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Japan Report

(FOUO 52/81)

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CONTENTS

DOW CHEMICAL'S STRATEGY IN JAPAN, WORLDWIDE ANALYZED

Tokyo SHUKAN TOYO KEIZAI in Japanese 17 Jan 81 pp 88-98

[Text] Survival Plan for Soda and Vinyl Chloride

Although the facade of the Japanese petrochemical industry appears unusually unperturbed by the aggressiveness of the American Dow Chemical, an unbearable sense of crisis constantly predominates behind the scenes. The Japanese petrochemical industry, built on a vulnerable raw material foundation, can be "wiped out unless some countermeasures are devised using this issue for momentum. The Dow activity is a warning bell" (chairman Fukashi Hori, Asahi Dow).

Activities among corporations and groups are being mobilized under the surface to respond to the approaches made toward Japanese firms by Dow. If an operational tie-up and joint tank construction take place, that will not only create a stir in the caustic soda industry but may even shake up the structure of the Japanese petrochemical industry.

The strategy toward Japan disclosed by Dow at the end of November last year included: 1) long-term mass import of ethylene dichloride (EDC), vinyl chloride monomer (VCM) and caustic soda; 2) construction of a tank base jointly with Japanese firms to receive the imports, with a target partial operational date set for the end of 1982; 3) construction of a VCM plant (annual production: 30,000 tons) operational in 4-5 years as a joint venture with Japanese firms at a cost of $125 million. Among these, the import of EDC and VCM and the construction of storage tanks pose an immediate problem to the related industries. The import of caustic soda is estimated to be on a scale of 200,000 tons (dry base) in the next 2 years, but the actual scale is likely to shrink considerably since the production must yield to the demand.

Also, a related source calculates that the production of VCM in Japan "will be delayed at least 7-8 years even if the project is undertaken. They don't intend to start it now. It's only a trial balloon announcement." In the circumstances, the focal point is how Japanese firms respond to Dow's idea of constructing a tank base which can handle an annual demand of 500,000 tons of EDC and 100,000 tons of VCM.

Using Fixation of EDC Import as a Lever

The basic reasons that Dow is aiming at the Japanese market are higher growth rate of VCM and EDC than in Europe and the expectation of demand for cost-competitive Dow products. Also, Dow is directing its aim at the moves toward structural renovation by the caustic soda industry, which is pressed by the second manufacturing method conversion due by the end of 1984, and the vinyl chloride industry which is also involved in it.

Incidentally, in 1979, EDC imports increased rapidly to 387,000 tons (double compared to the previous year). Although it is estimated that imports dropped to the level of 210,000-220,000 tons last year, that figure is still above the 190,000 tons recorded in 1978, which represented a dramatic almost four-fold increase compared to the year before that.

In the case of 1978, the increase in the demand for petrochemicals triggered a scramble for ethylene among polyethylene makers and vinyl chloride makers. Also, the stringency in the supply of chlorine was forecast due to the low demand for caustic soda, which, according to the analysis, kindled the expansion of EDC imports. Last year, these special conditions were eased and the demand for ethylene was considerably reduced, but the EDC imports have continued at a relatively high level. This is clearly attributable to the international competitive cost differential of chlorine.

It can be considered that these "pictures which indicate that EDC imports have taken root in Japan encouraged Dow's decision to launch an attack on the Japanese market" (executive director Okubo of Toyo Soda Manufacturing). Incidentally, it is said that approximately half of the EDC imports are Dow products.

Learning From Mistakes

At one time Dow experienced difficulty in its attempt to venture into Japan. Dow initiated a strategic move toward Japan using the 1972 complete liberalization of capital transactions for caustic soda and chlorine enterprises as momentum. In 1976, Dow obtained permission to manufacture caustic soda, and it also started import sales, snowballing its activities which reached a peak with the launching of a big plan to build a caustic soda plant.

However, the plant site selected had to be changed from eastern Tomakomai to Sodegaura in Chiba, Tachibana Bay in Tokushima and to Hario in Nagasaki due to opposition by the local communities. The scheme for advancement was after all cancelled. This failure to advance reflects a background of fanatic opposition by caustic soda firms, which had been weakened with the burden of the first manufacturing method conversion, and the strong opposition of the local communities loyal to the local caustic soda industry.

Meanwhile, it is also said that Dow had second thoughts about starting an electrolytic enterprise in Japan, where the energy cost was high.

Learning from these failures, since then Dow has steadily worked earnestly if not spectacularly in Japan. Already, Dow supplies 7 percent of the chlorine derivative products used in Japan, which is equivalent to 60 percent of the chlorine derivative

imports. Also, it has a Product Development and Research Institute (established in 1976) in Gotemba, and a polyole plant using urethane foam as the raw material is also under construction, with operation scheduled for this year, 1981.

The move taken by Dow at this time "is supported by the adequately strengthened relationship with related companies and by homework well done on the business world and market structure in Japan", commented a related source.

In addition, this time there are firms in Japan--for instance, Mitsui Toatsu Chemicals--which are examining Dow's proposal. In short, in the Japanese business world, there appears to be a change of mood in that the satisfaction of hunger precedes other matters, even if it means that Japanese companies must join hands with "notorious Dow," which devoured European markets by aggressive low pricing.

Mitsu Toatsu's Approach to Dow

At the moment, Mitsui Toatsu is making stealthy moves regarding association with Dow. Last year, concerned personnel went to Hong Kong where the Dow Pacific headquarters is located, and made an agreement to draw up an original plan between the two companies very soon in Hawaii.

Mitsui Toatsu took Dow executives to the Isumikita plant for a tour, demonstrating a positive attitude toward EDC imports and investigation of joint tank construction.

However, Dow has not clarified its intention as to whether Mitsui Toatsu can serve as Japan's window with the right to represent Dow or if it is to be treated merely as "one of several" upon organizing an import-sales firm. That is, discussions between the two companies have not reached a decision concerning the form of the new firm--a consortium or the use of Mitsui Toatsu as a sole partner with the right to represent Dow, as far as the Japanese side is concerned.

A source close to this deal in Mitsui Toatsu put it in perspective: "It may well take the form of polygamy. Although it depends upon the volume of transactions, that form might help us to alleviate the risk of totally depending on Dow." In such a case, the new firm might even be on a near commercial basis.

The name of Mitsui Toatsu is said to have been initially used in a release distributed at a press conference held by Dow. However, Toatsu arranged to have it altered to the phrase, "construction of tanks jointly with Japanese firms...."

The alteration, a related source pointed out, is evidence that the relationship between Dow and Mitsui Toatsu is consolidating at a rapid pace. Meanwhile, another related source expressed the opinion: "The relationship between Dow and Toatsu does not appear to be progressing as fast as the Dow side wants it to appear." It is suspected that Dow has also felt the pulses of all vinyl chloride makers in addition to Mitsui Toatsu, such as the Shin-Etsu Chemical Industry. This leaves room for speculation that Dow might tie up with a firm other than Mitsui Toatsu or with multiple firms. One source considers that the Oita Center of Showa Denko, which can offer tank base grounds as well as users in its proximity, is the best contender, although it is not a vinyl chloride maker.

The Japanese side, as seen in Mitsui Toatsu, is obviously investigating Dow's offer, because the structural problem of Japan's vinyl chloride industry and the problem of the second caustic soda manufacturing method conversion are intertwined.

Vinyl Chloride Industry Renovation Plan To Be Tacked On

The vinyl chloride industry led by the Vinyl Chloride Industry Association charted a structural renovation plan during the previous antidepression cartel period (May 1977 to August 1978). However, three companies--Toyo Soda, Nissan Vinyl Chloride (a production subsidiary of Nissan Chemical Industries) and Tokuyama Sekisui--announced their intention not to participate in this structural renovation plan. While the Vinyl Chloride Industry Association continued to urge the three to change their mind, demand was renewed and so the structural renovation plan was shelved.

This industry has encountered a downpour of depression since the spring of last year after the boom of 1979. It looks like it is constitutionally predisposed to "suffer from the progress of a malignant illness after recovering from one sickness" (executive director Fukae of the Kureha Chemical Industry).

The vinyl chloride industry traditionally maintains excessive equipment and perennially maintains a price war which can be criticized as being excessively competitive. In particular, the confrontation between the vinyl chloride monomer group and the polymer groups is fierce. Furthermore, the heavy burden of the manufacturing method conversion is an extra drag on the industry since many firms have branched into the field of soda and chlorine electrolysis.

In the circumstances, the companies may agree in general with the theory of scrapping equipment, but the realization of the idea at each step of the theory will be difficult in view of the growing conflict among them.

Recently, Mitsubishi Monsanto Chemical of the Mitsubishi group suspended production of VCM (annual production 80,000 tons) and caustic soda (annual production 200,000 tons) at the Yokkaichi plant, and decided to subcontract and concentrate production at the Mizushima plant of Ryobi. They signed a sales contract for Mitsubishi Monsanto to sell polyvinyl chloride (PVC) to Ryobi starting in 1978, but their tie-up advanced one step further to the intensive production of VCM. This deal was made rather smoothly to concentrate the operation within the Mitsubishi Chemical Industries group. Even among different business groups, three companies--Asahi Glass, Kureha Chemical Industry and Shin-Etsu Chemical Industry--have affiliated operations extending over vinyl chloride and soda. This agreement is built upon the tie-ups between Asahi Glass and Kureha Chemical Industry and between Asahi Glass and Shin-Etsu Chemical Industry. As a result, Kureha Chemical Industry suspended the annual 100,000 ton crude oil cracking operation in the VCM installations at the Nishiki plant, which suffered from the surging energy costs.

Similar to the Kureha Chemical Industry, the VCM installation at the Takaoka plant of Japanese Geon, the original process of which became unprofitable after the oil shocks, was closed down in June 1979. This move increased the operational ratio of Ryobi and Sunarrow and was also connected to the EDC imports from Dow.

In spite of these partial adjustments, the present state of the total picture of structural renovation, including scrapping of equipment, is very slow and frustrating.

Shackled by Soda Manufacturing Method Conversion

The structural renovation of the vinyl chloride industry is closely related to the caustic soda manufacturing method conversion. Caustic soda production capacity is 4.46 million tons per year (of which 1.65 million tons, or 37 percent, is made by the mercury method). Only the Noboribetsu mercury method installation scrapping plan of Hokkaido Soda distinguished itself, along with that of Nippon Carbide Industries, during the second manufacturing method conversion drive (to the ion-exchange membrane method in FY-80). Asahi Chemical Industry, Asahi Glass and Tokuyama Soda, which have their own technology, an ion-exchange membrane method, are expected to convert the remaining mercury method installations in 1981-82, earlier than the designated end of 1984 deadline. However, the remaining majority of firms so far have given no signs of starting to change the existing installations until the very end of the deadline.

In some cases, however, the possibility exists that some makers will get ambitious enough to scrap all or part of the remaining mercury method installations. This passive attitude reflects the heavy pressure of the cost of converting to the ion-exchange membrane method, the unpromising outlook in demand for soda even after the conversion, and the question of the cost competitiveness of the vinyl chloride, including the concurrently produced chlorine, in the case of the makers which also produce vinyl chloride.

Dow is charting its current strategy toward Japan as follows: "Japan's chlor-alkali industry is in a whirlpool of structural reorganization, such as closing of plants or the closing of installations in stages. Dow will fill the supply and demand gap created as a result of this reorganization" (president A. J. Butler of Dow Pacific). At the same time: "We will provide a long-term stable supply to meet the demand of the customers" (Butler).

Dow's pronouncement, no matter how softly it is expressed, is a written challenge to the Japanese industries, which are suffering from the caustic soda manufacturing method conversion and the structural renovation of the vinyl chloride operation.

