into operation in the fall of 1980. At the present time, still another unit, OP-2, with twice the performance of OP-1A with about 3,000 centrifuges has been installed. This operation is expected to be terminated in October, and the performance of this pilot plant is estimated at a final value of 50 tons SWU (separation operation unit), which would mean that approximately 12 tons of 3-percent enriched uranium could be produced per year. Actual enrichment is being conducted with the centrifuges already under operation, and about 3 tons of enriched uranium has been produced. One ton of this enriched fuel was shipped out in April for use in the new prototype converter reactor "Fugen."

Aim at Demonstrating Reliability

With the orderly progress in pilot plant plans and with the favorable evaluation within the country, there is an active movement toward commercialization. At the present time, the Atomic Energy Commission has established a domestic production group for uranium enrichment and is working on a prototype plan which will be the seedling for the next-step commercial plant. Although the details of this plan have not been set, its scale will be of the order of 250 tons SWU, which should produce roughly 60 tons of enriched uranium--sufficient to fuel 2 million kw class reactors for a year.

Emphasis is placed on the establishment of production technology and operating technology and on the demonstration of economic operation and reliability where this prototype is concerned, and these plans are expected to be definite this summer. If things go well, construction could start as early as next year, with completion expected by about the first part of the decade beginning in 1985. The type of construction seems to carry over from developments of the past in embodying the so-called Power Reactor and Nuclear Fuel Corporation concepts, but there is a chance that some purely private concepts might enter the picture where commercial plants are concerned.

Preparations are already under way for the next step, which is the commercial plant. The Federation of Electric Power Companies set up a uranium enrichment preparation office last March to undertake surveys on trends in supply and demands for uranium enrichment and price trends, as well as to make preparations to establish a company. According to Takegi Kawato, director of this federation, "This office will probably function for 1 or 2 years before entering into site selection by 1985."

While we must await future developments before any idea of the scale can be expected, about one-third of the total enriched uranium required to operate the nuclear reactors in Japan by the year 2000 is expected to be supplied by domestically enriched material, according to the report of the director of the Nuclear Power Section of the Advisory Committee for Energy, and this may become the sounding block.

Manufacturers Also Establishing Own Systems

Where the manufacturers are concerned, they too are laying specific plans to establish their systems for future operations. The three centrifugal separation equipment manufacturers, Tokyo Shibaura Electric, Hitachi Limited, and Mitsubishi Heavy Industries, established their UC engineering office (manager, Masayoshi Matsumoto) as a preliminary to a joint company devoted solely to the production of centrifugal separators. "Plans for future development starting with the prototype plant have now been clearly formulated, and we will set up this company once it has been established that this plant will make it" (Yoshiro Tsutsui, director of the Nuclear Power Industry Department of Hitachi Limited).

Not only are domestic plans involved where uranium enrichment is concerned, but there also is a joint business concept with Australia. This is a concept in which a plant will be constructed in Australia, which is a resource-laden country, using Japanese technology; joint surveys on the part of both countries have already been completed. At the present time, this country is awaiting Australia's answer as to whether it will actually participate in the direction of this concept.

At the same time, attention is also being directed toward the development of new technology. Construction was started in April at Himuke, Miyazaki Prefecture, on a model plant which will employ a "chemical enrichment method" using an ion exchange membrane developed by Asahi Chemical Industry. Although this scale is so small--on the order of 1-2 tons SWU--that centrifugal separation protagonists have not paid this method too much attention, this method of separation may serve in a supplementary role to the centrifugal separation method, and it also possesses potential as an exportable item to developing countries.

At the present time, the world's enriched uranium production capacity includes the 26,000 tons SWU of the United States, which is the top producer, the 7,000 tons SWU of the EURODIF Company of Europe, and the 400 tons SWU of the Yurenko Company.

The present situation is one of overcapacity because of difficulties with regard to nuclear plant siting. On the other hand, all of these plants are looking to an expansion in plant capacities, in view of the supply-demand imbalance of the United States. Japan is developing its capabilities step by step, keeping in view these activities in the Western world.

[17 Jun 81 p 12]

[Text] Light Water Reactor

Japan is continually planning to disengage itself from dependence on American technology in the operation of its light water reactors, which make up the main force of its nuclear power reactors. The power companies and manufacturers, disgusted with the frequent occurrence of malfunctions during power generation, have embarked on a program to alter this situation of complete dependence upon American technology and to develop a light water reactor more suited to this country. The results of their efforts are beginning to come forth. This desire to modify and develop is very strong in every company, and it seems that Japan, which has depended completely on American technology, is finally beginning to emerge from the shadows of this dependence and stand on its own feet.

Improvements in Line With Japanese Situation

The standardization of modifications of nuclear reactors introduced from the United States was the icebreaker in this program of disengagement from American technology. The Ministry of International Trade and Industry took the lead in this process with the participation of Mitsubishi Heavy Industries, which introduced the Westinghouse pressurized water reactor (PWR), and Tokyo Shibaura Electric and Hitachi Limited, which introduced General Electric's boiling water reactor. These parties started in on a program to modify their respective reactor types to something of higher reliability and safety more suited to Japanese conditions.

This program was divided into two phases: a first phase which lasted through JFY 1980, and a second phase which followed. There were more than 30 improvement items, and the results have been such that "the quality and performance of nuclear fuel produced in Japan are already the best available in the world" (according to Narimi Kokura, director of the Light Water Reactor Technology Department of the Prime Mover Industry Division of Mitsubishi Heavy Industries). He was referring to the kind of results that have been obtained.

There are also some independent developments which seem to be one step ahead even of the "main house," which is the United States. "Even a giant system such as a nuclear powerplant can be operated safely by just one operator, by introducing a central control system which has been developed. Should some abnormal operation take place somewhere within the system, this site is immediately pinpointed; automated operation and abnormality prediction also are possible. It seems that GE is trying to develop a similar system, but the present development is completely due to our own efforts. We even feel that our system is superior" (Yoshiro Tsutsui, director of the Nuclear Power Industry Department of Hitachi Limited).

This vaunted "central control system" is a completely new system which follows the readings of all the instruments from the central control room and displays them on Braun tubes. Computers are utilized to display the system diagram on a Braun tube in color, and any abnormality is displayed in a different color so that the operator will know immediately and be aware of this abnormality. The different data are given in graphic display, and the operating state and trends can be seen in a glance. The failure to spot the site of a malfunction resulted in a major disaster in the case of the Three Mile Island nuclear power incident, but the manufacturers stress that this system can be exploited to clear up human errors.

Toshiba, Hitachi in Production

This system had already been developed by Toshiba in 1973 ahead of Hitachi Limited, and the preparations of the BWR group have been completed. It has been decided to install this system in the No 3 and No 4 units of the Tokyo Power Company's Fukushima No 2 nuclear powerplant, slated for completion in 1985, and both companies have started production. "When completed, we will surpass GE and have the first practical system in the world," said Tatsuro Omura, chief technician of Toshiba's Nuclear Power Department. It is said that this development was made without any communication with Westinghouse, which had provided the original BWR technology.

