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Japan Report

(FOUO 24/82)

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POLITICAL AND SOCIOLOGICAL

SUZUKI'S REELECTION PREDICTED BY KOZAWA

Tokyo THE JAPAN ECONOMIC JOURNAL in English 30 Mar 82 p 10

[Political Scene column by Harubumi Kozawa: "Suzuki's Reelection Is Certain, But..."]

[Text]

In the midst of lingering recession and mounting trade frictions with the U.S. and Europe, there is a growing belief among ruling Liberal Democratic Party politicians that Prime Minister Zenko Suzuki will certainly be reelected to the party presidency (and the premiership) in the coming November election.

Political observers attributed Suzuki's nearly ensured reelection to the facts that: (1) the Suzuki Cabinet has managed to have assured the passage of the fiscal 1982 government budget before the fiscal year starts on April 1, after rejecting the opposition's demand for tax reduction, the biggest controversy in the current Diet session; (2) that the U.S. and European pressures on Japan over trade friction issues will not directly affect the fate of the Suzuki Cabinet; and (3) that even if the Second Ad Hoc Committee on Administrative Reforms comes up with drastic recommendations on the reorganization of the Japanese National Railways and others, it will be in the next ordinary Diet session slated after Suzuki's reelection that bills to realize such recommendations are proposed.

All opposition parties have demanded that the Government cut taxes, but they have been unable to gain any concrete concessions from the Suzuki Cabinet on the matter. Secondly, major bills that the Government and the LDP are trying to pass through the current Diet session are only the 1982 budget and the revision of the Public Office Election Law designed to change the national constituency system of the House of Councillors. But Suzuki's aides and LDP officials have recently said that they will "not stick to the previous stance" to pass the revised Public Office Election Law through the Diet session this time. Thus, if the 1982 government budget is assured of its passage, there is no prospect for any political turmoil during the present Diet session.

Under these circumstances, the biggest headache for Prime Minister Suzuki is trade friction for the time being. But since the current Diet session is to end before the Paris summit talks of the industrialized countries slated in early June, there is no prospect of worry for Suzuki that his administration will be grilled over trade friction issues by the opposition in the Diet session.

The most worrisome issue for Suzuki, in this regard, is the liberalization of Japan's market for farm and dairy products, including beef. But Suzuki's aides are rather optimistic over the issue, saying that "we can solve the matter by resorting to subsidies to farmers, if all other attempts have failed."

As for economic management, Suzuki has been rather indecisive as to whether he should follow budget and administrative reforms or reflationary measures. But recently, Suzuki has somewhat gradually changed his stance from emphasis on fiscal reconstruction to the reflationary policy side when he insinuated that there might be a tax reduction after fiscal 1983. In other words, Suzuki has adopted the stance proposed by Toshio Komoto, director general of the Economic Planning Agency, who is expected to

run against Suzuki in the coming LDP presidential election. This change of stance could be said to be one of Suzuki's moves to pave the way to his reelection.

A prevailing view within the LDP is that there will surely be simultaneous elections for both Houses of the Diet next year and if the LDP wins both elections, Suzuki will be able to maintain his power, but will "step down, if lost." If one assumes this scenario, in the event Prime Minister Suzuki can no longer dodge taking some decisive actions on administrative reforms, he can dissolve the Diet and pick the issue of the Japanese National Railways, which is under sharp attack for its bankrupt management, using it as an election issue which will enable Suzuki to rally support of the Liberal Democratic Party rather easily.

Thus, the implementation of administrative reform after his reelection is a critical test for the survival of the Suzuki Administration.

(Harubumi Kozawa is a Nihon Keizai deputy political editor.)

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POLITICAL AND SOCIOLOGICAL

CONFRONTATION BETWEEN KOMEITO, SOKA GAKKAI SEEN

Tokyo MAINICHI DAILY NEWS in English 25 Mar 82 p 2

[Nagatacho Doings column by Takehiko Takahashi: "Subtle Confrontation Between Komeito, Soka Gakkai"]

[Text]

The Komeito is a political party supported by the Soka Gakkai. The first time that the Soka Gakkai advanced into the National Diet was in 1931 when three of its members were elected to the House of Councillors.

In November 1936 a political organization called Koemi Seiji Renmei (Clean Politics Federation) was formed. After 15 seats were won in the House of Councillors election in 1937, an intra-Diet group called Komeikai was set up.

A political party called the Komeito was formally established in May 1939. The purpose was to advance into the House of Representatives. In the 1942 general election, five Komeito members were elected.

Following a sweeping advance, the Komeito stumbled in the dual elections for the House of Representatives and the House of Councillors in 1980 and it now has 33 seats in the House of Representatives and 26 in the House of Councillors. As the second largest opposition party, next to the Japan Socialist Party, the Komeito possesses a strong voice in the political world.

At the time when it first advanced into the Diet, the Komeito carried out movements aimed at "purifying the political world." In this respect the Komeito's recent attitude has begun to raise some questions. This is because newspaper and magazine reports of political movements have been taking up "the relationship between the Komeito and former Prime Minister Kakuei Tanaka" with increasing frequency.

Dissatisfaction

This recent attitude of the Komeito is arousing dissatisfaction in the Soka Gakkai also. A meeting of Soka Gakkai youths in the Shibuya district was held on March 14. At a gathering held afterward by members of the officer class, voices of dissatisfaction were heard about the Komeito being seen as having relations with Tanaka.

"We desire that the Komeito Diet members act by returning to the starting point" was one statement that was heard. The atmosphere was that the Komeito Diet members will be asked to do so more positively in the future.

Voices within the Soka Gakkai critical of the Komeito are heard in local districts also. Among local assemblymen in the Fukuoka district, there are some who are saying that in next year's local elections, they will secede from the Komeito and run as Soka Gakkai candidates.

The Komeito executives are undoubtedly aware of this atmosphere. Nevertheless, the relations between Komeito Chairman Yoshikatsu Takeiri and former Prime Minister Tanaka seem to be quite close. Because of obligation for "various assistance in the past," it seems that the Komeito is unable to change its attitude toward Tanaka.

Honorary President Daisuke Ikeda continues to wield considerable influence over Soka Gakkai even now. It is said that when mention is made of Soka Gakkai executives, the only name spoken by Soka Gakkai members is "Ikeda."

Ikeda is well aware of the dissatisfaction that the members have concerning the Komeito and, if possible, he would like to have someone else replace Komeito Chairman Takeiri.

Under Ikeda?

But if Honorary President Ikeda were to mention this openly, it would run counter to the principle of "separation of politics and religion." He cannot do that. On the other hand, in the case of the Komeito, Chairman Takeiri is the only one who can resist Ikeda to any extent. The Komeito members fear that if Takeiri is replaced, Ikeda's control over the Komeito would become absolute.

The Komeito is concerned about its rumored relationship with former Prime Minister Tanaka. At the present time, if Tanaka is judged guilty in connection with the Lockheed scandal, Komeito would like to sever its relations with Tanaka and again launch criticism of "money politics."

Until then, because of various circumstances, the Komeito can only go along as it has been doing.

Right now, the question is what should be done in case Diet member Takayuki Sato is found guilty in the Lockheed trial. The problem involved Sato's "resignation from the Diet." The Komeito executives are of the opinion that "Sato will voluntarily give up his Diet seat." They are not thinking of standing in the forefront to take action.

Such an attitude on the part of the Komeito is also causing a problem concerning the political choice to be made by middle-of-the-road parties.

The solidarity of the centrist parties is likely to come, if ever, only after judgment is handed down on Tanaka.

(The writer is an adviser to the Mainichi Newspapers and former chief editorial writer).

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POLITICAL AND SOCIOLOGICAL

KOMOTO FACTOR IN ELECTIONS EXAMINED

Tokyo THE DAILY YOMIURI in English 26 Mar 82 p 3

[Political Beat column by Kenji Kitahara: "The Komoto Factor"]

[Text]

With the passage of the fiscal 1982 budget by the House of Representatives, the domestic scene has become calm but there are tremors being carefully watched within the Liberal-Democratic Party (LDP).

Prime Minister Suzuki and members of the LDP mainstream are now paying close attention to Toshio Komoto, director-general of the Economic Planning Agency (EPA).

They are eager to determine whether he will continue to remain passive or take positive action politically. Whatever he does, this will have an influence on the political situation.

Along with Yasuhiro Nakasone, director-general of the Administrative Management Agency, Komoto is a leading candidate for the LDP presidency.

Former premier Kakuei Tanaka points out that Nakasone cannot escape from the task of administrative reform. Therefore, Nakasone is linked unwillingly to Suzuki.

Unlike Nakasone, Komoto is free to do what he wishes. And it must be noted that at 71, the coming LDP presidential election scheduled for November is regarded as Komoto's last chance.

Some political observers believe that Komoto may resign from the cabinet around June in order to prepare himself for election campaigning and maneuvering.

Komoto already has made considerable efforts to expand his influence within the LDP.