Mitsui Group's Possible Reorganization

The necessity of concentrating vinyl chloride manufacture in the Nagoya and Izumikita plants has been talked about for a long time at Mitsui Toatsu, which is trying to approach Dow. Ethylene at the Nagoya plant is transported from Osaka Petroleum Chemicals (OPC), and is relatively expensive. In caustic soda operations, Osaka is limited to the mercury method and Nagoya is limited to the membrane method. The cost will rise if Osaka's manufacturing method is converted. Therefore, the plan to purchase EDC from Dow is credible.

However, if EDC is purchased, a large bottleneck will be created for OPC to consume ethylene, since the company does not maintain a polyethylene operation but manufactures ethylene of high specific gravity for vinyl chloride use.

There is every indication that the plan to concentrate the vinyl chloride production by the Mitsui group, such as Toa Gosei Chemical Industry, Electrochemical Industry which is semi-Mitsui group, and Kanagafuchi Chemical Industry, may have been triggered by the Dow EDC import plan. However, there has been no sign of actions by Mitsui Toatsu to influence others in this direction.

Nevertheless, Electrochemical Industry is quite volitive: "It is very risky to join hands with Dow, but the vinyl chloride enterprises of tomorrow will seek a way to obtain inexpensive raw materials. We will be very interested if Mitsui asks us to join in the scheme to institute a EDC import company" (vice president Shinohara).

Kanegafuchi Chemical Industry remains cool and is merely observing the situation. Its EDC imports from Dow were the top-ranking in Japan in terms of transactions by yen until 2 years ago, including production on consignment for Korea. It buys ethylene from OPC. It might affect OPC's ethylene consumption, but it would be geographically advantageous for this company to decide to act in concert with Mitsui Toatsu.

If Dow and Mitsui Toatsu happen to head for a consortium, participation by Electrochemical Industry and Kanegafuchi Chemical Industry remain possible. Related sources comment on the establishment of such a consortium: "It would hold a quantitative bargaining power. If only one company participated, it would be criticized to the effect that the combine (complex) structure would be destroyed."

One thing that attracts attention in connection with the caustic soda manufacturing method conversion is the Kajima complex. In this area, Vinyl Chloride Monomer (capital invested 50 percent by Shin-Etsu Chemical Industry, 25 percent by Mitsubishi Petrochemical, 10 percent by Asahi Glass, 10 percent by Kanegafuchi and 5 percent by Asahi Denka Kogyo) proudly produces vinyl chloride monomer on the largest scale in Japan, accounting for an annual production of 270,000 tons. Chlorine is supplied by Kajima Electrolysis (capital invested 25 percent by Asahi Glass, 23 percent by Shin-Etsu, 23 percent by Asahi Denka, 21 percent by Mitsubishi Petrochemical and 8 percent by Kanegafuchi).

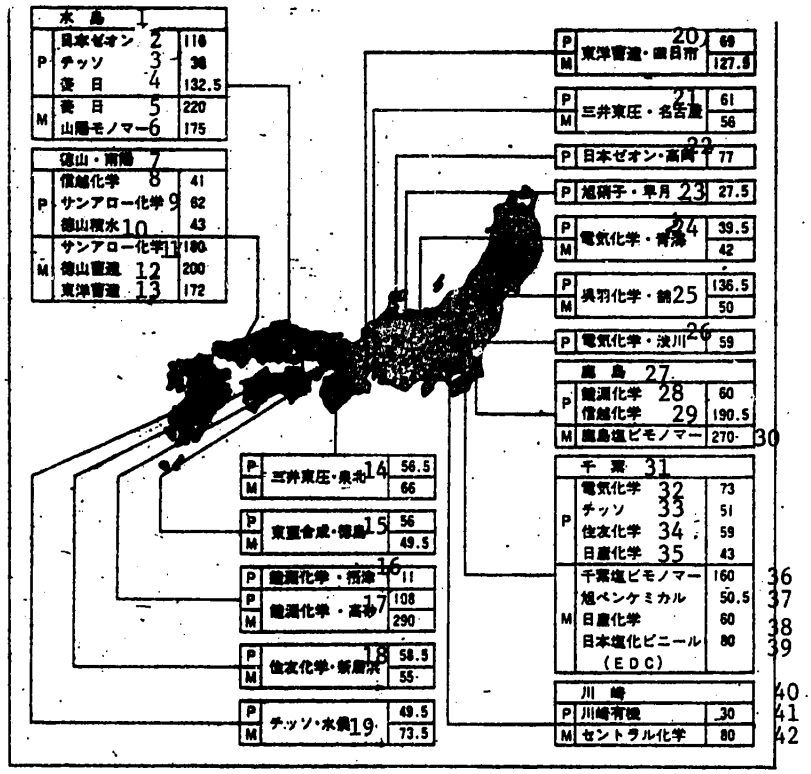
Incidentally, Kajima Electrolysis is equipped with Japan's most advanced large mercury method installation. It hasn't been converted yet at all. The burden of conversion will be enormous. If by any chance it is scrapped instead of converted, the adverse effect that will fall upon firms which totally depend on Kajima Electrolysis for chlorine, such as Asahi Denka, will be immeasurable.

With this in mind, it is very difficult for Kajima Electrolysis to make a fast move. Some calculate the possibility for the Kajima complex to serve as an import base for Dow's products judging from the geographical location. However, this is generally considered unlikely to take place in view of the presence of Asahi Glass, which has developed a new ion-exchange membrane technology.

Likewise, the position of previously described Ryobi, which has concentrated production within the Mitsubishi Chemical Industries group, is also delicate. This company supplies VCM to Japanese Geon (Takaoka) and Kanegafuchi Chemical (Takasago and Osaka). If these two companies start to show some move associated with Dow, it will affect the caustic soda manufacturing method conversion by Ryobi. The ratio of the installations of this company not converted is 42 percent.

There are more soft elements still remaining in the relationship between Dow's aggressiveness and the Japanese side, which is countering it. Nevertheless, "going against the current of the time does not work for Japan's petrochemical industry" (director Kenichi Watanabe of Showa Denko). A black ship named Dow may become the first blast pressing Japan's chemical market to open up its gates in earnest.

Figure 1. Placement of Vinyl Chloride Monomer and Vinyl Chloride Polymer Installations (production capacity 1,000 t/year)



Note: P for polyvinyl chloride, M for vinyl chloride monomer

Key:

1. Mizushima
2. Japanese Geon
3. Chisso
4. Ryobi
5. Ryobi
6. Sanyo Monomer
7. Tokuyama, Nanyo
8. Shin-Etsu Chemical
9. Sunarrow Chemical
10. Tokuyama Sekisui
11. Sunarrow Chemical
12. Tokuyama Soda
13. Toyo Soda
14. Mitsui Toatsu-Izumikita
15. Toa Gosei-Tikushima
16. Kanegafuchi Chemical-Settsu
17. Kanegafuchi Chemical-Takasago
18. Sumitomo Chemical-Niihama
19. Chisso-Mizumata
20. Toyo Soda-Yokkaichi
21. Mitsui Toatsu-Nagoya
22. Japanese Geon-Takaoka
23. Asahi Glass-Satsuki
24. Electrochemical-Ome
25. Kureha Chemical-Nishiki
26. Electrochemical-Shibukawa
27. Kajima
28. Kanegafuchi Chemical
29. Shin-Etsu Chemical
30. Kajima Vinyl Chloride Monomer
31. Chiba
32. Electrochemical
33. Chisso
34. Sumitomo Chemical
35. Nissan Kagaku
36. Chiba Vinyl Chloride Monomer
37. Asahi Penn Chemical
38. Nissan Chemical
39. Japan Vinyl Chloride (EDC)
40. Kawasaki
41. Kawasaki Yuki
42. Central Chemical

Last Moment of Complex Era

In Alberta, Canada, where Dow is planning to place a supply station for EDC and vinyl chloride monomer to be shipped to Japan, a gigantic petrochemical complex is being built. As a first-stage project, an installation that produces 540,000 tons of ethylene a year has been operating since September 1977 in the hands of local capital, Alberta Gas Ethylene.

Dow takes all of the ethylene produced and manufactures 200,000 tons of vinyl chloride monomer there. And 450,000-ton class installations are being newly constructed for EDC, soda, chlorine and EO-EG. A 3,000-km pipeline has been laid between Fort Saskatchewan, where the plant is located, and the Dow Sarnia plant in Ontario so that the remaining 180,000 tons of ethylene can be used as a raw material.

Products from this Sarnia plant will be shipped to the gulf coast on the east coast of the United States, which is truly a mecca for petrochemistry. An average 10 percent duty is applied to exports to the United States, so the cost competitiveness is not necessarily good.

The key products are derivatives which will be transported by rail from Fort Saskatchewan to Vancouver. This stretch is only half the distance to the Sarnia plant. Fort Saskatchewan has bountiful natural gas and rock salt, and electricity is also inexpensive. Products costing less than 100 yen (around 170 yen in Japan at present) per kilogram, on the basis of the ethylene price, arrive in Vancouver.

Commodity circulation bases such as EDC tanks and ships for exclusive use have been already constructed in Vancouver. Since only some 20 percent of the national demand exists on the west coast of the United States, they were certainly placed there to aim at the Southeast Asian markets. EG and the like have already arrived in Japan.

The second-stage and third-stage projects are being formulated in Alberta with the target operational date set at 1984 and 1986 respectively. The total ethylene up to the third stage will be on the 1.8-million-ton scale. As ethylene derivatives of the second-stage project, intermediate and low pressure polyethylene of Dupont, styrene monomer of Exxon or Shell and LLDPE (a third kind of polyethylene) of Dow are named as candidates.

The total Canadian ethylene and polyethylene production will be 3.5 million tons and 1.7 million tons (currently 600,000 tons) respectively in 1990, and some predict that two-thirds of the products will be exported.

Repositioning of Pacific Sphere

These positive activities in Canada are very characteristic of the future petrochemical development. In the United States, raw material costs will be 30-40 percent cheaper than in Japan and Europe due to the domestic price control over crude oil and natural gas. This price control is expected to be lifted (decontrolled) in September 1981 for crude oil and in 1985 for natural gas. After the decontrol, it is obvious that the competitiveness of American products will be lowered.

Also, in the United States, oil capital often enters into the petrochemical business. The present shares of each petrochemical product held by the oil company group in the United States are 60 percent in ethylene, slightly less than 90 percent in benzene, 60 percent in polypropylene and 40 percent in polyethylene.

These shares pertain to either refined products or primary reaction products. With fuel consumption regulation over passenger vehicles, gasoline demand is expected to drop. The oil companies are aggressively looking for a new source of profit in petrochemistry. The weight is, so to speak, shifting from conventional petro-"chemistry" to "petro"chemistry.

Adding to the forecast decline of the raw material advantage in the United States, competition between oil and chemical capital has opened an overseas rush to seek resources.

Furthermore, investment in advanced areas--Canada, Alaska and Australia--is in the limelight. These areas all belong to the Pacific sphere. The repositioning of outposts in this sphere that involves the Japanese petrochemical industry is shaping up.

Absolute Advantage of Resource Holders

In the past, the world's petrochemistry was established in Japan, the United States and Western Europe where gigantic demand existed, and was developed by each supplying its own market. The annual demand for ethylene in each area is 4.2 million tons in Japan, 13 million tons in the United States (estimated) and 12 million tons (estimated) in Western Europe.

Southeast Asia, flanked by these areas, currently shows a very small demand, 200,000 tons (estimated), although it has a potential growth capacity. Southeast Asia is relegated to being an export market of Japan, the United States and Europe. In the past, basically only the excess supply of each area was put out for export, a pattern where domestic demand had priority and the surplus was exported.

The basis for these market location type tripolar structures was that they could secure inexpensive raw materials and enjoy the benefit of large-scale investment.

However, midwifed by the two oil shocks, the absolute advantage of the resource holder revealed itself at last when 80 percent of the total cost of universal chemical products was claimed by raw material costs. Among the tripoles, the petrochemical industry of the United States is blessed with the optimal condition of having the market location as well as the resource location, and it retains outstanding competitive power.