The Ministry of International Trade and Industry has been providing subsidy funds to powerplant manufacturers and has embarked on a 5-year plan starting in 1980 to develop operating support systems for powerplants. This system teaches operators the proper operating procedures in the event of malfunctions or accidents in nuclear powerplants, and its objective is to completely eliminate the possibility of human errors. This system will most probably be incorporated into the central control system, where a display on a Braun tube will be one of the mechanisms employed. Manufacturers are showing great interest in the independent development of this project.

While Japan is not alone in this respect, Japan's industry is playing a central role in initiating plans to improve the nuclear reactor main bodies, including those from the United States. Six power companies--including Tokyo Power, along with Toshiba, Hitachi, and GE--are participating in the ABWR (new-type boiling water reactor) development project, in which a total of 10 billion yen has been earmarked to develop a "definitive" BWR for easy operation and maintenance.

This project envisions moving the recirculating pump for coolant water cycling inside the nuclear reactor pressure vessel, thereby simplifying the shape as well as facilitating production, and the incidence of cooling system ruptures is expected to be reduced. There also are plans to control fuel burnup in a more precise manner. Consensus on the basic goals has been reached by the participants, and a start may be made sometime during the year if all goes well. This development is planned over a 5-year period, and ABWR technology is expected to be established by 1985.

"Medium to Small" Developments

There is also some movement toward developing medium and small light water reactors for multipurpose applications such as power generation for own plant use or hot water utilization. The Ministry of International Trade and Industry is very active in this promotion and is planning to set up a developmental survey committee on medium and small light water reactors for multipurpose applications in the near future and go as far as industrialization surveys on medium and small reactors. Nuclear power production presently is beset with siting difficulties, and even medium and small powerplants will be difficult to site, while their space utilization efficiency will be much worse than with large powerplants. Furthermore, as evidenced by the bombing of the nuclear powerplant in Iraq, there are risks associated even with exports. This is why there has been considerable criticism by the industrial world regarding the intent of medium and small type reactor development, but there seems to be little objection to a survey intended to determine whether this development has a future.

It has already been more than 10 years since a light water reactor was introduced into this country. During this interval, this country has experienced a large number of difficulties, as evidenced by the very recent radioactivity leakage incident at the Tsuruga nuclear powerplant of the Japan Atomic Power Development Company. Japan's nuclear power industry has used these accidents and troubles of the past as training materials for the development of an even better system, and it hopes to surpass even the "main house" with respect to quality and performance in the future.

[18 Jun 81 p 19]

[Text] Reprocessing

Difficulties haunt the reprocessing of nuclear fuels which have been burned in a nuclear powerplant to recover the plutonium. Besides the technological problems which have to be overcome, there are also the "shackles" imposed by the United States, which cannot solve its own internal problems. These problems are causing people all kinds of grief. On the other hand, with the rise to the presidency of Reagan, a nuclear power promotion advocate, hopes have risen that these "shackles" will be eased, and the nuclear power industry of Japan is finally showing some life toward commercial fuel reprocessing.

United States Holds Prime Authority

Where Japan's reprocessing future is concerned, the United States, which is one of the countries which supplies Japan with nuclear fuel, and which has the contract to provide enrichment service, holds the deciding vote. The United States maintains authority over the handling of the nuclear fuel it supplies Japan and has the power to interfere with any of Japan's reprocessing activities. The United States exercised this power when it curtailed operations of the reprocessing plant operated by the Power Reactor and Nuclear Fuel Corporation at Tokaimura in Ibaraki Prefecture. "Shackles" were placed on the operating period and the reprocessing volume of this plant in September 1977. Furthermore, there was the edict banning "any conspicuous activity" toward the construction of a commercial reprocessing plant.

There is no basic change in this situation at the present time. The limitations on the operations of the Tokaimura reprocessing plant have been modified four times since the original ban, and the scale will have been expanded by more than a cumulative total of 149 tons over the initial limit as of October of this year, but the "shackles" on this facility and commercial plants still remain. On the other hand, President Reagan has given his O.K. to reprocessing and plutonium utilization within the United States and is in agreement with the removal of the "shackles" imposed upon Japan. Thus the present flow of events is changing to a trend favorable to Japan. This is why there is naturally great interest being stirred up among the reprocessing people in Japan.

For example, a Power Reactor and Nuclear Fuel Development Corporation official close to the reprocessing activities indicated his high hopes by saying: "We would like to see all limits removed from the operating period and reprocessing volume that have restricted operations at the reprocessing plant in Tokaimura. We look forward to a complete removal of limitations on Japanese reprocessing activities, including commercial reprocessing plants, at the next Japanese-American conference." The total quantity of fuel processed thus far at the Tokaimura reprocessing plant falls short of 90 tons, which is still below the limited amount, and the limiting period has been extended each time. Thus there has been no actual harm from these "shackles." On the other hand, the present hassle concerns the removal of the pressures caused by these psychological "shackles."

Private Facilities by 1990

Let us now look into the activities of the Nippon Nuclear Fuel Service (main office, Tokyo; president, Kiyoshi Goto; ca italization, 10 billion yen), organized last year for the purpose of engaging in commercial reprocessing plant construction and operations. Director Yobei Watanabe of the Plans Department said, "We hope to start construction of a reprocessing plant by 1985. Construction is expected to take about 5 years. We have targeted 1990 as the completion date. We intend to employ the best technology available in the world in this plant. Accordingly, we will adopt 'all-Japanese' line of thought and will promote equipment development and manufacture all over Japan. We intend to introduce any superior technology which may be found abroad, but since Japan has superior quality control, all manufacturing will be delegated to Japanese companies." Thus he spoke very positively about the timetable and the plans for the plant.

The reprocessing plant which this company plans to construct will have an annual capacity of 1,200 tons; thus it will be able to reprocess the spent fuel from 40 million kw class reactors. The area required for this plant will be 1.6 million square meters; the plant will be provided with docking facilities to accommodate a 3,000-ton ship; and there will be storage facilities for 3,000 tons of spent fuel. Blueprint planning is said to be progressing smoothly. The basic plans for the plant and equipment development have finally started assuming real advances. It is said that contract research funds granted by the Ministry of International Trade and Industry will be used to test-produce actual-size equipment to be used in the plant construction.

Selection of a site for this plant is also being pushed, in addition to the basic design and equipment development. This siting will probably be the most distressing problem to be faced by the people concerned.