He has bonds with Ichiro Nakagawa, director-general of the Science and Technology Agency, and International Trade and Industry Minister Shintaro Abe, both of whom are considered "new leaders" within the party. Also, he is strengthening ties with former premier Takeo Fukuda, former foreign minister Sunao Sonoda, who belongs to an independent faction, and Ikko Kasuga, permanent adviser to the Democratic-Socialist Party (DSP).

In the area of policy, he draws a clear line of demarcation between himself and Suzuki by strongly insisting upon positive fiscal and economic management.

All this considered, Suzuki and his supporters see Komoto rather than Nakasone as the strongest rival to the premier's bid for reelection.

But there are some obstacles and as yet unresolved factors which cause problems for Komoto in his challenging Suzuki.

If there is no preliminary LDP election and only Diet members have votes, there is little chance for Komoto to win the election.

It seems now that the court's verdict on Tanaka in the Lockheed payoff trials is unlikely to be delivered this year. Therefore, the LDP will escape the feared turbulence internally in a presidential election year.

Without strong plus factors, will the very rational and cool Komoto take such a step as to resign from the cabinet and run against Suzuki?

Komoto is reported in good health and unconcerned about his age and above all is not an impatient man.

It is possible that Komoto may decide that next and not this year is the time to make his move when the Tanaka verdict may very well cause a crisis in the LDP.

But in considering what the political developments might be in the near future, we cannot ignore Komoto.

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POLITICAL AND SOCIOLOGICAL

EDITORIAL ON WEINBERGER'S PROPOSAL

Tokyo ASAHI EVENING NEWS in English 30 Mar 82 p 7

[Editorial: "Weinberger's Proposals"]

[Text]

In his speech at the Japan National Press Club on March 26 and at the regular meeting of top U.S. and Japan defense officials on March 27, U.S. Secretary of Defense Caspar W. Weinberger asked Japan rapidly to develop the ability to defend 1,000 nautical miles of sea-lanes. In the regular defense officials meeting, he even proposed that measures for the defense of the sea-lanes should be studied in the working-level talks on defense in Hawaii this summer.

Concerning the sea-lane problem, there are still differences in the way the authorities in the U.S. and Japan view the matter. The statements that Weinberger has made since coming to Japan have expressed, as if it were only natural, the American interpretation of the allocation of defense roles between the U.S. and Japan, about which there is a great deal of disquiet within Japan. In the case of defending the sea-lanes, there is strong domestic opposition, and no consensus.

The plan to defend 1,000 nautical miles of sea-lanes was first broached when the Prime Minister visited the U.S. in May 1981. In the joint statement, it was said that Japan would make greater efforts for the defense of the sea and airspace around Japan. But Suzuki went beyond the "surrounding seas" and proposed the figure of 1,000 nautical miles. Now the U.S. has gone a step further and is trying to make Japan assume an even greater role than the Japanese envisaged.

But an important policy concerning the defense of the sea-lanes, which could mean a reinterpretation of the U.S.-Japan Security Treaty, should not be presented as a promise to the U.S. without being officially discussed by the National Defense Council.

The 1,000 nautical mile plan was originally proposed by the uniformed members of the Defense Agency, but defending 1,000 nautical miles of sea-lanes is a very difficult task even for the U.S. Navy. Some people say that the Self-Defense Forces cannot possibly undertake the task.

One cannot help fearing that the defense of the sea-lanes, which is anyway an impossible task, will be used by the U.S. as a lever in demanding that Japan increase its defense budget by more than it increases the budgets for other things.

The second problem is Weinberger's statement in his speech at the Japan National Press Club: "But Japanese forces capable of providing sea and air defense in the Northwest Pacific could complement U.S. strategic and conventional forces in the area." Japan's role under the U.S.-Japan Security Treaty is cooperation within the framework of defense only. What is the meaning of "complementing U.S. strategic and conventional forces"? The U.S. request in the Hawaii meeting last year, that Japan substantially increase the number of F-15 fighters and P-3C antisubmarine planes it possesses, can be construed as meaning that the U.S. wants Japan to assume the strategic role of countering the Soviet Backfire bombers and missile-firing submarines. If this is so, it clearly goes beyond the framework of defense only.

In addition, Weinberger went so far as to say, "The Japanese forces today have not yet reached the point of being able to carry out their constitutional mission fully." Though this is couched in terms that appear to respect the Constitution, one suspects that it is aiming at emasculating the Constitution.

In its decision to lift the ban on the use of the funds for the remodeling of F-4 fighters, the Government advanced the new interpretation that judgments as to whether something constitutes a threat to other countries can change as a result of developments in military technology. In this way, it has increased the scope of the armaments that the SDF can use. And in the matter of defending 1,000 nautical miles of sealanes, it is trying to increase the scope of defense.

If ambiguous redefinitions, the Defense Agency's constant presentation of faits accomplis and the violation of civilian control of the SDF are to be prevented, the Prime Minister has to stand by the principle of defense only and demonstrate his leadership. (March 28)

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ECONOMIC

SHIPBUILDERS EXPAND BUSINESS IN NON-SHIPBUILDING FIELDS

Tokyo INDUSTRIA in English Vol 12, No 3, Mar 82 pp 9-16

[Article by George Nakamura: "Major Japanese Shipbuilders Expand Business in Non-Shipbuilding Fields"]

[Text] New Moves

Topics now much talked about in Japanese industrial circles are industrial robots, mechatronics, microcomputers, biomass and biotechnology, to cite a few. All these are industrial areas that are considered to have great chances of expansion in the near future, and major Japanese shipbuilding firms are trying to join plans to industrialize products in these fields in one way or another.

The Japanese shipbuilders also have strong interest in the nation's defense industry. Last December, the Japanese Government published the national budget for fiscal 1982 beginning on April 1, 1982. The budget, subject to Parliamentary approval, provides an outlay of ¥2,586,100 million for defense expenditures. The figure represents an increase of 7.754% over the previous year. The growth rate exceeds the originally-set ceiling of 7.5%, while the growth of other appropriations is curbed to a bare minimum to reduce deficits in state finances. The ratio of defense spending to the gross national product is 0.93%. Indications are that the Government will continue to give top fiscal priority to defense buildup and that the ratio will most likely to surpass 1% of GNP in fiscal 1984 or 1985. On the other hand, the shipbuilding industry holds a major sector of the nation's defense industry.

Another area that Japanese shipbuilders are trying to put their hand to is the ocean development industry in which they can make better use of their technology than in any other areas of industry. The business of offshore structures, centering on submarine oil drilling rigs, enjoyed its first golden era during the past year or two. Submarine oil drilling projects are being carried out in the North Sea, the Gulf of Mexico, the Po Hai (Gulf of Chinll) and some other areas. In the Beaufort Sea (in the Arctic Ocean), Dome Petroleum Co. of Canada and major oil companies plan to launch oil drilling projects, and necessary equipment has already been ordered. The obtainable amount of undersea oil deposits in the Arctic Ocean area is estimated at 320,000 million barrels in the Middle East. The world's ocean development is steadily expanding to the icy waters. Japanese shipbuilding firms are losing no time in preparing for ocean development in the icy waters in the second golden era.

The challenge to a series of new growth industries by major Japanese shipbuilders is in line with the policy that they have been pursuing since 1975 - to "break with shipbuilding" - to enter new areas of business.

The Beginning of 'Breaking with Shipbuilding'

In 1975, when Japanese shipbuilders experienced the adverse effects of the oil crisis, they strongly felt that an unprecedentedly serious recession would come sooner or later. As they had feared, new shipbuilding orders stopped coming in 1977. This state continued through 1979, plunging the shipbuilding industry into what might be called a "destructive recession."

The industry took all sorts of measures to save itself from the predicament. Major shipbuilders cut their production facilities by 40% (35% for the entire shipbuilding industry, including smaller shipbuilders and related businesses), set new rules to control operation rates, formed an anti-depression cartel, suspended the recruitment of new school graduates, cut wages and curbed overtime work. A series of drastic measures, unprecedented in Japanese industry, was inevitable for corporate survival.

While trying to reduce their extra weight, the shipbuilders did not forget to take one more measure, that is, to expand the non-shipbuilding business – the inclination toward "breaking with shipbuilding," so to speak. The structural change in 1975 was not the first. During the 1950s, managers of some shipbuilders tried seriously to balance sales equally between shipbuilding and land equipment business. However, during the period between 1950 and 1975, shipbuilding orders continued to increase, and the supply and demand situation was rather stable as a whole. Therefore, shipbuilding did provide a stable source of income. Executives in charge of shipbuilding dominated business in a shipbuilding firm, while those who promoted land equipment business were compelled to submit to unduly cold treatment.

However, shipbuilding firms laid the foundations for land equipment business in those years through efforts by the promoters of land equipment business and through business mergers. This enabled the expansion of land equipment business, which, in turn, reduced the ratio of shipbuilding to total sales, as stated in the following section.