On the other hand, the Japanese petrochemical industry's international competitiveness rapidly declined. In 1975, after the first oil shock, domestic demand dropped drastically, and the surplus, mainly the universal use resins such as polyethylene, was placed for export. In addition, imports dropped drastically (see Table 2). This happened at a time when the price of domestic products was relatively expensive, 1,000-2,000 yen per kiloliter, compared to the imported naphtha, because the price of raw material naphtha was still on the rise in 1975-76.

Table 1. Continuous Depression of Exports

(unit: 1,000 tons, %)

	1	2	3	4	5	6	7
	49年	50	51	52	53	54	55
8 ポリエチレン	384	413	355	437	424	304	218
	(19.2)	(31.9)	(25.5)	(29.8)	(23.9)	(14.1)	(14.9)
9 ポリプロピレン	100	154	116	142	161	98	48
	(12.6)	(25.9)	(17.2)	(23.3)	(21.6)	(9.6)	(6.1)
10 塩ビ樹脂	147	131	119	90	54	82	48
	(10.0)	(11.7)	(11.4)	(8.8)	(4.4)	(5.2)	(4.0)
11 塩ビモノマー	—	64	117	166	181	150	105
		(5.0)	(9.0)	(12.4)	(12.1)	(8.1)	(7.4)
12 ポリスチレン	69	69	61	88	98	90	63
	(8.1)	(5.3)	(7.0)	(9.8)	(9.4)	(7.3)	(12.3)
13 スチレンモノマー	98	73	58	40	41	16	2
	(9.5)	(8.3)	(5.3)	(3.9)	(3.6)	(1.3)	(0.2)
B T X	409	237	229	300	381	341	360
	(10.1)	(7.4)	(5.8)	(7.4)	(9.2)	(7.6)	(10.3)
E G	—	—	15"	202	224	147	71
			(28.6)	(38.6)	(35.6)	(25.8)	(16.5)

14 (注) 55年は10月までの実績値, ( ) 内は生産に対する輸出比率
15 (出所) 大蔵省「日本貿易月報」, 通産省「化学工業統計月報」から作成

Key:
1. 1974
2. 1975
3. 1976
4. 977
5. 978
6. 979
7. 1980
8. polyethylene
9. polyprolylene
10. vinyl chloride resin
11. vinyl chloride monomer
12. polystyrene
13. styrene monomer
14. (Note) Actual value gained up to October for 1980, figures in ( ) are export ratio to production.
15. (Source) Prepared from NIHON BOEKI GEPPO by the Ministry of Finance and KAGAKU KOGYO TOKEI GEPPO of the Ministry of International Trade and Industry

Table 2. Basically Increasing Imports

(unit: 1,000 tons)

	1	2	3	4	5	6	7
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8 ポリエチレン	22	1	2	2	10	13	13
E D °C	134	2	69	52	193	388	177
9 ポリスチレン	19	4	4	7	14	31	32
10 スチレンモノマー	22	0	13	13	29	64	92
11 フェノール樹脂	13	6	14	25	29	47	—
B T X	84	72	193	87	106	189	96
E G	56	0	3	7	24	57	66
12 アクリロニトリル	—	5	7	0	3	29	56
13 合成ゴム	26	15	22	25	36	53	43

(注) 55年は10月までの実績値 (出所) 大蔵省「日本貿易月報」
14 15

Key:
1. 1974
2. 1975
3. 1976
4. 1977
5. 1978
6. 1979
7. 1980
8. polyethylene
9. polystyrene
10. styrene monomer
11. phenol resin
12. acrylonitrile
13. synthetic rubber
14. (Note) Actual value gained up to October for 1980
15. (Source) NIHON BOEKI GEPPO by Ministry of Finance

In contrast, this time, the surplus cannot be turned to export. Yet, imports are increasing noticeably in the sector of bulk products. It is natural that exports dropped in 1979, when there was nothing left to export because of the stringent supply of raw material and the favorable domestic demand. However, exports did not recover even when the domestic demand fell in reaction in 1980. This is because European products were the only competitors to Japanese products in the export market encircling Southeast Asia during the previous recession, while at present overwhelmingly cost-competitive American products have made a conquest of the market. For example, some vinyl chloride resin products on the market are even cheaper than the price of Japanese ethylene.

Others Besides EDC Await an Opportunity to Flow In

The American petrochemical industry had a small exportable surplus in the past, showing an export ratio of an average 10 percent, similar to Japan. The drop in automobile production and the housing slump gave a devastating blow to this industry in the United States, which primarily caused the universal use resin business to tumble down from the second quarter of last year. The drop in demand hit bottom, but the recovery is painstakingly slow.

These stagnant business conditions are one of the factors pressuring exports. The fact that there are other factors makes the root of the trouble deeper. No new ethylene installation projects are called for after 1982 in the United States. In this respect, it can be said that no installations will be built for export purposes.

However, this is true only within the boundary of the United States. Overseas investment, which is expected to continue in the months to come, cannot be considered without constant exports. The current export aggressiveness may convey by and large an impression of presale.

"The question of EDC from Dow raised at this time will not be limited to this item. Any products carried in bulk will be built into a long-term strategy," is the frequent serious reaction (director Kenichi Watanabe of Showa Denko).

Indeed, looking at Table 2, EDC imports dropped in 1980 compared to the previous year, when the shortage of chlorine and ethylene dramatically accelerated EDC imports, but styrene monomer, EG and acrylonitrile imports showed an upward trend.

Vulnerability of Japanese Industries

If export aggressiveness in Japan and Southeast Asia intensifies, Japan, to counter this, can also scheme to obtain overseas locations for pursuit of inexpensive resources. This is a reasonable theory. However, the Japanese petrochemical industry unfortunately does not have enough real power to assume the role of an advantageous resource holder.

In Singapore, a 300,000-ton ethylene operation, polyethylene, polypropylene and EO-EG operations are expected to be initiated in the fall of 1981 under the leadership of Sumitomo Chemicals. This is not a raw material location, but an oil refinery base. It is certain that the cost competitiveness will be low. Also, the securing of markets may encounter difficulty since the project was not approved by ASEAN. In addition, the more stringent pollution control may affect the project.

Meanwhile, Saudi Petrochemical is located in a nation which has resources but which suffers from political instability. It is often considered that normal operation will meet with difficulty from the aspect of technical transfer. "If a large deficiency does not appear, we must celebrate, under this system which gives priority to national interests" (a related source). The company is relieved to be able to scale down to 500,000 tons of ethylene following a joint operation agreement with Dow.

With the example of Mitsui's failure in Iran added to the uneasiness, the purpose of opening businesses in the developing nations, although they may have resources, is fading away in the petrochemical industry. In Iran Petrochemical, there was a plan to bring EDC to Japan. The fact that Mitsui Toatsu is whetting its appetite to purchase EDC from Dow may be one of the indications that the Iran route has been virtually "given up". This assumption is further supported by the Australia Redcliff Project announced by Mitsui Toatsu with Asahi Chemical Industry.

"Economically, Canada is preferable, but Redcliff also has natural gas. It may even have oil; we cannot be absolutely sure. We might even be able to obtain the right to hold resources," is the explanation of the advancement plan (Mitsui Toatsu).

However, preceding this, there was the episode of Mitsubishi Chemical Industries and Mitsubishi Corporation implementing a feasibility study. According to the results of the study reported at that time, "money will be consumed by stagflation investment, and the natural gas will not even last 10 years." The fact that Dow was hesitant to start a feasibility study and lost the option may have been due to such circumstances.

On the other hand, Mitsubishi Chemical Industries acquired the right to implement a feasibility study at Prudhoe Bay in Alaska "by following the trail of the Dow-Shell group."

However, the problem there is the ownership of natural gas. The assurance given by the state government for the location was the supply of natural gas held by the state. But the state owns only one-eighth of the entire Prudhoe Bay natural gas, and so it "can be worth only a 100,000-ton ethylene installation" (Mitsubishi Chemical Industries director Hiroshi Watanabe).

Dow is currently negotiating for the remaining seven-eighths of the natural gas with Exxon, which owns it. In any case, the vote of Mitsubishi Chemical Industries which has the right to hold resources is not significant.

Another example of a joint venture is five companies--Mitsubishi Chemical Industries, Mitsubishi Petrochemical, Mitsubishi Corporation, American Occidental Petroleum and Canadian Dome Petroleum--which have agreed to promote a petrochemical complex project that will produce 300,000 tons of ethylene, 100,000-150,000 tons of high pressure polyethylene and 300,000 tons of EDC in British Columbia, Canada.

"We would like to handle this as carefully as we are handling the possibilities in Alaska" (Watanabe, Mitsubishi Chemical Industries).

Are More Coming To Approach Japan?

As described above, Japan's petrochemical industry is vulnerable in light of the fact that it does not have the advantage of being a resource holder. At the same time, Japan's petrochemical industry has not acquired a global market, and cannot graduate from the practice which grew up during the days of the Japan-U.S.-Europe tripolar structure.

The overseas sales ratio of American petrochemical firms has reached a high level, for instance 50 percent for Dow, 40 percent for UCC and 30 percent for Dupont, whereas Japan's Mitsubishi Chemical Industries, Mitsui Toatsu, Showa Denko and Sumitomo Chemical all maintain only a 10 percent level.

As seen in Saudi Arabia and Singapore, Japanese petrochemical companies acquired capital power in the form of a consortium when they advanced overseas, and they often supplemented information networks and selling power by the participation of trading companies. Even with this preparation, the Japanese firms made good only in the Japanese market or the limited Southeast Asian market. If production activity is started in an oil-producing nation without a solid new market, the products can be sold only in the existing market.

Overseas locations are associated with the problem of delivery of goods. American teams can easily take the defenseless naked Asian market and are familiar with the ins and outs of the West European market, but they can get snarled up in the Japanese market. But if only there is a pilot, they can come in any time.

Americans will not play a power game by setting up a domestic or foreign joint concern or a consortium to sweep Japanese industries off their feet, but will devise a way to envelop Japan for a landing.

Japan's market is immense and has further potential growth compared to the American and European markets. It is possible to consume the inflow to an extent. Nevertheless, the high growth rate of an annual 20 percent increase that Japan once enjoyed is now beyond her dream. "The market is large, but not enough for a living for ourselves and the incomers" (Watanabe, Mitsubishi Chemical Industries).

The American goods offensive led primarily by bulk products is, however, inevitable. Now we have plunged into the time when the Japanese petrochemical industries must set up an operational strategy in proportion to this attack. And on the other hand, we must carefully avoid any policies tinged with protectionism such as an import narrier that will impede a rational conversion.

Collapsing Complex Structure

From the starting point of the Japanese petrochemical industry in the decade from 1955 to 1965, it was necessary to establish a production system that used naphtha as a starting raw material and collectively utilized propylene fraction, butane-butylene fraction and cracked residues which were produced in connection with ethylene. Large-scale operations were sought to gain the economies of scale and comprehensive operations to utilize each fraction efficiently.

To each complex, new industrialization of polypropylene and acrylonitrile and acetoaldehide manufacturing method conversions were implemented in the latter half of the decade. In addition, electrolysis equipment, ammonia and methanol were also incorporated into each petrochemical complex.

The cost reduction achieved by these large-scale, comprehensive operations increased the demand for products to be used for automobiles, home appliances and synthetic fabrics and created a demand for products used as paper and iron substitutes. A happy cycle appeared when these expanded demands made larger scale operations possible, recreating the increase in demand encouraged by the further cost reduction.

Since the first oil shock, however, the faults in the complex structure have been revealed by the integral effects of the unbalanced moves in demand. A further blow from an increase in foreign imports such as EDC could wipe out the balance of the integrated effective utilization of various continuously produced fractions that serve as the main pillar of the complex structure.