"The process of 'bride' selection is extremely difficult. As far as I am concerned, it would distress me no end if a bride were to refuse me. Even after marriage, it may happen that we are not compatible, and divorce is no easy solution. While there are prosective candidates, it will be quite a hassle before both sides get to understand each other," said director Watanabe as he revealed his inner thoughts by likening the siting to [choosing] a "bride." This company hopes to have this siting problem out of the way by the end of next year at the very latest, so that its construction schedule will not be delayed, and the selection process will assume gigantic proportions from here on. There is a good likelihood that the selection process has narrowed down to prospective sites in the Kyushu area.

Speed Up the Establishment of Utilization Technology

There is also a rebirth in the development of technology for utilizing the plutonium that is obtained from reprocessing. The Power Reactor and Nuclear Fuel Development Corporation produced 16 fuel elements to fuel the prototype of the new-type converter reactor "Fugen," using plutonium produced at the Tokaimura reprocessing facility. These have already been delivered to the reactor site, and the first domestically produced nuclear fuel using plutonium made at home will be loaded into the reactor.

The Power Reactor and Nuclear Fuel Development Corporation developed a new method of producing plutonium fuel called the "uranium-plutonium mix conversion method," and it has gone into construction of a fuel manufacturing facility employing this method. It has been said that the risk of nuclear proliferation is great if plutonium alone is used in fuel, so the final product of the reprocessing plant, plutonium nitrate solution, is mixed with uranium trioxide powder, from which a uranium-plutonium oxide product is obtained. "We simply applied the principle of the electronic range. There is no waste solution, and the process is simple. This is thought to be the best protection against nuclear proliferation," boasted Takao Tsubotani, director of the Plans Section of the Nuclear Fuel Department.

The only nuclear reactors to date which will use plutonium fuel are "Fugen" and the "Joyo" fast-breeder experimental reactor. This is why there have been no plans for immediate transfer of plutonium utilization technology to private areas. With the future promotion in reprocessing plans, there will probably be greater strides toward the establishment and stabilization of plutonium utilization technology.

2267
CSO: 4105/190

SCIENCE AND TECHNOLOGY

JAPAN'S BIOMIMETIC INDUSTRY MAY LEAD THE WORLD

Tokyo NIKKEI BUSINESS in Japanese No 295, 29 Jun 81 pp 130-132

[Interview with Zenichi Yoshida, Kyoto University professor, by Koichi Shiraishi, deputy managing editor of NIKKEI BUSINESS; date and place not given]

[Excerpt] Clarification of Enzymatic Functions and Synthesis of Enzymes

Methodology Differs from Biotechnology

Shiraishi: Please tell me about the steps involved in research, citing some specific examples.

Yoshida: Let us suppose that here is an enzyme. First, the function of this enzyme will be identified. With a known molecular structure, it is possible to synthesize an enzyme which may be able to work better than the original enzyme. This is what we call a synzyme (synthetic enzyme).

Shiraishi: In what fields do you think this can be made practical?

Yoshida: I believe that this can be made practical relatively sooner in the fields of medical drugs and agricultural chemicals. To be more precise, let me say medical substances, rather than medical drugs. It is possible to make something that is effective in preventing sickness and in maintaining good health. Functional substances exist in traceable amounts in living bodies, but they have not yet been identified. If these substances are identified by clarifying the functions of living bodies, they can be synthesized and can contribute to the maintenance of good health. Furthermore, it is chemically possible to modify part of the structure, and this eventually can produce artificial substances more effective than the natural substances that support life in a living body.

For instance, a multipurpose antibiotic named cephalosporin has drawn world attention. It is thought to be the miracle drug of this century. It is based upon Cephalosporin C, produced by a microbe. This is a natural product. By hydrolyzing this to remove C and adding something different to it, a product which is almost 100 times more effective than the natural substance can be obtained.

Shiraishi: This science then is similar to the concept of biotechnology that something useful for mankind is produced by utilizing a living body.

Yoshida: That's true, but its methodology is different. In biotechnology, the living body itself is utilized. However, because it is the living body, there is a limit to production. For example, it is impossible to increase production five-fold. Also, substances in biocells are extracted. In breaking the cells, the contents are often destroyed. In this aspect, the biomimetic chemistry that we study may be a science that is beyond biotechnology--a final method.

Beyond the Realm of Biofunctions

Aiming Principally at "Production" of Effective Substances

Shiraishi: Genetic engineering is workable only in the framework of biofunctions. In contrast, biomimetic chemistry breaks out of this restriction, artificially creates more efficient functional substances, and manufactures them on an industrial production basis. Is this the picture of science you are trying to explain?

Yoshida: Exactly. Professor Breslow of Columbia University is the originator of the term mimetic chemistry, but American and European thinking is still preoccupied by the first stage of understanding biochemistry at the molecular level. We, on the other hand, intend to add human wisdom to biochemical results to produce useful substances. This is our basic idea. Evidently we can say that we are one step ahead of the European and American level. We are burning with a desire to create something new which will entitle us to call the 21st century the era of Japan.

Shiraishi: I understand the Ministry of Education awarded a special research aid to this study beginning in FY 1980. What are the details of the research to be conducted here?

Yoshida: There are eight groups. Among them, there is a group in charge of research and development of artificial blood and a group in charge of studying metal catalysts specific to living bodies--that is, enzymatic metals that serve as a catalyst. Also, there is a team which is in charge of studying biofunctions themselves and developing synthetic enzymes. One group is in the field of biofunctional materials research. For example, it is possible to seek conductive materials in living bodies.

Shiraishi: Can you be more specific about the artificial blood...? How is it different from what the Green Cross has started doing?

Yoshida: The artificial blood developed by the Green Cross is for emergency use. It is soon discharged outside the body. In comparison, the purpose of the work being done in the biomimetic field is to understand the mechanism of blood that carries oxygen and to produce blood with a more efficient carrying mechanism. Specifically, hemoglobin in humans is the carrier, hemo is extracted, and the human globin is used. Since the proteins are not changed, this new blood will not be influenced by blood type.

Widely Applicable Enzymes "Activation"

There May Come a Day When Reagents Are Ousted From the Chemical Industry

Shiraishi: What can we achieve by practicalization?

Yoshida: Long-term preservation will become possible. At present, the preservation of blood for transfusions is limited to 2 weeks. Besides, some illnesses are caused by the reduced carrying ability of the blood. These problems can be solved by the use of this artificial blood. Even with a healthy body, if this blood is transfused to, for example, an athlete, his record will show remarkable progress. Serum hepatitis can be prevented.

Shiraishi: I have heard that the future plant system will be changed by biomimetic chemistry. What does that mean?