Changes in the Earning Ratio

Figures to be given below are comparisons in the sales ratios of shipbuilding and land equipment business of Japan's seven top shipbuilders between two half-year terms – the first half of the March 1982 term (April 1, 1981~ September 30, 1981: the late term) and the first half of the March 1975 term (the early term). The seven are Hitachi Shipbuilding & Engineering (Hitachi Zosen), Ishikawajima-

Harima Heavy Industries (IHI), Kawasaki Heavy Industries, Mitsubishi Heavy Industries, Mitsui Engineering & Shipbuilding, Nippon Kokan and Sumitomo Heavy Industries (alphabetical order).

In Mitsubishi Heavy Industries, shipbuilding accounted for 14% and land equipment 86% in the late term, as compared with 38% and 62% in the early term.

In IHI, the similar ratio was 30:70 for the late term, and 37:63 for the early term. In the late term, the ratio of shipbuilding rose to 30 due to sluggish business in land equipment, while the similar ratio for the previous corresponding term was 23, a typical ratio in recent years.

In Kawasaki Heavy Industries, the ratio for the late term was 26:74, as against 24:76 for the early term. As in the case of IHI, the ratio of shipbuilding was higher than those of other years because of stagnant land equipment business. The ratio of the previous corresponding term was 15:85. During the past 3~4 years, the ratio of shipbuilding has been between 10% and 20%, except for the first half of the March 1982 term. Among the seven firms, the ratio of land equipment business is quite high, along with Mitsubishi Heavy Industries and Sumitomo Heavy Industries.

In Hitachi Zosen, the ratio for the late term was 31:69, as against 60:40 for the early term. The ratio of shipbuilding and land equipment was completely reversed.

In Mitsui Engineering & Shipbuilding, the ratio for the late term was 39:61, as against 54:46 for the early term. In the cases of Hitachi Zosen and Mitsui Engineering & Shipbuilding, the ratio of shipbuilding had been higher than that of land equipment until the March 1978 term when the ratio was reversed.

Their corporate images as leading shipbuilders are gradually changing, as the figures show.

In Sumitomo Heavy Industries, the ratio for the late term was 20:80 (and 15:85 for the mid-1981 term), as against 36:64 for the early term. The reason why the ratio of shipbuilding was low at this point is that the company merged with Sumitomo Machine Industry and Uraga Heavy Industries in 1969.

Nippon Kokan is a steelmaker, rather than a shipbuilder. In fact, the sales ratio of shipbuilding business in the late term was only 6%. It was such a small percentage that we do not state comparative ratios.

From the above-mentioned comparative ratios of shipbuilding and land equipment business of the seven major shipbuilders, we can point out the following.

Firstly, Mitsubishi, IHI and Kawasaki have maintained the shipbuilding ratios of about 20% during the past three or four years, although this may not be true for the first half of the March 1982 term, because of sluggish land

equipment business in that half-year period. The continuance of the non-shipbuilding ratio of about 80% means that the policy of "breaking with shipbuilding" is nearing its end.

Secondly, as mentioned earlier, Hitachi and Mitsui had had larger ratios for shipbuilding than land equipment until fiscal 1976. The ratios were reversed in the following year and thereafter. Their shipbuilding ratios dropped to 30% in the mid-1981 term. The ratio of shipbuilding and land equipment in the order backlog was 34:66 for Hitachi and 44:56 for Mitsui. The fall in the shipbuilding share is not a temporary phenomenon. Although the corporate names of Hitachi Zosen (Shipbuilding & Engineering) and Mitsui Zosen (Engineering & Shipbuilding) carry strong images of shipbuilders, they may become disservice to their business operations before long.

Thirdly, the shipbuilding ratios of Nippon Kokan and Sumitomo Heavy Industries range from 5% to 19% at the highest. Nippon Kokan's main line of business is steelmaking, while that of Sumitomo is precision and construction machinery. When they try to expand their business, they will explore non-shipbuilding areas, including ocean development. They will probably be the first among the seven to "break with shipbuilding."

The business results in fiscal 1981 mean a "declaration for business recovery" by the shipbuilding industry. They also show that shipbuilders are divided into three business patterns and that there are moves to change a big current the shipbuilding industry is following.

Toward the Final Goal

In 1975 the seven major shipbuilders attempted takeoff for a "break with shipbuilding," and the attempt raised the share of land equipment business, though slightly. But none of them believe that they have completed their structural change toward "breaking with shipbuilding." The contents of their technological development, medium- and long-term programs and equipment investment indicate that the shipbuilders are giving priority to the expansion of non-shipbuilding business.

Stated below are their business prospects, aiming at increasing non-shipbuilding business.

Mitsubishi Heavy Industries is not only the leader of the Japanese shipbuilders but also a big business of the country, and its product lines are quite diverse. To be noted here is that many of these products have top shares in the domestic market. This means that Mitsubishi is the price leader of these products, which shows its very strength. The firm's sales for the annual term ending March 31, 1982, are estimated at ¥1,600,000 million – the biggest among shipbuilders (except for Nippon Kokan, whose shipbuilding share is very small).

Its product lines cover land, marine and aeronautic equipment, and it ranks high in the production scale of all these products. Its sales will probably reach ¥2,000,000 million in a few years. Mitsubishi is now placing emphasis on coal liquefaction technology, atomic energy and other energy related business, defense-related business and the production of industrial robots. The firm with a three diamond trade mark will retain its high position in Japanese industry in the future.

Ishikawajima-Harima Heavy Industries estimates its sales for the March 1982 term at ¥700,000 million, and aims to become a ¥1,000,000 million business in 1983 or 1984. If the aim is achieved, IHI will be the second ¥1,000,000 million business in the shipbuilding industry, following Mitsubishi Heavy Industries (excluding Nippon Kokan). The medium-range program is supported by land, maritime and aeronautic equipment business. IHI is giving priority to the manufacture of engines for F-15, the nation's next mainstay fighter plane, ocean development and energy. The firm is stepping up affiliations in technology with Toshiba Corp. to prepare for the era of "mechatronics."

The tie-up with the leading electric equipment maker will have great potentials for business growth.

It is noteworthy that IHI is participating in three of the 12 projects for research and development, which are being conducted under the "research and development system for basic technology for next generation industry," designed for industries to develop high technology with government support for use in the 1990s. The three projects concern (a) fine ceramics, (b) high-performance controllable crystal alloy and (c) compound materials. Since all the 12 projects are aimed at unexplored areas of technology, the participation in such projects may bring great success to the firm.

Kawasaki Heavy Industries estimates its sales for the March 1982 term at ¥750,000 million. It hopes to increase the sales to ¥1,000,000 million in 1990. The firm has two strong areas of business – defense-related equipment and industrial robots. In the defense field, the firm is the chief contractor for the manufacture of the Defense Agency's next generation medium-class trainer planes. The contract will total about ¥300,000 million. It is also the biggest supplier of submarines to the Maritime Self Defense Force. A rise in the nation's defense spending will benefit Kawasaki.

The firm is the nation's top supplier of industrial robots. The domestic market of such robots is still small, with 1980 sales being ¥78,400 million. The firm estimates its sales of robots in 1982 at ¥7,000 million, and plans to raise the sales to ¥20,000 million in 1984. The firm's robot sales have risen at an annual rate of about 40% during the past

five years. The Japan Industrial Robot Manufacturers Association estimates that the nation's robot sales will reach ¥290,000 million in 1985 and ¥600,000 million in 1990. The market is not very big. However, 70% of the industrial robots manufactured in the world are now being operated in Japan. The Ministry of International Trade and Industry (MITI) this year began giving help to develop intelligent robots. The industrial robot is a promising product in view of these facts.

Industrial robots now in use are "First Generation Robots," which are good for repeating jobs to achieve mass production, such as welding, painting and transporting. The intelligent robot that MITI wants to develop is a second generation robot which would have the following functions:

1) Sensing function (perception);
2) Operating function (action); and
3) Deciding function (thought).

MITI plans to spend ¥30,000 million during the seven-year period starting this year to develop high-performance robots. The emergence of new-type robots would inevitably expand the robot market. In this field, Kawasaki Heavy Industries is quite promising, and therefore it is quite an attractive manufacturer.

Hitachi Zosen sets its sales target for the March 1982 term at ¥440,000 million. As earlier stated, the company's sales ratio of shipbuilding and land equipment is 31:69. The company is trying to improve the business structure in an effort to reduce dependence on shipbuilding. The efforts the company is making include commercial production of newly developed products, development of basic technologies, expansion of production facilities and development of energy-saving technology.

Hitachi has been active in reducing dependence on shipbuilding as it had to do so for survival. In 1978 the company created the Offshore Business Headquarters and made Osaka Shipyard (in Sakai) a plant specializing in the manufacture of ocean structures, and Ariake Shipyard also a plant to handle offshore structures. This move was successful, and in 1981 the company ranked the world's 5th largest manufacturer of submarine oil drilling rigs. To further expand business in ocean development and launch full-scale development in the Arctic Sea, the company included ocean (icy waters) development in its ten major projects. It plans to begin work this year to build an icy water tank to be used for experiment at a cost of ¥1,500 million.