Inevitable Reorganization

The 500,000 tons of EDC imports that Dow is talking about far surpass the production of a single complex. The largest EDC installation in Japan is Tokuyama Doda's 200,000-ton scale operation. Even adding the 180,000 tons of vinyl chloride monomer produced by Sunarrow, which ranks parallel with the Idemitsu Petrochemical and Tokuyama Complex, the total production is slightly over 400,000 tons in terms of EDC.

And 400,000 tons of EDC is equivalent to 280,000 tons of chlorine and 120,000 tons of ethylene; this amounts to a large part of the complex. This is true of acrylonitrile and EG. Even if the ethylene supply is greatly depleted, the products manufactured in connection with ethylene such as olefins may be still needed, which creates a large imbalance.

Japan's petrochemistry must rely on foreign raw materials for crude, naphtha or intermediate raw materials. If naphtha which is customarily imported is replaced by an intermediate raw material which is obtained lower on the production line than naphtha, materials in the stream above this point will become unwanted.

The industry is pressed to cope with this from both sides--which product should be produced in order to be the most rational (horizontal), which stage of the production system should the Japanese petrochemical industry choose to start production (vertical).

In Japan, where users are very critical of product quality, the inflow of monomers as intermediate raw materials may be acceptable, but polymer imports will not be readily received in the market. However, in the field of LLDPE, where competition for technological development has intensified, rivalry for a share of the market is in evidence, including foreign technologies such as those of UCC and Dow. In Alberta, ventures by Asahi Chemical Industry with Dow technology or by Asahi Dow, a subsidiary shared 50-50 by the two companies, are being considered. Also, Nitto Chemical Industry supplies acrylonitrile to the parent company, Mitsubishi Rayon, but Mitsubishi Rayon, in a move going beyond the business affiliation, is substituting inexpensive imports for part of the supplies.

President Hisashi Kurokawa of Mitsubishi Petrochemical says: "The second-stage project of Kajima cannot be a copy of the first stage." If this statement is applied to existing complexes, a reorganization and reconstruction of the complexes are perhaps inevitable.

Intensified Dow Tactics to Grab World Market Shares

Among the world chemical industries, Dow Chemical is well known as a firm which has most aggressively enforced multinational development. The weapon it uses for this development is not particularly special.

Dow's approach clings to a very simple and crude theory that calls for the mass production of universal goods at a bottom low cost and the expansion of markets.

The main strength is the world's largest and most competitive chlorine products, specifically, vinyl chloride, styrene, and polyethylene. Furthermore, Dow's business practice dictates that it not get its hands into polypropylene at all, although it is a universal resin, and that it deal only with EDC and monomers, but not with polymers even among vinyl chlorides. To maintain competitive strength, Dow's conventional practice calls for locations advantageous from the aspects of raw material, energy and cost, and pursuit of an all-out scale of mass production.

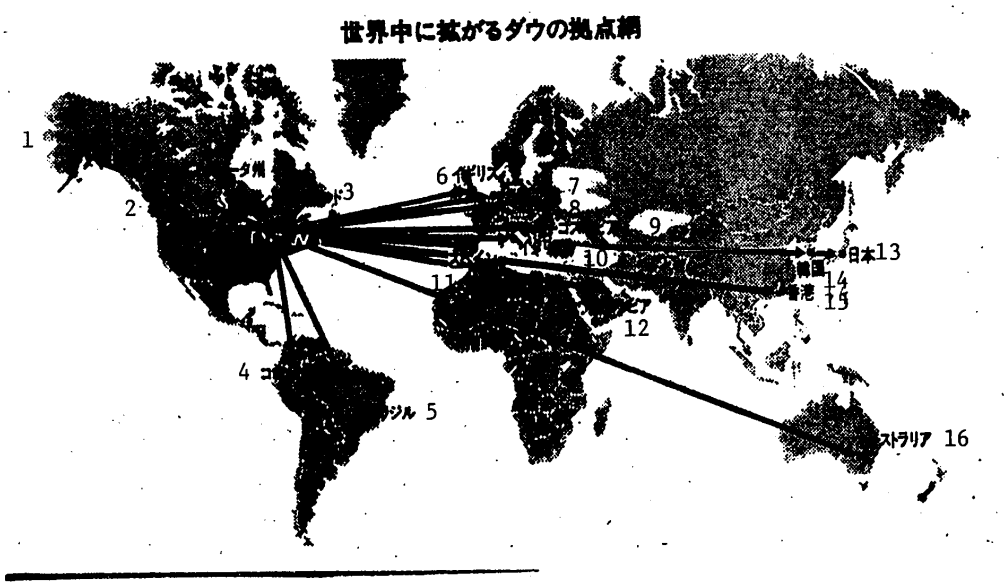
In Pursuit of Natural Gas

After the first oil shock, Dow sought plant locations advantageous in resources, on one hand, and extended its areas beyond the traditional European and American cultural sphere, on the other hand, with outstanding developments in Asia, the Pacific and Central and South America, especially in unison with the rise of the moderately developed nations.

After the oil shocks, the world chemical industry entered into an era in which a serious question arose regarding whether petrochemistry is downstream of the oil industry or still in the genre of the chemical industry. In reality, the large equipment investment for petrochemistry in the latter half of the seventies was overwhelmingly made by the major oil companies or crude oil holders such as the oil-producing nations, rather than by the purely chemical firms. In the midst of this trend, Dow intensified its move toward upstream by attempting to counter the major oil companies. It made a series of offensives--resource exploration in Canada together with Dome Petroleum, expansion of the service business of the dowel [phonetic] sector to the oil industries, holding of lignite deposits in Texas, and a crude oil refinery installation (180,000 barrels a day) in Oyster Creek, Texas. It also holds coal mining areas in Australia.

This company is self-supporting in 80 percent of the electricity it uses, and holds more than 10 percent of the natural gas it uses from its origin. However, these strategies are powerless against the oil majors, which formulated a scheme for control of the well spring of resources. It can be said that they are merely measures to maintain bargaining power.

Figure 2. Worldwide Network of Dow Bases



Key:

1. Alaska
2. Alberta, Canada
3. Midland, Michigan
4. Colombia
5. Brazil
6. England
7. Holland
8. Germany
9. Yugoslavia
10. Italy
11. Spain
12. Saudi Arabia
13. Japan
14. Korea
15. Hong Kong
16. Australia

A truly discreet approach is to bring a large plant to an area where inexpensive and plentiful resources are available.

This idea was embodied by the ventures into Alberta, in Canada, the Alaska project, the Redcliff project in Australia, the Saudi project and the project to advance into northern England and directly connect to the North Sea oilfields (liquefied natural gas). It also still has a project for advancing into developing nations with resources, such as Indonesia.

Of them all, the Alberta project was the first to be completed. In Canada, there is also the Sarnia plant, which was the company's first venture into a foreign country in 1946 and was built in a province adjacent to Michigan (where the main office of Dow is located, in Midland). This is the largest chemical plant in Canada, and it produces vinyl chloride, styrene and polyethylene.

The large-scale operation of the recently built Fort Saskatchewan plant in Alberta will make a pair with the Sarnia plant through pipelines.

The province of Alberta has shown interest in promoting second- and third-stage projects similar to the petrochemical enterprise to be completed in 1983 and 1986 respectively. It is said that Dow has already demonstrated a desire to get involved in the second-stage project.

To Australia, Saudi Arabia and the North Sea

In addition, in Alaska, where somewhat of a boom has been evident in recent years, Dow went into business at the head of a large consortium and acquired rights to conduct a feasibility study of Prudhoe Bay on the Arctic coast. This consortium is made up of eight companies, including two key companies of the Dow-Shell combine, Asahi Dow, Mitsubishi Chemical Industries and Dupont, etc. According to the project, a pipeline will be installed vertically across Alaska from Prudhoe Bay to the Kenai Peninsula on the south coast. A gas separation plant, a 450,000-ton ethylene plant, a 200,000-300,000-ton class polyethylene plant and a 250,000-ton EG plant will be constructed by 1985. The total investment reportedly will exceed $3 billion ($1.4 billion for the pipeline alone). This will be connected to Alberta and the American mainland eventually by pipeline, according to the blueprint.

On the other hand, an oil refinery plant in Oyster Creek, Texas in the southern United States was completed last spring. It is not only scheduled to supply naphtha to an ethylene plant (540,000 tons) which consumes 200,000 barrels a day and is newly built in Louisiana, but also to establish a raw material fuel self-supporting system for factories scattered in the gulf area. Meanwhile, the company is trying to establish a self-supporting system by holding lignite for electric generation in Texas.

The pursuit of resources has not been confined to North America. Although Dow's option in the Australian Redcliff project was revoked by the local state government last October due to a long delay in the project, since the latter half of the seventies, the project "will never be abandoned. We definitely want to go ahead with it," says Dow. (vice president Lundeen).

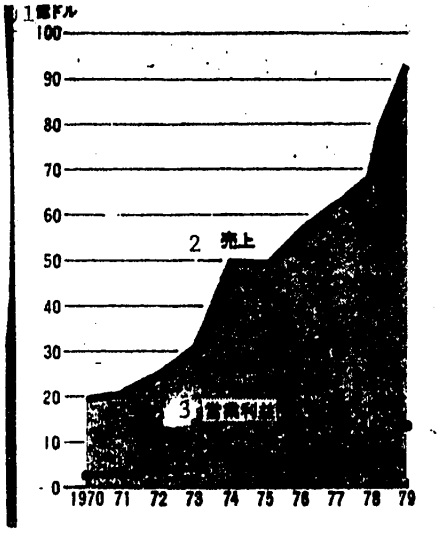


Figure 3. Steady Expansion in the Seventies

Key:
1. 100 million dollars
2. sales
3. operational profit

Also, the Saudi project was recently pushed forward by a joint venture with Mitsubishi. This finally set the course to begin serious investment in Saudi Arabia. Although the details have not yet been specified, it will certainly

be decided to reduce the scale of the derivative products that the two companies take delivery of, in addition to 500,000 tons of ethylene and 500,000 tons of EG they must share. Furthermore, the policy of the Saudi Government seems to stick to the principle of setting 30 percent of the total investment value as capital, of funding 60 percent by means of a 3 percent interest rate loan from the Saudi Government, and of procuring 10 percent through the market. In the $2 billion Mobil project in Yanbu, Mobil and SABIC (Saudi Basic Industry Corporation) provides $300 million each, the government loaned $1.2 billion, and the market loan was $200 million. In the $3 billion Shell project, Shell's investment share was allowed to be only $400 million. Dow and Mitsubishi appear to be investing dollars based upon these shares in investment.

Based on this principle, 15 percent or less may be Dow's share, which makes it quite a low investment. For the Dow company, which is unusually highly dependent on loans among American firms, this project has considerable advantage considering the present high interest rates. Informed circles agree that Dow is panting to obtain Saudi crude oil, since it is forecast that securing crude oil for the refinery in Texas will encounter some difficulty. They say the original purpose of Dow's advance into Saudi Arabia was oil.

Likewise, the eighties' greatest theme of resource pursuit activities is the move to obtain gas in the North Sea. Dow has announced a petrochemical project in Firth, Cromarty, in northern Scotland. It plans to build a gas separation facility and ethylene complex based upon a pipeline to be installed across land from a pipeline which has already been laid in St Fergas (slightly to the south) on the British mainland. The pipeline will be installed by 1984-85, a 400,000-600,000-ton ethylene installation will be completed by 1986, and the ethane gas surplus will be supplied to Dow plants on the European Continent. However, ICI, BP Chemical and Shell Chemical, which constitute the major English chemical concerns, are showing strong opposition.