Yoshida: Petrochemistry is now encountering a curve, for one thing, because of the pollution problem, and because of the limitation of oil resources for another. This is where the idea of utilizing metal catalysts specific to living bodies comes in. For example, silver currently is used as an oxidation catalyst for producing ethylene oxide from ethylene. Since it is activated by oxygen, naturally the ethylene is also burnt. Tbus the effective utilization ratio of the ethylene is curtailed. Another problem is that silver is effective only on ethylene. There are plenty of olefins, but silver is not effective on others and cannot be used for the development of fine chemicals. In this respect, catalysts which utilize activators in enzymes exhibit widely applicable effects.

Ordinarily, reagents such as chlorine, water, and sodium hydroxide are required when compounding olefins. The point of tomorrow's chemical industry is to get an objective compound using as few reagents as possible. That's why we are trying to use enzymes instead of reagents.

Great Contributions by Combined Academic Research Organization

Continuous Aid From the Government Necessary for at Least 10 Years

Shiraishi: You don't see these ideal types in natural enzymes, but you try to add desired functions to produce what you want.

Yoshida: True. Natural enzymes work only on one substance. This is fine in living bodies, but it will not be convenient for industrial use without universality. Efficiency is purused. Eventually, in the 21st century, a quiet, steamless, efficient production system that operates at normal temperatures will emerge, in contrast to today's process of the chemical industry. What will bring about this revolution will be the catalysts which utilize enzymes.

Shiraishi: Eight groups are working very extensively in the field of advanced technology--a very unique joint academic research organization. Does it work well?

Yoshida: I believe this organization is the first of its kind. It covers practically all the natural sciences--pharmacology, medicine, engineering, science. and agriculture. Furthermore, we asked for the participation of professors in major universities from north to south. It may work well, because we spent several years consolidating the foundation of the organization. Unfortunately, however, aid from the Ministry of Education will be cut off after FY 1982. We could achieve great results if we could maintain this setup for at least another 10 years.... I say this because, as I have mentioned before, American research efforts haven't gone beyond the clarification of biofunctions, while Japan is far in the lead in the subsequent development of research. The industrialization of biomimetic products is no longer a dream at the end of the 20th century, and this biomimetic seed will flower as a new industry in the 21st century. I wish there could be a governmental aid system and an industrial support system for a science like this. I hope the Ministry of International Trade and Industry and the Science and Technology Agency will succeed the Ministry of Education in the task.

Joint Academic Research Leading To Joint Industrial Technology

Opportunities for Japanese Technical Scientists To Exercise Their Creativity

Shiraishi: We worry and complain that Japan missed the chance to get on with genetic engineering. But in biomimetic chemistry, we are in a position to export technologies to Europe and America, aren't we?

Yoshida: To tell you the truth, we once led the world in genetic engineering. We were ahead in recombination by fixed enzymes. The issue of gene manipulation was raised, however, and our research was canceled. Meanwhile, Europe and America caught up with Japan and reversed the position. They took hold of the basic field. However, confronted with industrialization in the days to come, European and American manufacturers will ask Japan's help in production. After all, Japan surpasses others in fermentation engineering.

In the future, we need a method to develop domestically an advanced technology in order to follow through a science which has been created for the first time in the world. This joint academical research must produce joint industrial technologies. In the past, both the science and the technology were imported. We did not know the process of formulating the sciences or producing the technology. We blame the lack of creativity for this ignorance. Even though we are at the world's foremost front in the sciences, the achievements will be snatched away to Europe and America unless industries are ready to accept them and offer some support. We would like to get on with our research as a long-term project and to see it bloom as a technology that can be offered to Europe and America.

Present Status of Biomimetic Chemistry Research

Research Themes	Main Research Description	Applicable Field
Structure and function of substances responsible for respiratory phenomena	Research on respiratory hemoproteins and enzymes Structure and function of copper protein active sites	--
Artificial oxygen carrying system	Research on oxygen linkage of modified hem Oxygen carrying system using polymer complexes	Artificial blood
Metal Catalyst specific to living body	Oxidation action of coordinated oxygen and activation of other ligands Structure and function of metal complex with action similar to dioxykinase	New enzyme for chemical industry
Analysis of Enzyme Reaction	Analysis of enzyme reaction under high pressure Analysis of scattering structure of reaction system involving enzymes	--
Artificial enzyme system	Development and effective use of highly active artificial enzyme system Development and effective use of membranous artificial enzymes	Synzymes
Stabilization of enzymes and conversion of functions	Structure and function of heat resistant enzymes Function conversion of Vitamin B_6 enzymes by chemical modification and stabilization	Highly efficient enzymes
Biomimetic materials	Behavior of charges during electron conduction in in chloroplast Interactions among biosubstances and optical behaviors	Nonmetal conductive materials
Biosynthetic organic reactions	Chemical conversion of nucleic acid derivatives Study on oxidation reaction in biosynthesis	--
Research on function of regulatory substances in bioprocess	Research on contact points with receptors of chemical regulatory substances Metabolism of steroid hormone and appearance of bioactivity	Ultraprecision medical drugs Case diagnostic substances

8940
CSO: 4105/202

SCIENCE AND TECHNOLOGY

ENTERPRISES IN GENETIC TECHNOLOGY EXAMINED

Tokyo DIAMOND'S INDUSTRIA in English Vol II No 7, Jul 81 pp 31-34

[Text]

Ajinomoto made it clear on November 12, 1980, that it created for the first time in the world a new sort of escherichia coli which produces pure amino acid. Although the company has so far been conducting research on genetic technology without publicizing it, the company seems to have a policy of starting full-scale research on the matter on this occasion, thus attracting the attention of the circles concerned. Ajinomoto is the first company to announce publicly and concretely the name of a product manufactured with genetic technology.

There is a strong impression that Japan has been far left behind by firms in the United States and Europe in this field of business. But Ajinomoto is the second successful private company in the world next only to Genentech of the United States. And the pure amino acid is the fifth new product of genetic technology, following somatostatin, insulin, growth hormone and interferon.

What Ajinomoto produced successfully by means of escherichia coli is a sort of pure amino acid, threonine. It is difficult to produce threonine by conventional fermentation methods. According to the new method, genes to produce amino acid are separated from a sort of escherichia coli and incorporated with the gene carrier, called plasmid, and cultivated in another kind of strong escherichia coli. Usually, such antibiotics as chloramphenicol are used for cultivation, but Ajinomoto established techniques for enriching and taking out threonine only after adjusting culture fluid. Since the new method is different from the conventional one using the above antibiotics, the safety of threonine is ensured. And when it is utilized for industrial purposes, the removal of antibiotics from the product is unnecessary, thus eliminating a factor contributing to an increase in production cost.

In producing amino acid by the ordinary fermentation method, the process of separating and refining was unavoidable because the method has shortcomings of producing impurities other than the amino acid to be produced. But the new method does not make impurities, and the quality of the product is almost as good as that of final products (with threonine's purity reaching as high as 99%).

Since the rate of yield from refining is so high that the production costs can be lowered greatly. In addition, it is possible to produce twice the amount of pure amino acid per unit. This means killing three birds with one stone.