The company has set shipbuilding, land-based machinery and offshore structure as its three main business pillars. It is now trying to set the 4th and 5th pillars to achieve faster growth. Candidate lines for the 4th pillar are said to be general-purpose land equipment, such as heat pumps and rotary presses.

Mitsui Engineering & Shipbuilding estimates sales for the March 1982 term at ¥350,000 million and aims to raise the sales to ¥520,000 million in 1985. As in the case of Hitachi Shipbuilding & Engineering, the company is trying hard to reduce dependence on shipbuilding. It wants to launch full-scale business in the manufacture of chemical plants, boilers for power generation and the like, hoping to develop into a general engineering firm. The company is an early comer to the ocean development industry, along with Mitsubishi Heavy Industries. It has already expanded its business in the field of the manufacture of offshore oil drilling rigs, modules, plant barges and ocean engineering. The company, therefore, appears to be placing emphasis on ocean development in reducing dependence on shipbuilding.

The company has been active in icy waters development. Since 1975 it has been conducting various experiments using an ice force measuring tower built on Lake Saroma in Hokkaido. In the same year it concluded a business tie-up arrangement with Arctec Inc. of the United States to receive data and expertise on offshore engineering, such as ways to recover oil in icy waters and computation of ice force on the offshore structure. The development of ice-covered sea is being spotlighted in the world, and Japan's major shipbuilders are seen as suppliers of various equipment necessary for such development. Thus the development of ice-covered sea is a big area of business in the future.

Nippon Kokan is Japan's second largest steelmaker, following Nippon Steel. In Nippon Kokan, shipbuilding is under the heavy industry division, and, therefore, the situation is different from other shipbuilders. Sales for fiscal 1980 (April, 1980~March, 1981) totaled ¥1,423,300 million. Of this, the iron and steel division earned ¥1,166,000 million, and the heavy industry division ¥256,700 million, of which land equipment earned ¥155,000 million and shipbuilding ¥101,700 million. Shipbuilding accounted for only 7% of the total sales.

The problem is how Nippon Kokan will diversify its lines of business to reduce the high ratio of steel business. In other words, it is trying to "break with steel business," rather than to "break with shipbuilding." It is just impossible for the heavy industry division to grow into the size of the steel division. The question is how much the firm can reduce the gap between the two divisions.

The firm is now trying to expand business of the heavy industry division, such as energy-related business, steel plant facilities, pollution control facilities and floating platforms. It is Japan's only builder of ice breakers, namely

"Fuji" and "Shirase." It is also building in its Tsu Research Institute an icy water tank, measuring 21.3 m long, 6.0 m wide and 2.0 m deep, which is equipped with a refrigerating unit capable of cooling the tank to -25°C, the freezing point of sea water. The ¥1,000 million tank is to be completed ahead of a similar facility under construction by Hitachi. Therefore, it will be the first tank of its kind in Japan.

The development of offshore technology in the ice-covered sea is a major pillar for business diversification to correct over-dependence on steel business.

Sumitomo Heavy Industries is also in a situation different from other firms. Sales for the March 1980 term totaled ¥225,000 million and those for the March 1981 term totaled ¥263,600 million. Sales for the March 1982 term are estimated at ¥280,000 million. The sales ratio of shipbuilding during the period ranges from 15% to 19%. The policy of "breaking with shipbuilding" is advancing fairly well as in the cases of Mitsubishi and Kawasaki Heavy Industries. The ratio appears to be in an ideal range.

However, the firm plans to cut the ratio of shipbuilding further because of special conditions the company's ship- have. The firm's shipbuilding facilities include a 16,800-gross-ton building berth at Uraga Shipyard for war ships and a 210,000-gross-ton dock at Oppama Shipyard for merchant ships. Therefore, it is difficult to maintain high operation rates for shipbuilding facilities. Under the circumstances, Sumitomo is striving to expand business in the manufacture of steelmaking facilities, precision plastic molding machines, offshore structures and other non-shipbuilding facilities.

The Future

The business strategies of the seven major shipbuilders to "break with shipbuilding" can be boiled down to the following three points:

1) To expand the market share of favorite or promising lines in the existing land equipment sector.

2) To enter the robot, defense and ocean development industries and develop new markets.

3) To pursue offensive but flexible policies to readily meet changes in the business environment and smoothly carry out the medium-range program.

All the seven major shipbuilders have taken record new orders, while having record-high backlogs of orders. Their financial situation has recovered. In fiscal 1981 all but Kawasaki paid interim dividends for the first time in four years. At the time of such business recovery, investments in research and development as well as in plant and equipment are concentrated on non-shipbuilding fields. A larger amount of investment will be made in 1982 than in 1975 when the industry was dominated by the sense of crisis

created by a recession following the first oil crisis.

The moves to "break with shipbuilding," in no way, mean that the shipbuilders are withdrawing from shipbuilding business and reluctant to take new shipbuilding orders. All their efforts are designed to regain a proper supply and demand situation for the world's shipbuilding industry.

The Japanese shipbuilding industry has come to a turning point with all the seven major shipbuilders taking large-scale measures to "break with shipbuilding." However, nothing guarantees that their future will be rosy. When many Japanese shipbuilders branched out into the fields of big machinery, plant facilities, bridges and other steel-frame structures from the 1950s to the 1960s, they met strong resistance from specialized makers. And, only a few attained satisfactory financial results, when they entered the new fields.

If the specific land equipment market a shipbuilder enters is small, the entry will cause serious market confusion and fierce price competition that may make it difficult to make both ends meet. Therefore, the "break-with-shipbuilding" operation by big shipbuilders does not warrant optimism. But they still will have to challenge new ventures, because new shipbuilding orders are limited in volume.

If the major shipbuilders call the expansion of non-shipbuilding business at the time of the unprecedentedly serious recession in 1978 an "exodus for survival," they may call the current operation an "operation to build a bridge to the 21st century."

After having read this article, many readers overseas may have a question why the major Japanese shipbuilders would move toward the same direction. In the writer's view, the march in the identical direction has been the source of energy for the fast development of Japanese industry. Ironically, such an industrial behavior means that Japanese people or enterprises lack identities.

At the present stage, it is difficult to draw a conclusion on which of the two – a dash in the same direction by many businesses or the establishment of identity – is important. But the latter will probably become more important in the second half of the 1990s.

Experiments in Ice-Covered Sea [Boxed Item]

To meet the engineering challenge in icy waters, Japanese shipbuilders are engaged in various research and development activities. The following is the excerpt from the report on the "Offshore Development in the Ice-Covered Seas" published by Mitsui Shipbuilding & Engineering:

Mitsui has been carrying out the R & D programs in this field with cooperation of Japan National Oil Corp. and Arctec, Inc. of the United States. The

experiments were started in 1975 in the Okhotsk Sea off the coast of Mombetsu in Hokkaido, the northernmost island of Japan.

For measurement and analysis of ice loads, a cylindrical tower, 9.5 meters in height with a 2.5-meter diameter, later converted to conical shape of 11.4 meters in height and with a diameter of 5.5 meters at the water line, was erected some 600 meters off the coast.

With a view to finding the optimum types of structures to be used in ice-covered seas, various tests have been conducted to study the effects on ice loads with regard to:

1) diameter of columns and ice thickness;

2) cone angle and friction between structure and ice;

3) number of columns, ice orientation and jamming; and

4) the first-year pressure ridges, both non-consolidated and semi-consolidated.

The company's efforts are also made in the means of transport in ice-covered seas which include:

1) high powered icebreaking ship;

2) icebreaking supply boat;

3) icebreaking barge with special self-driving devices; and

4) hovercraft and other types of amphibious vehicles.

Overall research and development work relating to icebreaking ships is being carried out, including hull form design for minimum ice resistance and maximum maneuverability, ice-resistance propeller design and hull structure design, taking ice collision force into account.

In addition to resistance tests, self-propelled turning tests and resistance tests in rigid ice condition, respectively, theoretical work is also being carried out.

CSO: 4120/218

ECONOMIC

ALUMINUM-REFINING FACILITIES TO BE DISCARDED

Tokyo NIHON KEIZAI SHIMBUN in Japanese 4 Mar 82 pp 1, 7

[Text]

A plan for disposing of facilities by the aluminum-refining industry circles, which are aiming at freeing themselves from the serious structural depression, has been firmed up. On the 5th, MITI will show the Industrial Structure Deliberation Council Aluminum Sub-Committee (Chairman: Tokyo University Professor Tadao UCHIDA) a basic plan for the stabilization of the aluminum-refining industry (facilities disposal plan based on the Specific Depressed Industries Stabilization Temporary Measures Law), in respose to the report by the Deliberation Council. According to what was revealed by a source concerned on the 3rd, this plan is to the effect that among the facilities with an annual aluminum ingot output of 1,136,000 tons, which facilities are possessed by six aluminum-refining companies, those for an annual output of 424,000 tons, accounting for 37.3 percent, will be discarded (partly frozen) during two years -- fiscal 1982 and 1983. Among the six companies, two are to maintain their present facilities as they are. During the three years from fiscal 1982 to 1984, the aluminum-refining industry circles can import aluminum ingot without paying any duty (9% at present), with an amount equal to the total amount of the facilities to be discarded or frozen as the limit. However, it is thought that the way for the re-vitalization of the industry circles will be still thorny.