Sheer Snatching Tactics in Low Market Growth

Meanwhile, Korea, Japan, Hong Kong, Brazil, Yugoslavia and Spain, which tend to have growing markets, are almost virgin soil for Dow. Maneuvers to take some part of the market in these areas which have a high growth potential have been especially noticeable since the latter half of the seventies. In the Yosu complex, in Korea, a 240,000-ton soda plant, a 280,000-ton EDC plant and a 100,000-ton high pressure polyethylene plant were built and began operation in 1980. This complex, however, appears to be a big failure and is suffering from a low rate of operation, directly affected by the drastic slowdown in the Korean economy.

Meanwhile, Dow disclosed the intention to start a 360,000-ton soda (720,000 tons in the second stage) and electrolysis base petrochemical chlorine complex around 1975. It looked for locations for a while, but in the end, as announced by vice president Lundeen at this time, it appears that Dow settled on a policy of snatching a share of the Japanese market through product imports rather than building plants. This can be interpreted as meaning that it does not make much sense to get involved in production in Japan, where raw materials, energy (especially electricity) and cost are most expensive.

Figure 4. Increasing Multinational Flavor, Toward Downstream

(Unit: million dollars, %)

			75	76	77	78	79
1 地域別比率	2 売上合計		4,889	5,652	6,234	6,888	9,255
	3 アメリカ		55.7	54.4	55.5	52.9	49.5
	4 欧州・アフリカ		26.0	26.6	26.0	26.3	28.8
	5 カナダ		6.6	6.5	6.4	6.4	6.8
	6 太平洋		3.7	4.8	4.4	5.9	6.8
	7 ラテンアメリカ		4.6	4.1	4.4	4.9	5.1
	8 ブラジル		3.3	3.5	3.1	3.6	3.0
9 部門別収益	化学製品・金属製品	10 売13上	,747	3,048	3,333	3,535	4,786
		営業利益14	694	622	603	543	578
	プラスチック・包装資材	11 売15上	1,429	1,891	2,146	2,479	3,458
		営業利益16	301	392	373	414	693
	生化学製品・消費財	12 売17上	712	713	755	874	1,011
		営業利益18	82	82	44	94	63

Key:

1. Ratio by areas
2. Total sales
3. America
4. Europe, Africa
5. Canada
6. Pacific area
7. Latin America
8. Brazil
9. Revenues by sector
10. Chemical products, metal products
11. Plastics, packing materials
12. Biochemical products, consumer goods
13. Sales
14. Operational profit
15. Sales
16. Operational profit
17. Sales
18. Operational profit

Other than Korea, the relatively large plants built are a polystyrene plant of 70,000 tons a year in Hong Kong, and a plant of 15,000-ton scale in Thailand. As soon as the Hong Kong plant was completed in 1978, the exports to Hong Kong by the affiliated Asahi Dow (50-50 investment by Dow and Asahi Chemical Industry) showed a drastic decline.

On the other hand, in Latin America, the Aratsu [phonetic] complex in Brazil was completed with the investment of $200 million, and in conjunction with this, Dow Brazil was separated from Dow Latin America to become an independent firm. Aratsu produces PG, PO, soda and chlorine group products, and is Dow's largest plant in Central and South America.

Worthy of mention is the petrochemical business in Yugoslavia. This turned into a West-East joint operation which is the largest in Eastern Europe. A complex for ethylene cracking and production of vinyl chloride, polyethylene and styrene on Krk island will be completed in 1982-83. Already in 1978, a polystyrene plant in Zagreb started operation. The investment on Krk island will come to a total of $700 million. Recently, Dow opened a resident office in Peking, and it is reported that Dow has concluded a long-term blanket agreement with the Republic of China.

At any rate, Dow has steadily pursued resources and expanded markets with an insatiable appetite, but various sources point out that Dow's traditional business practice was about to encounter a sharp turn in the road. This was necessary due to the worldwide slackening of the growth rate of universal chemical products, the shrinking of areas available for market expansion, and the frequent labeling of petrochemicals as downstream products of the oil industry.

To combat these trends, Dow itself has decided to expand and replenish the bio-chemical field: it is rumored that it will expand into the gene engineering field and it will also purchase Richardson Merril, a large pharmaceutical company (it might very well end up in a joint concern or it might be a simple license purchase). Also, various projects such as special resin, hollow fiber and coal liquefaction are being brought to light one after another. A popular direction from commodity chemical to speciality has begun to be pursued even in a firm like Dow.

Still, it is questionable whether or not Dow, which has conducted business on the basis of mass production and mass sales, can successfully change its habits. Rather, it is more likely that the company will reinforce its accustomed business practice of expanding its shares in generally stagnant markets using traditional products and approaches. In this sense, it seems correct to accept first vice president Lundeen's usual press interview in Japan as an announcement that Dow is serious about grabbing a share of the Japanese market.

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FIRMS PLANNING TO WORK WITH BIOTECHNOLOGY SURVEYED

Tokyo NIKKEI SANGYO SHIMBUN in Japanese 13 Jul 81 pp 10-11

[Text] Biotechnology is being used for pharmaceuticals, chemicals, and food products. Even trading companies and machinery manufacturers are getting seriously involved in biotechnology. According to a poll conducted by the Nihon Keizai Shimbunsha, 95 companies, 72 percent of the 132 companies responding, were found to have specific business plans for biotechnology. It has been called the last technological revolution of this century. Industry has begun to put real effort into research and development for this indispensable and potent technology in order to create future business vitality. There are many different target dates for commercialization. Some companies expect to make use of the technology in 1 or 2 years; some have long-range targets of more than 10 years. This shows that biotechnology has already passed the "fever" stage and has been incorporated into business strategy.

Commercialization for 47 Percent of Companies in 2 to 5 Years; Sights First Set on Pharmaceuticals

Biotechnology will first be applied commercially to pharmaceuticals, next it will spread to chemicals and food products, and in the future it will move to the larger fields of energy and agriculture. This is roughly the commercialization strategy of the companies planning to work with biotechnology.

The 95 companies (86 manufacturers and 9 trading companies) which have business plans for biotechnology are aiming at quite different fields. Almost half--44 percent--are planning to apply it to pharmaceuticals, 23 percent to chemicals and food products, and 10 percent to energy. Also, many manufacturers gave specific names of products, such as interferon (virus propagation prevention gene), antibiotic substances, and amino acids. From this we see that biotechnology is becoming firmly entrenched in the field of pharmaceuticals. Specialized manufacturers such as Takeda Chemical Industries Ltd have always been involved, but companies in different businesses such as Suntory, Toray Industries, Mitsui Petrochemical, and Calpis Food Industry Company can be seen entering the field. The new technology is being used as a takeoff point for ventures into pharmaceutical and chemical products.

Pharmaceuticals are the initial target because their high added value and growth potential make this a perfect market for commercialization of the new technology.

In the period of low growth, the pharmaceutical industry maintained a growth of close to 10 percent and secured a high rate of profit. With this in view, companies seeking to diversify find that "there is no business more attractive" (Suntory).

The target date for commercialization is 2 to 5 years from now for 47 percent of the companies. However, there are many businesses, like Showa Denko's amino acid manufacturing, which are already in operation. Also, there are many "reserve forces" ready for commercialization. Takeshi Tsuchikata, president of Sumitomo Chemical Industries, says: "We have roughly decided on pharmaceuticals, agrichemicals, and petrochemicals. Now we have to narrow our sights."

When it comes to energy and agriculture, commercialization will occur later than in other fields. For example, Idemitsu Kosan will "require at least 10 years" to produce chemical products using gene recombination. Morinaga Confectionery "would like to improve seeds by cell fusion, but it will take 5 to 6 years to accomplish this." In agriculture, it is necessary to manipulate higher forms of life such as plants. In the field of energy, the price competition between crude oil and synthetic fuels is an important issue.

The practical application of biotechnology will lead to the expansion of peripheral markets such as machinery and plant construction. The large shipbuilders such as Mitsui Shipbuilding and Engineering and Hitachi Shipbuilding and Engineering have announced their intention to "undertake construction of chemical plants using biotechnology." In addition, major companies that specialize in planning such as Chiyoda Chemical Engineering and Construction and Sumitomo Chemical Engineering are competing for orders for facilities to prevent biohazards in testing facilities. Also, general trading companies are watching the situation carefully. Mitsui and Co Ltd is actively working to effect a tie-up between U.S. business ventures and Japanese industries. Marubeni, Ito Chu, and Tomen also have ambitions: "We want to get involved in pharmaceuticals and industry."

In technology, expectations center on the following processes in the order given: gene recombination, fixed fermentation, semisynthesis using fermentation, cell fusion, and large-scale cultivation of cells. Gene recombination technology is considered to be a central part of biotechnology. Many companies "are in the process of learning" about it (Takeda Chemical Industries Ltd, Fujisawa Pharmaceutical Co Ltd, Ajo no Moto Co Inc, and Meiji Confectionery Co Ltd) and are working hard to secure the necessary technology. Some concrete results can be expected in 1 or 2 years.

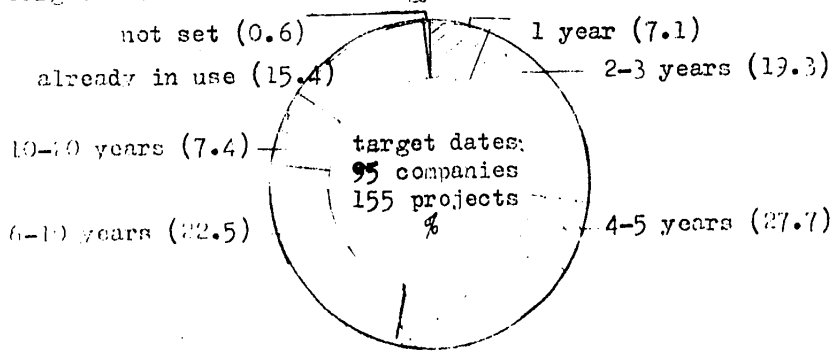
It is generally felt, however, that cell fusion has more practical value than gene recombination in the near future--for example, for use in diagnostic drugs. There is also strong interest in applications for improvement of agricultural products, not just pharmaceuticals and diagnostic medicines. The fixed fermentation process is being applied to the production of amino acids and fats and oils and to research and development of synfuel alcohol. Companies which have gotten results with these technologies such as Tanabe Seiyaku, Miyoshi Oil and Fat, and Kansai Paint are relying on biotechnology for manufacturing.

Culture tank for production of interferon (Central Research Laboratory of the Green Cross Corporation)

Target Fields of Commercialization for Biotechnology

pharmaceuticals	chemicals food products	energy	miscellaneous
44 %	23 %	10 %	23 %

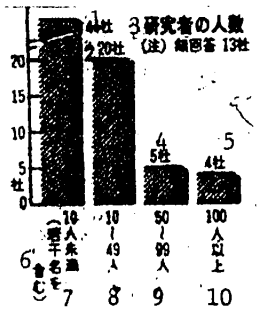
Target Dates for Biotechnology Commercialization



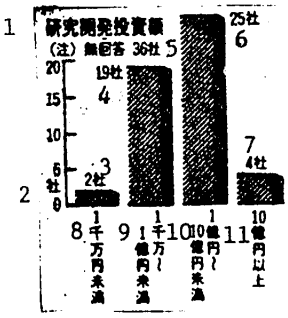
Research: Trying To Catch Up With the United States and Europe in Quantity and Quality; Positive Approach to Business Tie-ups

Of the 80 companies undertaking or planning to undertake business related to biotechnology, 62 companies already have a related research department. Seventeen companies do not have a special research organ but are beginning to conduct research. Pharmaceutical manufacturers which specialize in organic chemicals and even ordinary chemical manufacturers have already set up bioscience research centers. For example, Mitsubishi Chemical Industries established such a research organ as a separate company 10 years ago, in 1971. The research capability of such companies is rapidly taking shape.

But looking at the overall situation, there are many companies which are not yet equipped to handle this new technology. Also, 44 of the companies, more than half, responded that they have less than 10 researchers (including the "several" category). Then there were 20 companies which had from 10 to 49 research personnel. Only 9 companies had 50 or more. Biotechnology is said to require "a human wave of geniuses." Considering that a U.S. genetic engineering venture, Genentech, has 60 researchers with doctor's degrees, it cannot be denied that we are behind the United States and Europe in both quantity and quality.