Production is still in the experimental stage and it is only after a large industrial plant has been set up that the company can enjoy such merits of production by the new method. But the fact that Ajinomoto has announced the above prospects for future production is of the greatest significance.

There are other notable points in Ajinomoto's techniques, with which it succeeded in having escherichia coli produce threonine. The company tackled genetic technology as a continuation of its previous business instead of developing new pharmaceuticals which would take long time for a clinical demonstration and five to ten years before contributing to the company's business results. Amino acid is not such high-priced items of merchandise as insuline and interferon, which are traded in terms of milligrams, but it is an item for the masses, so to speak, and handled in terms of kilograms. Since Ajinomoto is undisputably the top maker of amino acid, enjoying a world market share of 70% to 80%, it could not fall behind other makers in devising a new production method.

In other words, it was necessary for Ajinomoto to tackle genetic technology in order to develop the most up-to-date techniques to maintain the company's superiority in amino acid production.

In this sense, Ajinomoto intends to apply the new techniques to the production of other sorts of amino acid, including tryplophan jointly developed with Kyodo Shiryo Co. It is expected that Ajinomoto will attain good results in its development efforts.

Originally, fermentation business is the speciality of the company whose techniques are at the top level in the world. It has a central research institute staffed by 600 researchers and other members and it has recently completed a laboratory on genetic technology, whose safety is at the highest level of P III. There is a high possibility of the company developing epoch-making new products other than amino acid, such as pharmaceuticals, by using genetic technology.

This spring the central research institute developed an epoch-making new method of preventing, without using anti-biotics, the "fall of incorporated genes," which was a bottleneck in applying genetic technology to actual production. The new method will make possible stable and continuous production at large plants, thus carrying a step further toward commercial production through the application of genetic technology.

New Drugs by Using Escherichia Coli

Mitsubishi Chemical Industries Ltd.

The company which has the largest accumulation of bio-technology in Japan is Mitsubishi Chemical Industries, the leader in the chemical industry. The company exceeds its rival, Sumitomo Chemical, in terms of sales but falls behind in the field of fine chemicals, such as pharmaceuticals and agricultural chemicals. Mitsubishi Chemical Industries plans to develop epoch-making new pharmaceuticals and new production methods by using bio-technology as a leverage and keep the position of the top general maker of chemicals.

Mitsubishi established Life Science Department in its headquarters on October, 1980. It was the first Japanese firm to establish such a formal section in an effort to commercialize life science. It surely has clear prospects for attaining its goal.

The history of the company's research on life science dates back to 1971 when Mitsubishi Kasei Institute of Life Science was established. It was set up with the foresight and decision of the late President Hideo Shinojima. The previous chief of the institute was Dr. Fujio Egami, an authority on biochemistry in Japan. Under his guidance, the institute has been continuing research mainly on DNA and neurological function, and it has obtained two patents related to genetic technology – one regarding the process for referring of plasmid and the other for referring of protoplast. Eight of the 42 patents granted in Japan by the end of last year were those of Japanese firms. So a quarter of them are owned by Mitsubishi Chemical Industries. It can be said that the company is a leader in this field.

Since the institute has achieved such remarkable results in the period of ten years, the company thought the time has come to move from basic studies to commercial production and set up the Life Science Department to smooth the transition. In November, 1979, the "scholar" chief of the institute was replaced by Vice President Makoto Niwa, who had been in charge of research and development at the head office. (He is a doctor of science, who majored in catalyzer chemistry at the Science Department of Tokyo University and graduated from it in 1938.) The move, intended to unify basic studies and the application of technology, shows that the company is quickly heading for the goal of putting genetic technology to practical use in the 1980s.

While reorganizing its structure and re-locating personnel, the company announced at the end of last year that it would complete by the middle of this year highly-safe P III class facilities for experiments in order to strengthen research on genetic technology. The new facilities to be used jointly by Mitsubishi Chemical Industries and Mitsubishi Kasei Institute of Life Science is to be built at the site of the institute at Machida, Tokyo. The facilities of the P III class have the highest-level safety among those in the private sector in Japan. Facilities of the P II and P I classes are already in the institute. But the company decided to construct the P III facilities, as obligated by national guidelines for experiments on incorporating mammal genes with escherichia coli, since such experiments are indispensable for developing higher application technology.

At the same time, the company announced a plan to have escherichia coli produce new pharmaceuticals by using genetic technology. The company plans to establish within this year techniques to have escherichia coli produce two kinds of new internal active metabolite which are created in human body and to start their production as pharmaceuticals as early as possible. It was the first time that a concrete plan on the development of new pharmaceuticals with genetic technology had been made public in Japan.

It has not yet been disclosed for what diseases the new pharmaceuticals are, but Mitsubishi Chemical Industries says they are not interferon, insuline or growth hormone. At any rate, the company intends to start a clinical demonstration in about three years and produce pharmaceuticals in about six to seven years at the earliest. But there is a strong possibility that the company will apply the technology earlier to the improvement of production processes in petrochemical and chemical industries than to the production of pharmaceuticals which will take a long time.

The company is also branching out actively into the field of pharmaceuticals produced by conventional methods. Investing in Key Pharmaceuticals of the United States in 1979, the company has been engaged in joint research with the U.S. firm. Late last year, they succeeded in developing a new anti-asthma drug. Mitsubishi Chemical Industries is forming a pharmaceutical sales network through capital tie-ups with existing drug makers. It acquired 1,400,000 shares of Nikken Chemicals in July, 1980, and 4,000,000 shares of Tokyo Tanabe in February this year.

Techniques for Producing an Immunity Diagnosis Drug by Hybridization

Mochida Pharmaceutical Co., Ltd.

Mochida Pharmaceutical, which is studying the manufacture of interferon by the fibroblast technology introduced from G.D. Searle & Co. of the United States, is to start a clinical demonstration of its own this year.

In the field of genetic technology, it has developed techniques for producing an immunity diagnosis drug by the method of hybridization. Since different kinds of cells are hybridized to create "new cells" which are cultivated later, the new method can lower the cost considerably compared with the conventional method using rabbits. It is said that immunity diagnosis drugs in the future will be produced all by this new method. The company plans to start commercial production in two years.

The company, which is a medium-class pharmaceutical maker having strong foothold in hormone and enzyme and specializing in drugs for clinics and hospitals, needs to step up basic studies and safety tests in such new fields as genetic technology. It started the construction of a research institute at Gotemba, Shizuoka Prefecture, in March this year at a total cost of ¥2,100 million.

Aiming at Using Bio-Technology for C_1 Chemistry

Mitsubishi Gas Chemical Co., Inc.