The aluminum-refining facilities disposal plan, which MITI has been checking into, is based on the report by the Industrial Structure Deliberation Council Aluminum Sub-Committee in October last year, and the result matches the "structure for an annual output of 700,000 tons by domestic facilities" called for by the report.

According to the source concerned, the largest amount of facilities is to be disposed of by Mitsubishi Light Metal Industry (Head Office in Tokyo; President: Yoshio SUZUKI; capital: ¥10 billion). It will dispose of facilities with an annual output of 160,000 tons at its Naoetsu Plant. Showa Light Metal (Head Office in Tokyo; President: Takehiko HAYASHI; capital: ¥17 billion) also will reduce its facilities to less than half the present amount. Two companies -- Mitsui Aluminum Industry (Head Office in Tokyo; President: Isao KAWAGUCHI; capital: ¥13,500 million) and Sumitomo

Light Aluminum Industry (Head Office in Tokyo; President: Satoshi Beppu; capital: ¥18 billion)--will not dispose of their facilities, as initially scheduled.

Four Companies To Discard or Freeze Aluminum-Refining Facilities

(Commentary) New facilities structures of six aluminum-refining companies have been firmed up. However, four of them are to discard or freeze their facilities. Mitsui Aluminum Industry (Head Office in Tokyo; President: Isao KAWAGUCHI; capital: ¥13,500 million) and Sumitomo Light Aluminum Industry (Head Office in Tokyo: President: Satoshi BEPPU; capital: ¥18 billion) will retain their present facilities completely.

Mitsui Aluminum is to retain its present facilities because it is regarded as capable of maintaining its international competitive power, for the reason that it obtains electric power for refining at its Miike Plant (in Fukuoka Prefecture) by thermal-power generation with powdered coal. Also, Sumitomo Light Aluminum is aiming at surviving through an energy conversion under its plan for a change from oil-burning to coal-bourning at the thermal-power plant operated jointly with Tohoku Electric Power for its Sakata Plant (in Yamagata Prefecture).

As to the disposal of facilities this time, it has been decided that all facilities will be discarded at two plants -- the Naoetsu Plant (in Niigata Prefecture) of Mitsubishi Light Metal Industry and Omachi Plant (in Nagano Prefecture) of Showa Light Metal. However, the moves of Sumitomo Aluminum Refining, which is the biggest company of this kind, are also to be noted. It has three plants -- the Isoura Plant (in Ehime Prefecture), Toyo Plant (in Ehime Prefecture), and Toyama Plant (in Toyama Prefecture). Among them, the Isoura Plant is suspending operations completely because of the reduced production of ingot, and therefore, the possibility is great that the facilities here will be completely discarded or frozen. However, the company is racking its brains also on the handling of the Toyoma Plant where the cost is the highest. This company says that "We want to decide which plant is to be retained, according to the contents of the stabilization basic plan." Therefore, it is fluid at present.

The facilities disposal plan this time will serve as data for the apportionment of aluminum ingot imports free of duty. MITI intends to decide on frameworks for duty-free imports for the various companies in the light of the following three points: (1) The amount of facilities to be disposed of; (2) the amount of ingot imports; and (3) the amount of remaining facilities. It seems that the frameworks for duty-free imports in the industry circles as a whole will be 393,000 tons in fiscal 1982, and 424,000 tons in fiscal 1983 and 1984. The equivalent of the tariffs amounting to a little more than ¥10 billion annually will contribute to the improvement of the profits among the six refining companies. However, many of the six aluminum-refining companies are in a state close to excess liabilities, and, moreover, it is difficult to hope for a rapid rise in the price of aluminum, because of the depression in the US. Therefore, it is expected that it will become difficult to maintain the facilities for 712,000 tons, which are to be retained this time through the industry circles.

CSO: 4105/81

ECONOMIC

CARDBOARD INDUSTRY FORMS DEPRESSION CARTEL

Tokyo NIKKEI SANGYO SHIMBUN in Japanese 19 Mar 82 p 13

[Interview with Shinichi Kaizaki, chairman of the Japan Corrugated Cardboard Industry Association Depression Cartel Preparatory Committee, by Reporter Hirogami; date and place not specified]

[Text]

Corrugated cardboard industry circles have started to move toward forming a depression cartel. Both the Japan Corrugated Cardboard Industry Association, composed of big manufacturers concerned, and the National Federation of Corrugated Cardboard Industry Associations, centered on the medium and small manufacturers concerned, have begun to make preparations through the establishment of their respective experts committees. The possibility is thus becoming stronger that in corrugated cardboard industry circles, an "all-industry cartel" set-up will be established for the first time. This paper asked Japan Corrugated Cardboard Industry Association Depression Cartel Preparatory Committee Chairman Shinichi KAIZAKI, concurrently Tomoku President, about the situation in the industrial circles concerned and future prospects. (Reporter HIROGAMI acted as interviewer.)

Question: Why is it that a mood calling for the formation of a depression cartel has recently come to mount suddenly?

Answer: The situation has become difficult since around the summer of last year. After the beginning of this year, our deficits have increased still further. The prices of raw materials for corrugated cardboard have not dropped since the sharp rise in chip prices the year before last. This has given an impetus to our suffering from difficulties. Both corrugated cardboard manufacturers and corrugated cardboard-consuming industry circles had thought that the prices of raw materials would decline, sooner or later, but the actual situation is not so. In particular, corrugated-cardboard users strengthened their request for the lowering of corrugated-cardboard prices in anticipation of a decline in the prices of raw materials. Therefore, corrugated-

cardboard manufacturers have also accepted [the request for] the lowering of the prices, because of their speculations as to their share (market holding) rates, and due to the excessive competition. The prices of corrugated-cardboard sheets have decreased by as much as about 20%, when compared with the level seen around the spring of last year, and those of corrugated-cardboard cases, by about 10%. The trend, in which raw material prices are high, while manufactured product prices are low, has thus become clearer.

Question: The absolute amount of demand has not decreased so greatly. As far as can be said from seeing the data on demand and supply, it is also felt that you cannot be said to be in straitened circumstances.

Answer: To be sure, the amount of demand for 1981 decreased by only 3% or so, compared with the preceding year's level. From the beginning, however, the corrugated cardboard industry has had a low rate of payability, and moreover, the cost burden has become very heavy, accompanying the doubling of raw material prices. In addition to the thoroughgoing implementation of economization measures by users, business is becoming more stagnant. It is expected, therefore, that this year, too, the amount of demand will probably be on the same level as in the preceding year, or drop from the preceding year's level. Since around the autumn of last year, some companies have been reduced to deficit management. At present, 80% of all manufacturers concerned are probably suffering from a deficit. In the case of my Company, the interim settlement of accounts for February showed a real deficit. In corrugated-cardboard industry circles, there are about 300 companies jostling one another. If this situation continues as is, then some companies will probably go bankrupt.

Question: When will a cartel be formed?

Answer: To begin with, I want to conduct surveys on the situation concerning the payability of the manufacturers, affiliated with the Japan Corrugated-Cardboard Industry Association, and the operation rate, thus obtaining necessary data for submitting an application, as quickly as possible. In order to obtain approval, it is necessary to have the actual situation understood fully by the Fair Trade Commission and user industry circles. At the present stage, it is difficult to say definitely [that a cartel will be formed] from around what time. Anyway, my true intention is to carry out [the formation of a cartel] as quickly as possible.

Question: In the case of corrugated cardboard, it is an order-receiving industry. Therefore, will a production-adjustment cartel, intended for inventory adjustment, achieve satisfactory effects?

Answer: In the case of big manufacturers, I would like to restrict the number of days of operation and the length of time for carrying out

operations through the formation of a depression cartel on the basis of the Anti-Monopoly Law, and in the case of medium and small enterprises, under the co-ordination clause based on the Medium and Small Enterprises Organization Law. This is an order-receiving industry; therefore, it is not felt that excess stockpiles are putting pressure on management. Recently, however, there are also many enterprises which are carrying out production in anticipation of an increase in demand. Companies concerned will go bankrupt together unless they take action for a cartel. There are no differences at all in the degree of severity, between big enterprises and medium and small enterprises. I am fully aware that there are difficulties different from those in the case of the inventory-adjustment cartel formed as to machine-made paper. I also intend to explain the special nature of corrugated-boardcard industry circles to the Fair Trade Commission, taking time.