Key:
1. 44 companies
2. 20 companies
3. Number of Researchers (note: 13 companies did not respond)
4. 5 companies
5. 4 companies
6. (including "several persons")
7. 10 or less
8. 10-49
9. 50-99
10. 100 or more



Key:
1. Research and Development Investment (note: 36 companies did not respond)
2. companies
3. 2 companies
4. 19 companies
5. 36 companies
6. 25 companies
7. 4 companies
8. less than 10 million yen
9. 10 million yen to 100 million yen
10. 100 million yen to 1 billion yen
11. more than 1 billion yen

The main problem is getting the personnel (researchers). Of 86 companies, 32 are attempting to get the needed personnel by hiring people in midcareer. This is an unusual practice in the Japanese employment system. This shows how much high-quality researchers are needed for biotechnology and how desperate many companies are for personnel.

Because of this situation, all of the companies are diligently working to train people quickly. Looking at the methods of personnel training (composite answers), 53 companies said that they rely on in-house training. However, even more companies (59) send their people to educational institutions within Japan, while 32 companies send their people to overseas educational institutions. Aji no Moto prides itself on being the world leader in fermentation technology. However, according to the president, Katsuhiro Utada: "We are continually sending our personnel as students to educational institutions such as Stanford and MIT in the United States and Tokyo University and Kyoto University in Japan and we are careful not to have the relationships cut off."

With respect to research and development investment, four companies are spending more than 1 billion yen annually: Mitsubishi Chemical Industries (2 to 3 billion yen), Sumitomo Chemical Industries (several billion yen), Aji no Moto (approximately 2 billion yen), and Ringen (approximately 1 billion yen). The largest group, 25 companies, spend between 100 million yen and 1 billion yen. Compared to the generosity of Dupont, which gave 6 million dollars to Harvard University for biotechnology research, Japanese companies still have a long way to go. However, we can see that in research investment as well as in personnel education, they are quickly building up their capability.

There are also many companies eager to make tie-ups with other companies for research and development and personnel training. The poll showed that 40 companies have already made tie-ups or are in the process of doing so. Several tie-ups have been made with U.S. business ventures such as Mitsui Toatsu Chemicals and the Green Cross Corporation with Gennex. Most observers believe that there will be an increasing number of companies who use tie-ups with other companies to secure new technology more quickly at the stage where their own accumulated technology has reached a high level and their development goals are clear.

One aspect of biotechnology is its use in diversification, for example the development of medical products or fertilizer additives by a petrochemical manufacturer. Many of the people involved declare: "In commercializing, one cannot avoid tie-ups."

Method of Poll

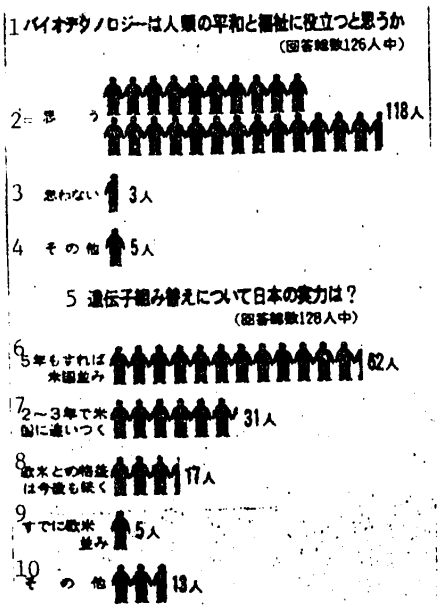
A questionnaire was sent to 200 important companies involved in the field of biotechnology such as chemical and food companies. Replies were received from 132 companies by the end of June, and the results were analyzed. Together with questions on the companies' business plans and research organizations, the opinions of research and development supervisors were surveyed.

Of the companies which responded, 85 companies submitted the main points of their answers in the form of a chart. The following companies did not submit because of format limitations or the desire not to reveal heretofore unpublished information:

Nippon Oils and Fats, Fujisawa Pharmaceutical, Wakamoto Pharmaceutical, Kaken Chemical, Santen Pharmaceutical, Amano Pharmaceutical, Ishihara Sangyo, Nippon Noyaku, Tokuyama Soda, Mitsubishi Gas Chemical, Shinetsu Chemical Industry, Nippon Synthetic Chemical Industry, Nippon Synthetic Rubber, Nippon Sanso, Hoya Glass, Sakai Chemical Industry, Chiba Butajien Industry, Nitta Gelatine, Jomo Nenshi, Honshu Paper, Kanzaki Paper Manufacturing, Japan Tobacco and Salt Public Corporation, Mitsui Norin, Nitto Seifun, Toyo Sugar Refining, Kyodo Shiryo, Fuji Seiyu, Yoshihara Oil Mill, Prima Meat Packers, Ito Ham Provisions, Hayashikane Sangyo, S B Food Products, Okura Shuzo, Chlorella Industries, Kawasaki Heavy Industries, Tsukishima Kikai, Nikkiso, Mitsubishi Electric, Mitsubishi Corp, Mitsui and Co, C. Itoh, Marubeni, Sumitomo Shoji, Nissho-Iwai, Tomen, Kanematsu-Gosho, and Nichimen.

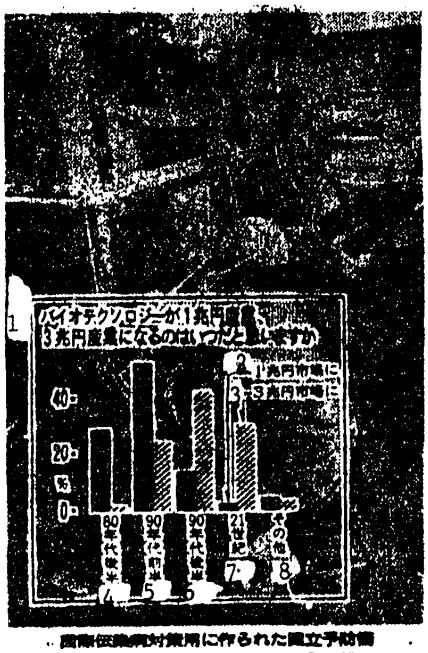
We surveyed the opinions of executives in charge of biotechnology and department managers of 132 companies which have a strong relationship with biotechnology. They believe that this is a promising technology with great importance for the next generation. They have confidence in the possibilities of commercialization and are dealing with it rationally. We compiled the replies as follows: 94 percent believe

that biotechnology will contribute to the happiness of mankind. Four out of five believe that the level of Japanese technology will be up with the United States within 5 years. However, more than half believe that "administrative restrictions" and "citizen's movements" will create obstacles to the commercialization of biotechnology and many said that the recent boom in biotechnology is building up excessive expectations.



Key:

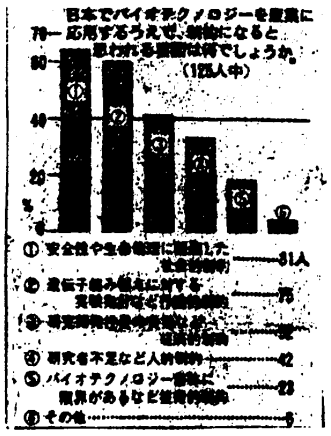
1. Do you think that biotechnology will contribute to the happiness of mankind? (126 total respondents)
2. Yes
3. No
4. Other answer
5. What is the Japanese capability in gene recombination? (128 total respondents)
6. Will be equal to the United States in 5 years
7. Will catch up with the United States in 2 or 3 years
8. Gap between Japan and the United States and Europe likely to continue
9. Already equal to the United States and Europe
10. Other answer



国際伝染病対策用に作られた国立予防衛生研究所の高度安全実験施設（P 4級）

National Preventive Hygiene Laboratory High-Safety Test Facility Made for International Communicable Disease Program

1. When do you think that biotechnology will become a 1-trillion-yen industry? A 3-trillion-yen industry?
2. 1 trillion yen market
3. 3 trillion yen market
4. late 1980's
5. early 1990's
6. late 1990's
7. 21st century
8. other answer



What do you think will restrict the application of biotechnology to industry in Japan? (125 respondents)

(1)	social restrictions related to safety and life ethics	81
(2)	administrative restrictions such as testing guidelines for gene recombination	75
(3)	economic restrictions such as the burden of research and development costs	52
(4)	personnel restrictions such as a lack of researchers	42
(5)	technological restrictions such as intrinsic limitations in biotechnology itself	23
(6)	other answer	6

Market: Majority Believe It Will Grow to 1 Trillion Yen in 10 Years; Gene Recombination Technology to Catch Up with the United States in 5 years; Opinion Poll of Related Executives and Department Managers

First, opinions emphasizing the importance of the world to be opened by biotechnology were evident. "To put it strongly, we are approaching one of the greatest turning points since the beginning of mankind" (development department manager of a trading company). "It is an effective means for solving the food shortage of the 21st century" (development department deputy manager of a major sugar refiner). "After electronics, it is the second most revolutionary technology since the war. I believe it is a means of solving the world's fuel and food shortages" (director and production technology group general manager of a major fermentation company).

What size worldwide market will be formed by biotechnology and at what time? In the survey, we asked when the market would reach 1 trillion yen and 3 trillion yen. A majority (52 percent) responded that a 1-trillion-yen market would be created by the early 1990's. In other words, the respondents believe a 1-trillion-yen market is possible in about 10 years. The largest number of respondents, 42 percent, thought that the market would expand to 3 trillion yen by the late 1990's. However, 30 percent thought that it would take until after the beginning of the 21st century. So there was quite a divergence of opinion on the pace of market expansion.

Some observers in the United States say that there will be a 6-trillion-yen market in the 1990's. Compared to this, the estimates of Japanese companies are very conservative. In the United States, this technology is expected to expand to agricultural fields, such as seeds, and to energy. In Japan, developments are expected to concentrate on pharmaceuticals and chemicals. Perhaps this difference in approach is reflected in the estimates of market size.

Next, we asked what percentage of chemical processes using high temperature, high pressure, and large equipment will change to energy-saving processes at ordinary temperatures and pressures. The overwhelming response was less than 10 percent in the next 10 years. Fifty-three percent of the respondents said 10 to 30 percent in 20 years. Narrowing it down to only those respondents involved in chemical industries, we found that 64 percent replied 10 to 30 percent in 20 years. This means

that in the first part of the 21st century chemical industries are expected to show a great change because of biotechnology. We can see a readiness for the change.

However, opinions like the following were also heard. "The reaction of living organisms is slow and catalysts for fermentation are unreliable. It will be difficult to use them in the manufacture of petroleum products in the near future" (technological research department manager of a chemical manufacturer). "Biotechnology will soon have a central role in a technological revolution in medicine. But its application to chemical industries will be limited for some time" (director and research and development manager of a major chemical company).

What is the capability of Japanese technology in the field of biotechnology? We asked the individuals involved how they would rate this level for one of the newest technologies, gene recombination. Only 4 percent replied that "Japan has already caught up with the United States," 24 percent said that we would be "equal with the United States in 2 or 3 years," and 48 percent or almost half of the respondents believed that we would "catch up in 5 years."

As was the case with semiconductors, we have been told by many observers in the United States and Europe that Japan will soon catch up in gene engineering. Most of the relevant personnel of these Japanese companies also believe that "this will happen in 5 years." This shows that Japan is rapidly gaining confidence in this field. Already some people are saying: "Biotechnology fits Japanese culture. It is possible that Japan will soon be the world leader in this field" (pharmaceutical planning department member of a major liquor company).