The company has decided to embark on research on genetic technology, aimed at using bio-technology for C_1 chemistry (chemical compounds with one carbon molecule). In Japan, pharmaceutical and foodstuff makers and chemical companies have begun research on genetic technology but chemical companies, such as Mitsubishi Chemical Industries, Sumitomo Chemical, Mitsubishi Petrochemical and Kanegafuchi Chemical Industry, have set their targets in fine chemicals, such as pharmaceuticals.

In view of the situation in the United States and Europe, however, Mitsubishi Gas Chemical decided to tackle genetic technology for applying it to the chemical industry for the first time in Japan. The company plans to combine the technology with C_1 chemistry using natural gas as a raw material, a field in which the company has been consistently engaged.

In concrete terms, the company plans to manipulate genes of microbes which eat methanol, one of the basic materials in C_1 chemistry, in order to develop a new chemical process.

Genetic Technology with its SCP Techniques

Dainippon Ink & Chemicals, Inc.

The company is at the top of the world in techniques on SCP (single cell protein). Commercial production of SCP was not realized in Japan due to the controversy over the safety of such protein and the sharp spirals in oil prices. But the plants developed by the company have started the world's first commercial production in Rumania.

Starting operations at the end of June last year, they increased the monthly production to more than 1,000 tons in July. Although the monthly production capacity is 5,000 tons, it is turning out 1,200 to 1,300 tons of SCP a month because the supply of the raw material, N-paraffin, cannot catch up with production. The production capacity is to be doubled to 10,000 tons a month in the future after the supply system is improved.

The company intends to place emphasis on technological exports to oil-producing countries where husbandry is carried out and SCP feedstuff is needed. But the company is expected to branch out into the field of genetic technology by utilizing techniques on SCP, while continuing research on the commercial production of SCP using methanol as the raw material.

Research on Interferon

Asahi Chemical Industry Co., Ltd.

The company is active in branching out into the field of genetic technology as a promoter of the "meeting of companies on bio-technology."

Regarding fermentation, the company has techniques accumulated since it switched to the fermentation method in producing chemical seasoning through a joint study with its subsidiary, Toyo Jozo.

The company has begun research on and development of interferon by utilizing such techniques. While introducing techniques on interferon from the National Cancer Institute of the United States, it has dispatched technicians to four universities in the United States. It is also constructing at the Fuji Plant P III level facilities for the experiments on biological containment, thus taking steps for the commercialization of genetic technology.

In the pharmaceutical field, the company is in tie-up with Toyo Jozo and has made considerable progress in the development of inosine and adenosine; anti-cancer drugs, Sunfural and Sunrabin; and intermediate for cephalosphorine antibiotic, "7-ACA."

CSO: 4120/291

SCIENCE AND TECHNOLOGY

SHIPPING INDUSTRY REPORTED ON COURSE TO RECOVERY

Tokyo BUSINESS JAPAN in English Vol 26, No 7 Jul 81 pp 59-61

[Text] IT hasn't been the best of times for the Japanese shipping industry. A prolonged recession brought a cutback in the number of merchant ships, and the soaring costs of manpower struck a blow to its international competitive ability. But these troubled waters seem to be behind it now, thanks to the bullish tramp market sustained for the last two years, brisk exports, and depreciation of the yen.

The industry can also be grateful for the results produced by a three-year emergency ocean-going ship buildup program which was put into effect by the government in fiscal 1979. The soaring cost of manning ships, for one, is now being rectified through concerted labor-management efforts to modernize the recruiting system, with encouraging signs of improvement appearing on the horizon.

The various problems currently faced by the Japanese shipping industry were met head on with ways to resolve them in the vigorous recommendations submitted in March last year by the Shipping and Shipbuilding Rationalization Council, an advisory organ to the Transport Ministry. The three-year emergency ocean-going ship buildup program, which has been revised in line with the recommendations of the council, was rated very highly for having produced far better results than anticipated.

The original government-financed plan called for the construction of three million gross tons of ocean-going ships over three years. However, in the first two years alone in fiscal 1979 and fiscal 1980, as many as 63 ships tor a total of 3,470,000 gross tons were constructed.

Moreover, although government budgetary appropriations set aside for fiscal 1981 are just enough to build 1,240,000 gross tons of ships, there has been an unofficial report of bids to build more than 2,500,000 gross tons of ships. The problem for the government at the present time is raising additional funds.

These results speak for themselves of the effectiveness of procuring long-term, low-interest government loans, including interest subsidies, for the construction of cost-saving ships to be manned by a small crew in sustaining international competitiveness. The merits of this program will serve as valuable guidelines when debate begins on what course to follow after fiscal 1982 when the emergency shipbuilding program comes to completion.

On February 19 of this year, the government convened the Shipping Policy Panel of the Shipping and Shipbuilding Rationalization Council to seek its advice and recommendations on ocean-going ships after fiscal 1982. Policy measures are now being discussed by this task force and an interim report of policy proposals and recommendations is scheduled to be made around the middle of July.

Already discussions have been conducted on the significance of the shipping industry in Japan, as well as its standing in international competition, and on the issue of flags of convenience. Ongoing studies include research of shipping industry promotion measures and tax measures of various countries as well as the policy objectives behind these measures.

In late June, some members of the Shipping Policy Panel will join a Japan

Maritime Research Institute mission to Europe to observe various shipping concerns there. Great expectations have been placed on the results of this observation trip and of the task force work as a whole as being invaluable in shaping future shipping industry policy.

Needless to say, Japan is one of the major countries which depend on exports for survival. Of the approximately 3,600 million tons of maritime cargo movement in the world, Japanese cargo movement accounts for about 700 million tons. We need not stress anew the importance of the role being played by the Japanese shipping industry in ensuring stable transportation of trade goods. As regards international payments, Japan suffered a deficit of about US$10.8 billion on a fiscal 1980 basis in its current account balance, a figure approaching its invisible trade deficit which was about US$11.3 billion.

In view of this, it is no exaggeration to say that the invisible trade balance holds the key to the improvement of Japan's international payments position. In particular, it must be noted that shipping-related international payments account for about one-third of invisible trade payments. On the 1980 fiscal year basis, Japan posted a deficit of about US$3.3 billion in international payments related to shipping. In order to reduce shipping-related deficit, and so in turn improve the invisible trade balance, reduction in charters of foreign ships as well as the curtailment of fuel oil consumption would be very effective steps to take. In order to reduce charters and fuel oil consumption, the most direct move would be to construct highly efficient cost-saving ships fitted with energy-saving engines that would sail under the Japanese flag.

It is obvious that recovery of international competitiveness of Japanese ships is primary to ensuring a healthy future for the Japanese shipping industry. Particularly important in this connection is the procurement of highly competent Japanese seamen. Now that the public has come to recognize the need for Japan to possess a minimum number of ships to ensure economic security as well as to cope with an emergency, it is more a question of how to recruit Japanese seamen to operate these ships. As a matter of reality, the number of those who wish to become seamen, a job that looks increasingly demanding and unglamorous in comparison with work on land, is declining year after year not only in Japan but also the world.