CSO: 4105/81

ACCURATE INSTRUMENTATION FOR SAFE PLANT OPERATION

Tokyo TECHNOCRAT in English Vol 15, No 1, Jan 82 pp 11-19

[Article by Shinsaku Kinugasa, Sales Engineering Division Hokushin-Electric Works, Ltd.]

[Text]

1. Introduction

An important responsibility placed on modern technology is that of preventing serious industrial accidents originating in plants. Particularly in Japan, a country of high population density, where such accidents could result in a major catastrophe, a variety of measures are being devised as a pressing national need.

This paper describes the means of assuring plant safety, laying particular emphasis on the use of appropriate instrumentation among the measures being taken for accident prevention. Proper instrumentation is regarded as an effective means not only of assuring the safety of plants but also of maintaining quality and production. This is achieved by allotting instrumentation the task of monitoring and controlling normal plant operation and detecting and/or taking effective countermeasures in the event of abnormal conditions occurring.

In detail, instrumentation for safety must include methods for intensified types of interlocks and emergency shutdowns (widely used in conventional instrumentation), exceptional control function to cope with low-probability emergencies, increasing the reliability of measurement and control instruments, introducing online diagnostic techniques for industrial equipment, and adopting rational man-machine systems suitable for safe operation. Also required, to secure the above system functions are effective training for operators and management for maintenance of the instruments.

These problems are too extensive to deal with briefly. This paper therefore, covers only the problem of how to provide safety instrumentation systems; emphasis being laid on techniques for detecting abnormal conditions.

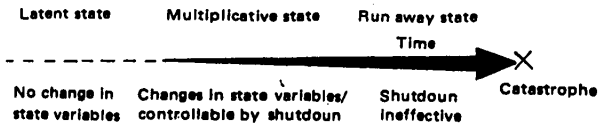

Fig. 1. Abnormal State in Time Process

2. Normal and Abnormal Operation in Plants

Machines and apparatus within an industrial environment are regarded as operating normally when they are running as originally planned. Abnormal operation results in a decrease in production, a drop in product quality, and on occasions accidents. To secure safety, it is necessary to detect abnormalities as early as possible, and promptly take appropriate countermeasures.

There are many levels of abnormality[1] One level may denote slight abnormality, not affecting overall plant operation. Another may denote a state for which, when detected, it is too late to do anything. Fig. 1 outlines abnormality gradings.

In service, plants generally deteriorate as the materials of which they are made are gradually affected over time by abrasion, fatigue and corrosion. In many cases this gradual deterioration may not be readily apparent, but be a latent source of accelerated degeneration in the future. If deterioration progresses so far as to cause abnormality of state variables, this abnormality can form excessive stress and thereby accelerate deterioration. A self-propagating state occurs, multiplying the rate of deterioration and rapidly aggravating the situation, ultimately resulting in a major failure.

The process of hidden (dormant) deterioration generally takes a fairly long time. Some grades of trouble directly lead to the self-propagating state without passing through a dormant stage. Since an accidental failure or an excessive disturbance can lead to this self-propagating "chain reaction," detection of trouble in the early stages, followed by prompt action, is very important in securing the safety of the plant.

3. Disaster Generating Process – Self-Propagation of Abnormality[3),4)]

There are various generating patterns for disasters in plants. In some cases, pressure or temperature in a container can rise excessively, resulting in a fracture or explosion. In others, despite temperature and pressure complying with design standards, inner material defects can cause a sudden fracture. In general, the common denominator in these plant disasters is that, in the final stage, abnormality is dramatically increased by the multiplicative effect of several factors leading to a disaster.

Disasters occur by chance; failure of components including auxiliary apparatus, energy supplies, and measuring and control instruments, disturbances such as misoperation, power failure, sudden changes in the quality or quantity of charged materials and changes of load, acts of God such as earthquakes or lightening, or fire spreading from a neighboring location. Developments in the final stages may be so rapid that disasters are effectively instantaneous.

Let us take a pressure vessel for example. If one of the bolts which secures the end plate to the cylindrical vessel breaks, an increased tension is applied to the other bolts. This causes these bolts to successively break, bursting the end plate

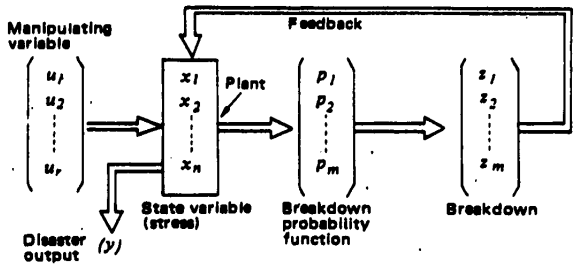

Fig. 2. Disaster Generating Process

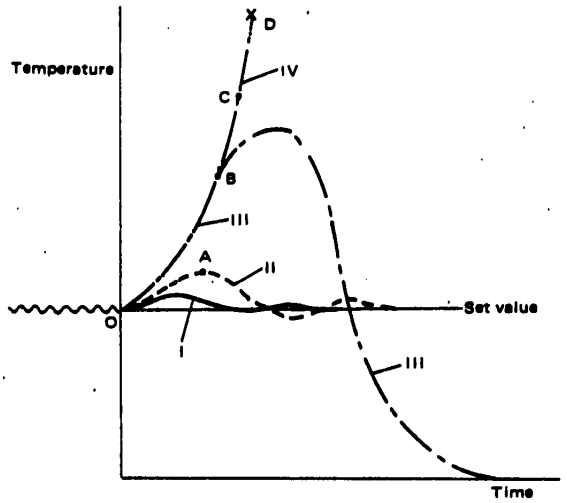

Fig. 3. Different Measures Against Abnormal State With Time

Fig.2 shows the "chain-reaction" process. Failure modes (such as leakage, cracks, and trip of rotation or operation) occurring in a plant or its components, such as auxiliary apparatus and measuring and control instruments, can all be represented by symbols as follows. The probability of breakdown j occurring in time dt is $P_j dt$. The failure probability function P_j is a complicated nonlinear function of state variable x of the particular plant. Thus,

$$P_j = P_j / x_1, x_2 \ldots . x_n, t / \qquad (1)$$

If failure z occurs, state variable x of the plant changes, causing P_j to change through a feedback reaction. In other words, variations in the state variable caused by failure can result in excessive stress, successively inducing other breakdowns and rapidly leading to a serious situation.

The state in the period in which x can be returned to 0 (the standard value) by manipulating variable u, i.e., the controllable time duration, is called off control. This state includes the following two cases: one that permits automatic return to the normal state, and the other that, if left as it is, leads to an emergency state. The operator changes the set point of specific control loops at his own discretion or tries to accomplish a return to normal through manual operation.

An emergency state is when state variable can be returned to the safe area by manipulating variable u. If this is impossible, a disaster occurs. If the change of x due to z and u can be expressed (as it can for most cases) in the form

$$x_j = x_j(0) \exp \alpha_j / z_1, z_2 \ldots . z_m, u_1, u_2 \ldots . u_r / t \qquad (2)$$

the situation is regarded as an emergency when

$$\alpha_j / z_1 z_2 \ldots . z_m, u_1, u_2 \ldots . u_r / < 0 \qquad (3)$$

for all α; otherwise, it is a disaster. This is because, if even one α_j is positive, state variable x_j increases with time t, leading to an accident. If, on the other hand, one α_j is negative, x_j converges to 0, resulting in only a temporary emergency. Of course, to keep α_j negative, variable u must be given an appropriate value. In other words, to prevent a disaster, it is essential to take appropriate action in the abnormality stage.

Since state variable x changes at a speed corresponding to the time constant of the plant, and failure z takes time to occur, it takes some time for an abnormality to develop into an accident. Thus, disasters can be prevented by taking appropriate measures in the early stage of abnormality. Thus the importance of detecting and diagnosing abnormality can be appreciated.

Large ultimate output y generated by a plant, for which the plant is responsible, is called a disaster. y is a tremendous emission of substances or energy that, among other factors: is harmful to humans; causes trouble to residents outside the boundaries of the site; and causes public agencies including fire trucks to be dispatched to prevent secondary disasters.

Figure 3 shows an example of emergency action taken, indicating a process in which state variables, initially normal are suddenly disturbed at point O. Case I indicates a simple disturbance which subsequently returns to normal without external intervention. Case II shows a return to normal after manual intervention at point A. Case III illustrates emergency cutoff applied at point B because of an emergency shutdown preventing continuous operation. Case IV illustrates a runaway state as a result of no preventative action being taken. Swift cutoff action was taken at point C, but emission of energy could not be stopped, resulting in a catastrophe at point D.

cutoff action was taken at point C, but emission of energy could not be stopped, resulting in a catastrophe at point D.