On the other hand, 13 percent of the respondents said that "the gap between Japan and the United States will continue for some time." Also, there are many requests for improved capability. "Unfortunately, the talented people in this field are going overseas. We need positive action by the government and financial sector such as economic assistance, improvement of facilities, and relaxation of regulations" (development office director of a seed manufacturer). "If we are to expand the fields of application for fermentation technology, which is very advantageous for Japan, more effort must be put into basic and peripheral technology" (director and research and development division manager of a chemical product manufacturer).

Although companies which are not involved in biotechnology say that it has "great merit," it is clear that they are hesitating. This technology is based on basic research in a broad range of scientific fields including biology, agriculture, medicine, biochemistry, chemistry, and biophysics, so haste is not in order. Another problem is the rather large research and development cost required. The products must be narrowed down to those with high added value. All companies, including those not yet actively involved, have very high expectations of biotechnology.

An Issue: Wariness of Emotional Reaction; Viewpoint of "Life Ethics" Cannot Be Ignored

Many respondents said that "social restrictions related to safety and life ethics" and "administrative restrictions such as testing guidelines for gene recombination" are important problems in promoting business in this field. Three out of five

respondents consider that these two things are obstacles. On the other hand, those who picked "economic restrictions such as the burden of research and development investment" and "the difficulty of securing human resources such as researchers" did not constitute a majority. In short, the results showed that even though the companies are highly motivated, they are afraid that citizens' movements and overly stringent government regulations will shackle positive progress.

On the other hand, there were many who consider that safety measures should have priority. "Measures should be taken by the government to prevent those who have not received training from lightly indulging in experiments" (research and development planning department deputy manager of a major textile manufacturer). "This field involves certain dangers, just as does nuclear energy, and sufficient consideration should be given to respect for human life" (technology promotion department supervisor of fat and oil company). In addition, admonitions against racing ahead recklessly stood out. "For example, cloning technology is a field where the ethical view of scientists becomes very important" (director of applied development laboratory of beer company). "Even in Japan, the people are likely to be critical of this type of research. We should remember that the commercialization of this technology is possible only if it is socially accepted" (deputy director of research laboratory of food products manufacturer).

Companies which cannot decide whether to enter this field or not gave the following sorts of opinions. "Pharmaceuticals and increased food production are fields where microorganisms and plants can be used. However, it is not permissible, for ethical reasons, to fool around with animal genes. The very study of cloning of animals or human beings should be forbidden" (central laboratory director of chemical manufacturer).

"Even if new products are useful for particular human purposes, might they not destroy the balance of the natural world?" (deputy director of research and development office of oil refining company). It is interesting that there were many respondents in industry who consider that because biotechnology is a very promising and revolutionary technology, commercialization should be carried out circumspectly.

There were only 3 respondents out of 126 who answered "no" to the question "Will biotechnology contribute to the happiness of mankind?", while 118 respondents answered "yes".

However, of those who answered "yes", there were only a few who were as unconditionally positive as in this opinion: "Biotechnology has technological limits. There is no danger of repetitive self-propagation of monsters" (director of central research laboratory survey and planning office of a food products manufacturer). Most respondents wanted to apply conditions even though they believed that biotechnology could contribute to the happiness of mankind. "Whether it can be useful or not is a problem for human beings." "A necessary condition is the establishment of a social ethic under which only research which aims at increased human happiness is allowed" (life science research laboratory director of major fat and oil company).

To summarize, biotechnology is still a young area of science and technology. It should be evaluated rationally and cultivated with understanding. For this purpose, proper guidance and measures for cultivation by the government are indispensable. Also, it will not do for the general populace to have excessive expectations derived from science fiction or to protest on the basis of emotion alone. The problem is what specific actions will be taken by industry to create the proper environment for progress.

	Business Plans Related to Biotechnology			Research Capability	
Company Name	Business Field	Technology Used	Time Needed for Commercialization	Name of Research Organ	No. of researchers
-- Pharmaceuticals					
Takeda Pharmaceutical Industries	pharmaceuticals	cell fusion, gene recombination and other arrangement	5-8 years	Biotechnology Laboratory, Fermentation Products Lab	30
Sankyo Co	pharmaceuticals	cell fusion, gene recombination	10 years	Fermentation Laboratory	several
Shionogi & Co	pharmaceuticals plant and animal medicines, clinical diagnostic medicines	gene recombination fixed enzyme fermentation, cell fusion	7-8 years	--	several
Tanabe Seiyaku	amino acids, organic acids	fixed microorganism method	already applied	Applied Bioscience Lab, Microorganism Laboratory	--
Eisai Co	physiological active substances	gene recombination cell cultivation	10 years	Bioscience Group	several
Yamanouchi Pharmaceutical	pharmaceuticals	semisynthesis using fermentation cell fusion	5 years	Cell Physiology Laboratory	--
Banyu Pharmaceutical	antibiotics	gene recombination cell fusion	--	R&D Group Office	several
Yoshitomi Pharmaceutical	pharmaceuticals	gene recombination	5-6 years	Central Laboratory	several
Mochida Pharmaceutical	interferon diagnostic test chemicals	cell cultivation cell fusion	unknown 2-3 years	--	several
Otsuka Pharmaceutical	interferon	cell fusion	5 years	Cell Technology Research Dept	approx 30
Tokyo Tanabe Co	pharmaceuticals	fixed fermentation	3-4 years	Natural Substance Lab	several
Riken Vitamin	food products	fermentation	1-2 years	--	--
-- Chemicals					
Mitsubishi Chemical Industry	pharmaceuticals chemicals food products diagnostic test chemicals	gene recombination semisynthesis using fermentation fixed fermentation cell fusion	5-10 yrs " already applied in 1981	Bioscience Lab, Biochemistry Lab, Technology Laboratory	several tens

Training and Employment Plans	R&D Expenses (1981 Plan)	Fermentation and Biology-Related Business Already Underway
in-house training, overseas education, new graduate employment, midcareer employment	--	pharmaceuticals, amino acids, nucleic acids
in-house training, new graduate employment	--	pharmaceuticals, yeast fermentation
in-house training, outside education in Japan and overseas, new graduate employment, midcareer employment	approx 100 million yen	pharmaceuticals
in-house training	--	amino acids, organic acids
in-house training, outside education in Japan	small amount	pharmaceuticals, animal medicines, food product ingredients
in-house training, overseas education, midcareer employment	--	antibiotics
in-house training, outside education in Japan	--	pharmaceuticals
outside training in Japan and overseas, new graduate and midcareer employment	--	pharmaceuticals
" " "	--	enzymes, hormones
new graduate and midcareer employment	approx 400 million yen	--
in-house training, outside education in Japan, new graduate employment	--	enzyme manufacturing agents for medical use
--	--	--
in-house training, outside education in Japan and overseas, new graduate employment, midcareer employment	2-3 billion yen	steroids, diagnostic test chemicals, isomerized sugar, soybean milk

(table continued)

Sumitomo Chemical	pharmaceuticals interferon chemical products	gene recombination cell cultivation bioreactor	7 years 5 years 10 years	Bioscience Lab Pharmaceutical Div Research Dept
Showa Denko	amino acids	gene recombination	2-3 years	Bioscience Lab
Mitsubishi Petrochemical	pharmaceuticals, agrichemicals, diagnostic test chemical products	gene recombination, cell fusion, cell cultivation, fermentation	4-10 years	Central Research Lab, Mitsubishi Petrochemical Pharmaceutical Laboratory
Mitsui Petrochemical Industries	physiologically active substances	fermentation, cell fusion, tissue cultivation	2-3 years	Comprehensive Research Laboratory
Kanegafuchi Chemical Industry	intermediate pharmaceuticals, pharmaceuticals	semisynthesis using fermentation, gene recombination	already applied 2-3 years	Bioscience Laboratory
Seitetsu Kagaku	pharmaceuticals and intermediates	synthesis using fermentation	3-4 years	Research Dept Bioscience Group
Toyo Soda	sweeteners pharmaceuticals enzyme analysis equipment	fermentation gene combination --	2-3 years 5-10 years 2-3 years	Planning Lab
Nippon Soda	pharmaceuticals chemicals	gene recombination and fermentation " " 	5-6 years 8-10 years	Bioscience Lab
Asahi Denka	food products chemical products	fixed fermentation semisynthesis using fermentation	3-4 years 5-6 years	Food Products and Oils and Fats Development Laboratory
Chisso	pharmaceutical components	fermentation	5-6 years	Development Office, Yokohama Branch
Nihon Shokubai Kagaku Kogyo	chemical products	gene recombination	10 years	Central Research Lab
Sekisui Kaseihin Kogyo	use of unused resources	semisynthesis using fermentation	5-7 years	--
Asahi Glass	field being selected	--	--	R&D Dept
Nippon Paint	pharmaceuticals chemical substances	cell cultivation gene recombination and cell culture	5 years	Technology Center
Kansai Paint	chemical products	fixed fermantation bacterial method	4-5 years	Technology Group
Dainippon Ink and Chemicals	food products chemical products	cell fusion	5-6 years	Bioscience Division

several tens	in-house training, outside training in Japan and overseas, employment of new graduates and midcareer employment	several billion yen	--
several	in-house training, outside education in Japan, employment upon graduation and in midcareer	--	amino acids, etc
--	in-house training, outside education in Japan and overseas, employment upon graduation and in midcareer	--	heat resistant enzymes
approx 10	" "	approx 200 million yen	--
approx 100	outside education in Japan and overseas, employment upon graduation and in midcareer	--	bread mold, glutathione
several	outside education in Japan, employment of new graduates	20 million yen	--
approx 30	in-house training, outside education in Japan, employment upon graduation and in midcareer	300-400 million yen	--
several	outside education in Japan and overseas, new graduate employment	--	urokinaze (pharmaceutical)
several	in-house training, new graduate employment	50 million yen	--
approx 10	in-house training, employment upon graduation or in midcareer	50 million yen	--
several	outside education in Japan, employment in midcareer	--	--
--	--	--	--
several	--	--	drainage water treatment process
several	new graduate employment	10 million yen	--
several	--	--	--
several	in-house training, outside education in Japan, new graduate employment	approx 100 million yen	microbial protein

Kyowa Hakko Kogyo	pharmaceuticals amino acids special antibodies, enzymes alcohol	gene recombination gene recombination cell fusion and large-scale cultivation fixed bacterial method	5-6 years	Tokyo Lab, Technology Laboratory
Nippon Kayaku	pharmaceuticals chemical products	gene recombination and cell fusion gene recombination and fixed fermentation	5-6 years 10 years	Pharmaceutical Div Pharmaceutical Lab, Agrichemical Div Jomo Lab, Technological Development Dept Takasaki Lab
Kumiai Chemical	cell wall dissolving enzyme	--	--	Bioscience Lab
Hokko Chemi-Industry	antibiotics	gene recombination	5-10 years	--
Kao Soap	food products chemicals	gene recombination fixed fermentation	5-6 years "	Bioscience Lab
Lion Fat and Oil	biomass development plant breeding oil and fat manufacturing enzymes for medical use	fixed fermentation gene recombination cell fusion, etc gene recombination	10 years 3-4 years 3-4 years 4-5 years	Bioscience Lab
Miyoshi Oil and Fat	lipid synthesis	fixed fermentation	3-4 years	Manufacturing Group
Sanyo Chemical Industry	chemical products	fixed fermentation	5-6 years	Planning and Development Group, Planning Dept
Shin Nippon Rika	chemical products	fermentation, fermentation using enzymes	6-7 years	--
Sun Star Dentrifrice	interferon antibiotics	cell cultivation cell fusion	5-7 years 7-10 years	Bioscience Lab