Although bright spots have finally begun to appear on the horizon of the Japanese shipping industry, the environment surrounding the industry is still gloomy. The political and economic situations throughout the world are still unpredictable, what with the Middle East in turmoil, the power struggle in Poland, recession of the U.S. and EC economies, the oil problem, and the deterioration in the international payments position of non-oil developing countries.

To make the situation worse, the tramp market which has made a brisk performance for two years is showing signs of weakening. The international situation that surrounds the Japanese shipping industry, marked by the aggravating North-South confrontation in shipping, and the intensification of activities of non-Conference ships among the East European shipping industries and of some major American shipping companies, is expected to become increasingly severe.

However, it is true, at the same time, that the Japanese shipping industry is on the way back to international competitiveness, thanks to the three-year emergency ocean-going ship buildup program. To assure a complete recovery will take some specific hardline measures, namely labor-management self-help efforts and appropriate government support in the form of policy measure. With this in mind, we place expectations on fruitful policy proposals and recommendations to come forth from the task force of the Shipping and Shipbuilding Rationalization Council.

It is essential that the government not lose track of the importance of the shipping industry under pressure to rehabilitate its deficit-ridden national finance. Rather, it needs to formulate and enact just and appropriate policy measures that can enhance the international competitive power of the Japanese shipping industry, and thus keep Japan a leader in trade. □

CSO: 4120/297

SCIENCE AND TECHNOLOGY

PROSPECTS OF SEMICONDUCTOR, INTEGRATED CIRCUIT INDUSTRY EXAMINED

Tokyo BUSINESS JAPAN in English Vol 26, No 7 Jul 81 pp 32-34

[Article by Gene Gregory]

[Text]

DURING the seventies, the Japanese semiconductor industry emerged as a second pole of technological innovation in a global microelectronics revolution, winning worldwide recognition for its productive prowess. In the coming decade, microchip manufacture promises to bring major changes to both the Japanese and international industrial structures.

Propelled by rapid changes in micro circuit technology, the electronics industry will be the most dynamic sector of the Japanese economy during the next two decades. In 1979, the gross product of the electronics industry in Japan was less than half that of the steel industry and only about 40% of that of the automotive sector. By 1990, total output of electronic products is expected to surpass US$100 million, not accounting for inflation, exceeding steel output by a considerable margin. Only the automobile industry is likely to remain larger in terms of total output, and it will itself have become a major consumer and producer of electronic devices.

Assuming that the output of electronic products grows at an average 10% per annum throughout the 1980s, industry planners expect semiconductor production to grow at an appreciably higher 16% a year. Most of this growth will be in integrated circuits (ICs), with output of discrete semiconductors (mainly transistors and diodes) remaining stagnant or declining.

During the four years from 1975 to 1979, the annual growth of IC production averaged almost 34%, exceeding the total production of discreet semiconductors for the first time in 1978. In August 1979, also for the first time, Japan became a net exporter of ICs, marking a significant strengthening of the Japanese position in world markets.

Prospects are good that, despite a rapid growth in the home market, the Japanese industry will remain a net exporter in the future, substantially increasing its share in world marketplaces. According to estimates made by Nomura Securities, which look to be quite conservative by past performances, domestic demand for ICs will expand more than 2.5-fold during the first half of the 1980s. As a result of the combined growth of domestic demand and exports, according to the 1980 report on the industry by BA Asia, a Bank of America consulting firm, Japanese manufacturers could account for one-third of the US$20 billion world semiconductor market by 1985.

Such a substantial improvement over the present 26% share of world markets does not reflect simply, or mainly an anticipated increase in

Japanese exports of ICs. Rather, it is the expected result of a more rapid and pervasive diffusion of semiconductor technology throughout the broad spectrum of industrial production in Japan than will take place in North America or Western Europe.

Applications of ICs by Japanese industry have been at once more varied and at a remarkably faster pace than in other advanced countries throughout the 1970s. While the computer industry has provided the single largest market for advanced LSIs (large-scale integrated circuits), and will continue to do so in the future, it accounted for only 25% of the ¥364 billion domestic consumption of ICs in 1979. Audio-video manufacture took an equal share of available ICs, assuring Japanese makers a leading position in world markets for home entertainment equipment. Likewise, cameras, watches and calculators have evolved through successive product design generations in pace with advances in semiconductor technology. And the rate of application has been just as rapid in telecommunications, office machines, automobiles, home appliances, toys and a bewildering miscellany of products.

Perhaps most outstanding of all, however, has been the rate with which semiconductors have been applied in machinery in Japan. The expanding park of industrial robots which many Japanese factories use around-the-clock exemplifies the special zeal with which semiconductor technology has been adopted in Japanese industry.

This zeal is not manifested haphazardly, however. As systematic as semiconductor technology itself, the application of successive generations of ICs has been systematized into a separate technology: mechatronics.

As the name suggests, mechatronics is simply the combination of mechanics and electronics, but done in such a way as to assure in each product the optimal combination of the two technologies. This practice is not new, of course. But the development of the microcomputer and other semiconductor devices, all available at relatively low prices, has accelerated the process, giving rise to public policies and corporate strategies to encourage and direct the process of change.

Mechatronics in Japan has sped the process of semiconductor applications because of several systematic and ongoing changes:

- total replacement of conventional mechanical devices, wherever possible (calculators, watches);
- partial substitution of mechanical functions by electronic devices (sewing machines, cameras, copiers, automobiles); and
- addition of electronic control devices to conventional machines (numerically controlled machine tools, robots, electronic controls for engines).

Phenomenal advances in Japan in application of semiconductor technology in calculators, watches, cameras, NC machine tools and robots are manifestations of the intensive and extensive development of mechatronization beyond the stage of serendipity and spasmodic impulse into a special highly refined systematic production technology.

The result, in turn, is to create a high-growth market for ICs. But the dynamics of the process does not stop here. The substitution of electronic for mechanical products also has stimulated incremental demand for the whole product.

The electronic watch well illustrates this dynamic interaction of semiconductor technology, market and production. From 1964 to 1972, unit shipments of watches in Japan increased at an average annual rate of just under 2%. After the introduction of the electronic watch in 1972, however, the growth rate has been over 7% a year. As a result, IC makers and watch manufacturers have both benefited from this trend, not only from increased volume, but from higher value added per unit of production.

Semiconductor manufacturers have a special advantage, however. As systematic mechatronization increases domestic consumption of ICs, the resultant higher volume production hastens learning curve advantages of the latest product generation, making it possible to reduce production costs accordingly and improve their position in the highly competitive world markets.