4. Methods of Detecting and Diagnosing Abnormality

Needless to say, the most desirable way to prevent accidents is to detect defects and deterioration while in the dormant state. Diagnostics in industrial equipment[5] are very effective for this, and are a powerful means of preventative maintenance. However, use of this method is limited and difficult to apply for on-stream inspection (OSI) to detect abnormalities when the state variables are apparently unaffected. Thus, in most cases, equipment diagnosis cannot but be performed during shutdown maintenance (SDM), inevitably lengthening the inspection period. In addition, it is ineffective against random failures which occur without warning.

For this reason, additional measures of avoiding accidents must be taken into consideration by detecting abnormality early in the runaway state. This paper mainly reviews these means. Technical methods used individually are not different in essence from diagnostics in industrial equipment. But emphasis is laid on diagnosis following the occurrence of abnormality in the state variables.

Section 2 suggests that in order to prevent accidents, measures be taken to detect abnormality prior to the actual occurrence of an accident. For this purpose, it is sufficient to detect and observe abnormalities in the state variable. The methods of detecting abnormality, classified mainly by differences in processing detected information, are as follows:

1) Method Aimed at Detecting Abnormality in the Special State Variable

This method draws attention to large changes in the state variables that will have major effects on the safety of the plant, such as temperature in furnaces, pressure in pressure vessels and liquid levels in tanks. A typical example is conventional upper and lower limit alarms in common use. This method is, so to speak, the last fort for securing safety. It cannot be abolished even if an advanced alternative detecting or diagnostic system is adapted. However, this method is limited in anticipating abnormality because it is not able to provide sufficient time allowances prior to catastrophes.

2) Rational Decisions Resulting From Use of Fixed Algorithms

Abnormality is determined from an overall evaluation of collected data of multiple variables deviating from predetermined mathematical relations. There are many levels of algorithm, ranging from simple to complicated. Typical methods used are the comparison of algebraically calculated values, setting a number of high and low alarm output limits in a logical computation, and using these two methods together.

Another method is used for estimating specific state variables (state observation), by computing a number of variables to reduce the processing required for method (1). This has the drawback of requiring design and production algorithms for each plant. Yet, it is regarded as the most powerful method

for diagnosing future abnormality.

3) Integrated Determination From Evolutional Algorithm

In a large production system, even if each unit of equipment is regarded as being safe(a state which may be called local safety), the safety of the system as a whole (total safety) must still be maintained. For example, if a protecting relay opens freely in response to slight overheating of motor for a cooling water pump, it will have a serious effect on the other components.

Operators control the overall safety of the plant by observing the operation of each individual component. Advanced decisions required for this can hardly be formed by a fixed algorithm. The possibilities of using computers for this are reviewed and proposed as the course of future technical trends. Details will be described later.

5. Arranging Diagnosis of Abnormality by Matrix

Since there are a large variety of plants and multifarious, specific failure modes, and there are, in practice, numerous methods for diagnosing abnormality. Once a method of diagnosis is established, applications can be extended to similar situations. Thus, an attempt is being made to classify methods of diagnosing abnormality. Table 1 shows a proposed method.

The first column on the left side contains roughly classified plants and auxiliary equipment. In the field of statistics and pattern recognition, collections of common individual cases are called clusters.[6] The top line contains clustered failure modes. On this matrix, which is prepared beforehand, methods of detecting abnormality are written at the intersections of the relevant horizontal and vertical lines. Dashes (–) in the table denote that there is no relevant abnormality or failure. A question mark (?) denotes doubts about the effects of possible action. Table 1 is largely complete, yet some of the methods given may not be applicable or may be ineffective. Table 1 indicates that the presently established techniques for detecting abnormality are only the visible peak of an iceberg. This table, so to speak, indicates the need for abnormality detection. At the same time, it gives a direction for application of similar methods and thus is important in systematizing techniques for detecting abnormality.

It may be possible that cluster tables like Table 1 are, in practice, too approximate. For example, heating furnaces are not always the same. Those in the petrochemical industry are quite different in structure and working temperature from those in the iron and steel industry. Because failure modes are different for particular equipment in different industries, a specific table must be prepared for each industry. In addition, Table 1 lays emphasis on OSI, dealing with diagnostics in industrial equipment secondarily. Although it involves these problems, the table is presented as one item to be reviewed in developing and providing diagnostic techniques for abnormality. Other matrices related to this subject have been published by other researchers.[7]

6. Diagnosing Abnormality From Simple Algorithms

If a specific state variable important to the safety of a plant cannot be measured directly, other related values must be measured and calculated to find the state variable. Fig.4 shows a tuyere leakage detection system for blast furnaces. Inlets for hot blast air are called tuyeres which are made of hollow copper blocks to allow cooling water to pass through. Tuyeres gradually wear due to burn loss at high temperatures. Holes in a tuyere result in cooling water entering the furnaces, causing an explosion. This is very dangerous, so, inlets and outlets for cooling water are provided with Karman vortex flowmeters or pulse-output type electromagnetic flowmeters, and output pulses are passed to reversible counters of flow monitors.

These meters detect slight differences in flow between inlet and outlet and give an alarm when holes are still small enough not to be dangerous. Sensors are designed to recognize abnormality when the totalized value of pulse difference, or the total value of leakage water, exceeds a specific level. Airflow is stopped and defective tuyeres are replaced. Since 30 or 40 tuyeres are usually used together, they are dealt with together by means of monitors equipped with microcomputers.

Generally, detection of leakage by means of flow differences is limited in application because of the limited accuracy of these meters. Karman vortex flowmeters and magnetic flowmeters provide a maximum accuracy of 0.5%, and are normally only accurate up to 1%. By ensuring identical installation and ambient temperature conditions and by making adequate adjustments for differences between meters, settings for alarm triggering by means of flow differences can be limited to ±0.5% or less.

Fig.5 shows the essentials of a monitoring system for the shell thickness directly below the mold in the continuous casting equipment[8] in the iron and steel industry. Molten steel delivered at a temperature of θc (as measured by an immersion couple) from a tundish (reservoir holding molten steel) is cooled to a solid with cooling water in the mold made of a hollow copper block. As steel bar, it is hardened in running water in a secondary cooling zone. In this solidification step the steel bar is only solid on the surface which forms a solid phase shell. If this shell is too thin, the steel bar is torn (called breakout), and moleten steel drops from the tundish. This is very dangerous.

Now, assuming that the melting point of the steel is θ_m, the density of the steel is ρ_m (there is no practical difference between solid and molten steel), the specific heat of the molten steel is Cf, the latent heat of the fusion of the steel is h_m, the specific heat of water is C_W and the density of water is ρ_W, the other dimensions are determined as given in Fig.5. Assuming that the temperature of the steel portion directly below the mold is uniform over the plane perpendicular to the travelling axis of the steel bar, i.e., the horizontal plane, and that heat is taken away only by cooling water in the mold, the cross sectional area S_S of the shell just emerging

Table 1. Matrix Table for Trouble Diagnosis Technology

Cluster / Plant	Abnormality / Plant (example)	Gush; outflow (heavier than leak)	Overflow; emptying	Instability *2	Internal leak (mixture, reaction)	External leak (simple leak)	Internal defect; local deformation; corrosion	Inclination, uneven subsidence
Gas container	High pressure, high-pressure hot, combustible or poisonous gas holder	Gas detector *3, pressure drop detection	–	–	–	High-sensitivity gas detector		
Gas-liquid mix container (low temperature) (medium temperature) (high temperature)	LPG tank Oil distilling tower; heating furnace Boiler	Gas detector Gas detector acoustic detector	Level meter Flowmeter? Level meter	– Pressure, temperature, flow, etc.	– Flow difference ? H_2 analyzer?	High-sensitivity gas detector Hydrometer?		
Liquid tank (combustible) (large capacity)	Oil tank Large capacity water tank	Gas detector Liquid level drop detector	Level meter	–	–	High-sensitivity gas detector –	Strain gauge?; AE?; infrared camera?	Measurement; inclination gauge, dislocation detector
Stir-inclined chemical reaction tank	Chemical plant	Gas analyzer *3	Level meter	Temperature, pressure, flow rate, etc.	Flow rate difference (cooling water)	High-sensitivity gas detector		
Combustible, toxic gas piping Combustible liquid piping	C. and other gas piping Oil pipeline	Flow rate difference meter? Flow rate difference meter	–	–		High-sensitivity gas detector Resistance method, etc.		
Molten metal vessel	Blast furnace *5 Converter *5 Continuous casting machine	Surface thermometer – –	Level meter Mold level meter	Instruments – –	Flow difference (for cooling water) –	Infrared camera *6 – –		
High-temperature heat exchanger	Hot stove Steel heating furnace	Radiation pyrometer *6 Thermometer	– –	– –	– –	Infrared camera *6 –		
Cluster / Auxiliary equipment	**Abnormality / Auxiliary unit (example)**	**Destruction**	**Stoppage; blockade**	**Ignition failure; backfire**	**Load contact**	**Bearing burn loss**	**Mechanical vibration**	**Surging; combustion shake**
Rotary machine; fan	Turbine Blower	Trouble *4 Trouble *4	Tachometer	–	–	Thermometer	Vibrometer; sound analyzer	– Vibration; pressure flow rate
Burning machine	Burner	Furnace explosion	Flow meter	Flame detector Thermometer	–	–	–	Pressure meter (furnace pressure) Sound analyzer
Carrying machine	Conveyor; feeder		Tachometer	–	Tachometer; electric power meter	Thermometer	–	–

*1 This table covers machines and equipment usually used in the heavy chemical industry.
*2 Instability means a dangerous state out of controlled balance.
*3 The gas detector only senses presence of gases. The gas analyzer can measure gas density.
*4 The term "trouble" here means trouble which will not dissipate until retained energy is completely consumed.
*5 In blast furnaces and the converters can be subject to local disorders but not overall disorders.
*6 The radiation pylometer and the infrared camera check the brick lining for burn loss but do not detect leaks.