-- Textiles, Paper and Pulp

Asahi Chemical Industry	urokinaze	tissue cultivation	5-6 years	Technology Lab, Research Section of Food and Pharmaceutical Plants
Toray	interferon various amino acids	gene recombination technology applying enzymes	a few years	Basic Research Laboratory

approx 40	in-house training, outside education in Japan and overseas, employment upon graduation and in midcareer	700-800 million yen	pharmaceuticals, alcohol and fuel, amino acids, enzymes, etc
several	outside education in Japan, employment of new graduates	30 million yen	pharmaceuticals, amino acids
several	--	--	agrichemicals
--	--	--	agrichemicals
40	in-house training, outside education in Japan and overseas, employment of new graduates	500 million yen	production of surface-active agents
approx 100	in-house training, outside education in Japan and overseas, employment of new graduates and people in midcareer	900 million yen	soap containing enzymes
several	in-house training, employment of new graduates	20 million yen	fat and oil analysis
several	in-house training, outside education in Japan, employment of new graduates and people in midcareer		
--	--	--	--
approx 15	overseas education, employment of new graduates	250 million yen	--

--	outside education in Japan and overseas, employment of new graduates	--	sodium glutamate, pharmaceutical ingredients
--	in-house training, overseas education, employment of new graduates and people in midcareer	--	pharmaceuticals, amino acids

Teijin	pharmaceuticals chemicals	gene recombination, fermentation and tissue cultivation	5-6 years 8-10 years	Biomedical Lab Central Laboratory Basic Research Dept
Kanegafuchi Spinning	pharmaceuticals pharmaceuticals	cell fusion and cell cultivation fixed enzyme fermentation	5-6 years 7-8 years	Pharmaceutical Research Laboratory
Unitika	pharmaceuticals chemicals	fixed enzyme fermentation --	4-5 years --	Central Research Lab, No 3 Lab
Kuraray	pharmaceuticals chemical products agricultural and livestock products	gene recombination fermentation gene recombination	5-6 years 3-4 years 10 years	Central Research Laboratory, No 3 Lab
Mitsubishi Rayon	alcohol	fixed enzyme fermentation	1-3 years	Central Research Laboratory, No 8 Research Group
Nitto Boseki	pharmaceuticals limited enzymes	fixed enzume fermentation --	10 years --	Development Laboratory
Kohjin	pharmaceuticals chemicals	gene recombination semisynthesis using fermentation	5-6 years 2-3 years	Saeki Plant Research Dept
Oji Paper	timber breeding	protoplast separa- tion and cultiva- tion technology, cell fusion	5-6 years	Timber Breeding Laboratory
Sanyo Kokusaku Pulp	--	tissue cultivation, fixed enzyme fermentation	4-5 years	Iwakuni Research Lab, Etsu Branch, Fermentation Group
Jujo Paper	pharmaceuticals food products	semisynthesis	--	Central Research Lab, Chemical Products Group

-- Food Products

Kirin Brewery	new yeast breed- ing technology new barley breed- ing technology	cell fusion, gene recombination gene recombination cell cultivation	10 years 10 years	Comprehensive Research Laboratory
Suntory	physiologically active peptides food products	gene recombination fixed enzyme fermentation	10 years	Biomedical Laboratory, Central Research Lab

--	in-house training, outside education in Japan, employment of new graduates	--	--
approx 10	" "	40 million yen	pharmaceuticals
approx 20	in-house training, outside education in Japan and overseas, employment of new graduates and people in midcareer	300-400 million yen	--
several	outside education in Japan and overseas, employment of new graduates and people in midcareer	100-200 million yen	drainage water treatment with microorganisms
4	in-house training	30 million yen	--
several	in-house training, outside education in Japan, employment of new graduates	50 million yen	amino acid synthesis, enzyme fixing
approx 20	outside education in Japan, employment of new graduates	approx. 100 million yen	yeast, enzymes
10	outside education in Japan, employment of new graduates and people in midcareer	50 million yen	forestry
several	in-house training, outside education in Japan, employment of new graduates	50 million yen	protein yeast, ribonucleic acid
several	in-house training, employment of new graduates	--	yeast, nucleic acids

several	in-house training, outside education in Japan, employment of new graduates and people in midcareer	several tens of millions of yen	beer brewing, plant and microorganism enzyme production, malt production
approx 50	in-house training, outside education in Japan and overseas, employment of new graduates and people in midcareer	--	liquors, food products, pharmaceuticals

Sapporo Breweries	food products (yeast, etc) seeds pharmaceuticals	cell fusion tissue cultivation gene recombination	8-12 years 10-15 yrs 10-15 yrs	Central Lab, Applied Development Lab, Raw Material Testing Lab
Asahi Breweries	food products pharmaceuticals agricultural and livestock products	gene recombination enzyme fermentation cell fusion	3 years 3 years	Central Research Lab
Toyo Jozo	--	--	--	Bioscience Lab
Sanraku Ocean	alcohol amino acids antibiotics	fixed yeast fermentation gene recombination cell fusion	5-6 years 5-6 years 5-10 years	Central Research Lab
Godo Shusei	ethyl alcohol biomass conversion	fixed enzyme fermentation production of high-performance bacteria	3-4 years 5-6 years	Central Research Lab
Aji no Moto	amino acids "	gene recombination fixed enzyme fermentation	3-5 years 2-3 years	Central Research Lab, Bioscience Lab
Kikkoman	physiologically active substances	semisynthesis using fermentation	3-5 years	Central Research Lab, Noda Industrial Science Lab (Foundation)
Chukin Vinegar	vinegar mfg	gene recombination, fixed fermentation	5-6 years	Chukin Bioscience Lab
Snow Brand Milk Products	dairy products food products pharmaceuticals	fixed enzyme fermentation use of new enzymes, microorganisms semisynthesis using zymotic microorganisms	already applied 1-2 years 3-4 years	Technology Research Lab Bioscience Sec.
Meiji Milk Products	food products pharmaceuticals	gene recombination	10 years	Bioscience Lab
Yakult	pharmaceuticals food products	gene recombination "	5-10 years "	Central Research Lab
Calpis Food Industry	antibiotics antineoplastics	semisynthesis using fermentation cell ufsion	5-10 years "	Tokyo Research Laboratory, Basic Research Sec.

approx 50	in-house training, outside education in Japan, employment of new graduates and people in midcareer	20 million yen	alcoholic beverages
20	in-house training, outside education in Japan and overseas, employment of new graduates	--	beer, malt, yeast
approx 30	in-house training, outside education in Japan and overseas, employment of new graduates	--	alcoholic beverages, pharmaceuticals, food products
60	in-house training, outside training in Japan and overseas	400 million yen	
approx 20	in-house training, outside education in Japan, employment of new graduates and people in midcareer	approx 100 million yen	drinking alcohol, enzymes, alcoholic beverages
approx 150	in-house training, outside education in Japan and overseas, employment of new graduates	approx 2 billion yen	amino acids, nucleic acids, yeast, pharmaceuticals
approx 40	in-house training, outside education in Japan and overseas, employment of new graduates and people in midcareer	approx 800 million yen	soy sauce, alcoholic beverages, food products, alcohol
several	in-house training, outside education in Japan and overseas	50 million yen	vinegar manufacture
approx 50	in-house training, outside education in Japan and overseas, employment of new graduates	500-700 million yen	cheese, lactobacilli, fermented milk drink, pharmaceuticals
several	in-house training, outside education in Japan	undetermined	fermented food products
approx 20	outside education in Japan, employment of new graduates and people in midcareer	--	fermented milk drink, fermentation agents, lactobacillus agents
	in-house training, outside education in Japan	--	fermented food and beverages, plant and animal food products

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Meiji Seika	antibiotics enzymes physiologically active peptides	gene recombination cell fusion fixed bacteria method, enzyme fermentation	1-2 years " "	Central Research Lab, Pharmaceutical Development Research Lab, Fermentation Technology Lab Pharmaceutical Development Sec.
Morinaga Confectionery	pharmaceuticals food products chemicals seeds	gene recombination " " cell fusion	5-6 years " " "	Bioscience Lab
Meito Sangyo	synthesized products (yeast)	fermentation	already applied	Fermentation Development Dept, Synthesis Development Dept
Mitsui Sugar	food products made by combination and conversion of disaccharides	fixed enzyme fermentation	within 3 years	R&D Dept
Taito	food products	semisynthesis using fermentation	several years	--
Hokkaido Sugar	food products (beet sugar, maltose)	--	--	Fermentation Plant Research Section
Nippon Shokuhin Kako	sugars (pharmaceuticals, food products) dextrine(")	fixed enzyme fermentation	--	Research Lab
Ringen	interferon dextrine chemicals active substances inside organisms	cell fusion fixed enzyme fermentation microorganisms	2 years already applied "	Ringen K.K. Technology Dept Ringen Bioscience Lab
Oriental Yeast Industry	breading of yeast molecules, biochemistry test chemicals, automatic analysis equipment	cell fusion, etc fixed enzyme fermentation "	2-3 years already applied 1 year	Research Lab, Enzyme Development Center, Biology Lab
Takii Seeds	improved vegetables, flowers	cell fusion	already applied	Basic Research Laboratory

-- Other Manufacturing Industries

Idemitsu Kosan	biomass energy chemical products	cell fusion, etc gene recombination	5-10 years more than 10 years	Central Research Lab, new dept

--	in-house training, outside education in Japan and overseas, employment of new graduates	--	pharmaceuticals, foodstuffs, agri-chemicals, veterinary medicines, enzymes
approx 30	outside education in Japan, employment of new graduates people in midcareer	approx 200 million yen	alcohol
approx 30	in-house training, outside training in Japan, employment of new graduates	approx 200 million yen	enzymes such as rennet, dextran
several	in-house training	--	sucrose manufacturing
several	outside education in Japan	small amount	natural pigments
6	in-house training, outside education in Japan, employment of new graduates	40 million yen	melibiaze, maltose production enzymes
--	in-house training, outside education in Japan, employment of new graduates	--	sugar syrup, dextrose for use in pharma-ceuticals
approx 120	outside education in Japan, employment of new graduates	approx 1	maltose and pururan for use in pharmaceuticals, grape sugar for use in food, sweeteners
several	in-house training, outside education in Japan, employment of new graduates and people in midcareer	--	bread yeast, steri-lizing livestock feed, SPF (specific pathogene free) animal breeding
several	in-house training, outside education in Japan and overseas, employment of new grads	15 million yen	improvement and sale of seeds
several	outside education in Japan and overseas, employment of new graduates and people in midcareer	100 billion yen	--

Nippon Oil	alcohol for use as fuel pharmaceuticals	fixed microorganisms fermentation by variant roots	within 10 years 3-4 years	Central Research Lab
Hitachi Shipbuilding and Engineering	chemical production equipment	bioreactor	5-6 years	Technology Research Lab, Chemical Research Section
Mitsui Shipbuilding and Engineering	pollution prevention artificial protein	high-density continuous fermentation --	in 1981 --	Bioscience Laboratory
Japan Gasoline	synfuels	fixed microorganism method	2-5 years	Technology Research Lab
Chiyoda Chemical Engineering and Construction	biohazard prevention equipment	--	already applied	--
Toyo Engineering	cellulose plants	enzyme reaction	undetermined	Technology Laboratory Process Lab
Sumitomo Chemical Engineering	biohazard prevention equipment	--	--	Technology Dept
Matsushita Electric Industrial	methane production equipment biosensor	biomass conversion technology fixed enzyme fermentation	1-2 years 4-5 years	Energy Conversion Laboratory, Matsushita Battery Industry Lab
Fuji Electric	biohazard prevention facilities	--	already applied	--

several	in-house training, outside education in Japan, employment of new graduates	approx 200 million yen	--
	employment of new graduates and people in midcareer	--	equipment for sludge treatment
several	in-house training, employment of people in midcareer	several tens of millions of yen	active sludge method, alcohol fermentation
several	in-house training, employment of people in midcareer	100 million yen	all types of related plants
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several	outside education in Japan and overseas, employment of new graduates and people in midcareer	approx 100 million yen	fermented alcohol plants
several	outside education in Japan and overseas, employment of new graduates	10 million yen	--
several	in-house training, employment of new graduates and people in midcareer	several hundred million yen	biomass conversion energy
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