This process is expedited, not so much by massive government subsidies or special tax advantages, but by an efficient financial system which makes possible the high and flexible rates of investment which the highly capital- and technology-intensive semiconductor industry requires. Japanese manufacturers in such high-growth, high-value-added sectors have access to capital on the sustained and rational basis which advanced and rapidly changing technologies require.

Equally important, the vertical and horizontal integration of large-sized, highly diversified Japanese manufacturers of electrical and electronic products have a special advantage in the allocation and use of resources for rapid application of the rapidly changing semiconductor technology. This explains in part why semiconductors were first applied to consumer electronics and calculators in Japan, rather than in the U.S. where the basic technology was originally developed. American IC manufacturers began as semiconductor manufacturers and merchandisers and concentrated on a broad range of devices to cover as large market segment as possible.

This structurally-induced efficiency in the application of new semiconductor technology by integrated Japanese manufacturers has been both the cause and the effect of a remarkably higher degree of specialization in semiconductor production than is found in leading American semiconductor makers. Specialization in Japan, to meet in-house product requirements, tends to assure the greater economies of scale and learning so critical to semiconductor manufacture.

The next stage in the macrodynamics of this industry was entirely predictable. It is an immutable law of techno-economic behavior that basic technology flows to the point of most efficient application and production. During the first 30 years of the microelectronics revolution, the basic technology was developed in the United States and transferred to Japan and other Asian countries where the technology was more readily, efficiently and economically applied. Now, in the second stage of the microelectronics revolution, the lead in development of basic technology itself is shifting to the point of application and production, where organizational, financial, human and informational resources are optimally available in the necessary combinations for continuing innovation.

The 1980s have begun with the significant lead taken by Japanese manufacturers in the 16K RAM (random access memory) marketplace. Fujitsu's lead in the fielding of 64K RAMs, ushering in the VLSI era, was even more remarkable, scoring a technological advantage for Japan in the crucial big volume memory segment of the market. And, as a recent study of Daiwa Securities notes, Nippon Telephone & Telegraph, Fujitsu and NEC succeeded collectively in developing the world's first 128K RAM, which has since been followed with the announcement by Japanese manufacturers of 256K bit VLSI chips.

In VLSI development, Japan has clearly taken the lead. And once more, Japanese industry is best equipped to use the new technology to the greatest advantage in new product development.

But those spectacular changes in the industry, although momentous, are by no means the whole story. As BA Asia's 1980 report points out, Japanese applications for IC patents have been growing steadily in recent years, while foreign patent applications have stagnated. The dimensions of the trend are important: total semiconductor patent applications in Japan increased from 4,406 in 1974 to 6,397 in 1977, while foreign applications dropped from 10% to 7% of the total.

Most new technologies developed in Japan have been in assembly processes and manufacturing rather than inventions of new devices. As a result, however, Japanese mass production and automation technology are generally agreed to be the highest in the world, assuring better production yields and greater product reliability.

Sony's recent perfection of a method to grow better silicon crystals under the influence of a magnetic field, increasing IC production yields by up to 20%, is a case in point. Reduction of imperfections in silicon wafers becomes especially critical in the production of VLSI chips, Sony claims.

Even less visible than such breakthroughs by major manufacturers has been the emergence of a number of smaller scale leaders in semiconductor materials and processing equipment technology.

- Shin-Etsu Semiconductor has grown to become one of the world's largest single-crystal silicon makers, with production facilities in Singapore and the U.S.
- Kyoto Ceramic is the largest maker of ceramic packages for ICs and LSIs, accounting for 70% - 80% of the world market.
- Dai Nippon Printing, Toppan Printing, Sumitomo Metal Mining, Sumitomo Special Metals, Tamagawa Metal & Machinery, and Mitsui Mfg. have developed technological strength in the production of IC lead frames of highly efficient conductors such as ferro-nickel, cobalt alloy, and silver-stripped phosphorous bronze.
- Dai Nippon and Toppan are also leaders in the production of photo masks, glass plates with circuit designs printed on them for transferring the design onto silicon wafers.
- Canon is the world's second largest mask-aligning equipment manufacturer.
- Kokusai Electric is a leading manufacturer of single-crystal silicon production apparatus, diffusion furnaces, ion implantation apparatus and other equipment used in IC production.
- The chief achievements of the government-sponsored VLSI Technology Development Union, which has already applied for over 1,000 patents, are the developments of revolutionary electron beam exposure equipment and high-speed electron beam drawing equipment which will enable the Japanese semiconductor industry to produce mega-glass VLSIs.

As demand for ICs is expected to increase at approximately 22% annually through 1985, the outlook for the production materials and apparatus sector is as bright if not brighter than for the semiconductor industry as a whole. Demand for production apparatus will be supported not only by growth of the industry, but also in large part by an unusually fast replacement cycle which accelerates with ever more frequent innovations.

At the same time, with production going international, as the industry establishes plants in major markets of North America and Europe in response to protectionist pressures, the demand for equipment and materials will increase. Although this demand will be met in many instances by foreign suppliers, Japanese equipment and materials manufacturers will undoubtedly be important beneficiaries of the move to overseas production. ◘

CSO: 4120/297

SCIENCE AND TECHNOLOGY

PAPER-THIN LITHIUM BATTERY DEVELOPED

Tokyo DIAMOND'S INDUSTRIA in English Vol II No 7, Jul 81 p 18

[Text] Matsushita Battery Industrial Co. Ltd., a battery manufacturing subsidiary of Matsushita Electric Industrial Co., Ltd., developed the world's first paper-thin sheet-type lithium battery measuring 1.3 mm thick, yet featuring a high energy density.

The company has succeeded in combining both "paper-thin battery technology" first developed by Matsushita Battery in 1970 using a manganese dry battery configuration and "lithium battery technology" which yields one of the highest energy densities of any battery.

The new paper-thin lithium battery uses lithium in its negative electrode and carbon monofluoride as the positive electrode. Nominal voltage is 3V, double the voltage of ordinary batteries. Energy density is as much as 10 times higher than manganese dry batteries. In addition, the temperature characteristics provide high performance even at low temperatures. The battery is, therefore, well suited for electronic watches, liquid crystal display calculators and professional comunications equipment.

The company's conventional paper-thin batteries which use same materials as manganese dry batteries (manganese dioxide and zinc) are suited for applications requiring a low electric current. In contrast, the new paper-thin lithium battery has an energy density high enough to drive electric motors.

The new battery comes in three sizes measuring 20 mm x 70 mm and 1.3 mm thick, 43 mm x 70 mm and 1.3 mm thick, and 75 mm x 94 mm and 1.3 mm thick. The smallest version is as small as a piece of chewing gum but has an increased capacity four times higher than conventional manganese paper-thin batteries. The second version has electric capacity of 35 mAh about as high as that of an AAA size battery (slimmer than the AA penlight battery). The largest version, about half the size of a post card, produces 1,500 mAh which is equivalent to that of two AA penlight batteries.

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