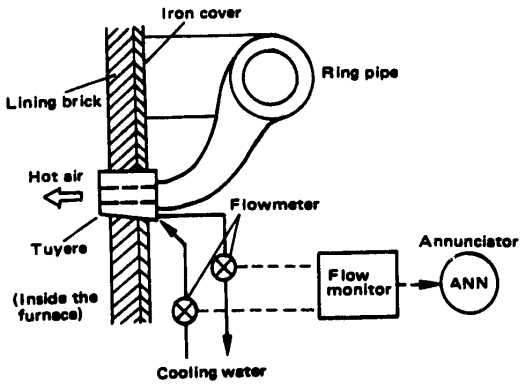

Fig. 4. Water Leak Monitoring System for Blast Finance Tuyere

from the mold can be obtained from a simple calculation of heat balance as follows:

$$S_S = \frac{C_w \rho_w}{h_m \rho_f} \cdot \frac{\Delta T}{v} q - \frac{\theta l - \theta m}{h_m} C_f \qquad (4)$$

The basic theory for this is as described above, though in practice calculations are performed using computers on the basis of more complicated models, and empirical data together with corrections.

In diagnostics for abnormality, large errors due to defective measuring instruments or failure to operate due to breakdowns can give rise to disastrous misjudgments. For this reason, various reduntant systems are included in the collection of important information. Dualized and backup systems effectively increase the reliability of measurement; yet they are not always applicable because instruments must be provided with self-diagnostic functions.

In the 2 out of 3 method, three units of an instrument are provided in parallel to measure each point. If one of the three units gives a divergent output or reading, it is eliminated from the measurement and the numerical mean of the results given by the other two units is used. In a way, this system has a kind of probabilitic diagnostic function. If the outputs of the three units are x_1, x_2 and x_3, the estimated value $\hat{x}$, nearest to 2 out of 3, can be computed with a microcomputer, or the like, from the following equation.

$$\hat{x} = \frac{1}{2} \cdot \frac{\dfrac{x_1+x_2}{(x_1-x_2)^{2n}} + \dfrac{x_2+x_3}{(x_2-x_3)^{2n}} + \dfrac{x_3+x_1}{(x_3-x_1)^{2n}}}{\dfrac{1}{(x_1-x_2)^{2n}} + \dfrac{1}{(x_2-x_3)^{2n}} + \dfrac{1}{(x_3-x_1)^{2n}}} \qquad (5)$$

when n is any positive integer. The greater n is, the better the estimate; but usually an n of 2 is sufficient.

7. Rational Determination Using Complex Algorithms

Plants must be balanced with respect to materials and energy. If these are apparently not in balance, it should be assumed that there is either a leakage or abnormal energy emission or that something is wrong with the measuring instruments. If the relationships between pressure and flow do not meet a predetermined mathematical model, it is highly probable that pipelines or resistant element are clogged or control values may have failed to shut completely. Generally, any excess or lack of flow of material and energy in and out of a plant will accumulate as time passes, causing potential values, such as temperature and pressure, to become abnormal. Therefore, one may conclude that diagnosis by flow should be made prior to diagnosis by potential value, and thus is a desirable method of diagnosis for abnormality.

However, checking by flow has to rely on slight deviations in levels between inlets and outlets and this is difficult because of the limited accuracy of instruments, as described earlier.

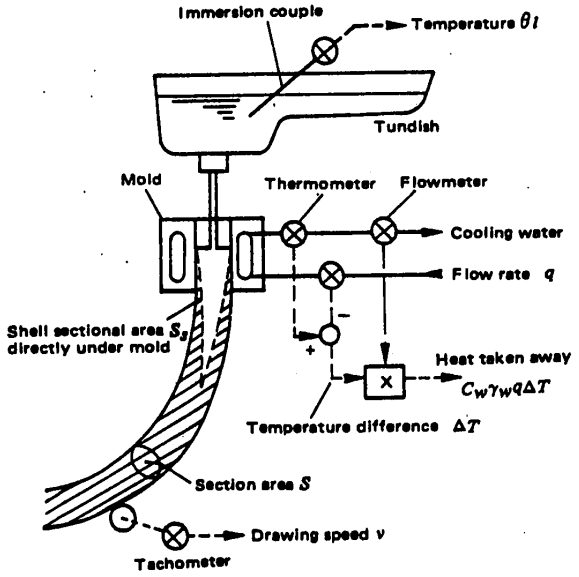

Fig. 5. Shell Wall Thickness Computation System

Fortunately, in plants in general, considerably data is available from instruments monitoring general operation, and it is possible to ascertain the existence of abnormality and further to estimate the position of failure on the basis of the most reasonable values or the statistically most probable data obtained, by comparing data from different sources.

A description of the above for a practical plant would require a lot of space. So, only a typical process is examined as an example.[9] This example is of a diagnostic system for an abnormal flow line system, as shown in Fig. 6.

If the true value of flow in the line is assumed to be x, and the following static characteristics are established for the control value and the nozzle:

$$x = C_V(u)\sqrt{P_1 - P_2} = C_n\sqrt{P_2 - P_3} \qquad (6)$$

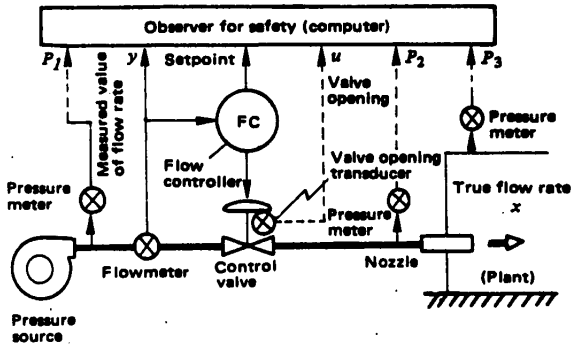

Fig. 6. Trouble Diagnosis System

Table 2. Diagnosis Table for Logic Computation

Flow rate difference	Control output	Valve opening	P_1	P_2	Breakdown element
Over the upper limit	Full open	Full open			Controller
		Full shut			Control actuator
	Full shut	Full open			Control actuator
		Full open	Over the u.l.		Pressure source
					Control valve
Under the lower limit	Full-open	Full open			Control valve
			Under the lower limit		Pressure source
				Over upper limit	Nozzle closed
		Full shut			Control valve drive
	Full shut	Full open			Control valve drive
		Full shut			Controller

where $C_V(u)$ and C_n are values proportional to the so-called CV. Assume that the standard values (values for normal operation) of $C_V(u)$ and C_n are $C_{VO}(u)$ and C_{nO}, respectively, and deviations from the standards are $\Delta C_V(u)$ and ΔC_n. From equation (6), approximate flow values x_1, x_2 and x_3 indicated by the flowmeter, the control value and the nozzle, respectively, as follows:

$$\begin{aligned} x_1 &= y \\ x_2 &= C_{VO}(u)\sqrt{P_1 - P_2} \\ x_3 &= C_{nO}\sqrt{P_2 - P_3} \end{aligned} \qquad (7)$$

Using this and the 2 out of 3 method result of equation (5), the most reasonable flow value $\hat{x}$ can be obtained. And here, error Δy of the flowmeter, and deviations $\Delta C_{v(u)}$ and ΔC_n of the control value and the nozzle can be expressed as follows:

$$\begin{aligned} \Delta y &= y - \hat{x} \\ \Delta C_{v(u)} &= C_{vo(u)} - \hat{x}\sqrt{P_1 - P_2} \\ \Delta C_n &= C_{no} - \hat{x}\sqrt{P_2 - P_3} \end{aligned} \tag{8}$$

If Δy, $\Delta C_{v(u)}$ *and* ΔC_n exceed control limits, the process can be regarded as being abnormal, and the location of the breakdown can be ascertained.

There is another method of diagnosing abnormality. It discriminates input data into three thresholds -- high, intermediate and low -- and diagnoses by means of a logic table. Table 2 shows the logic table for Fig.6. This is not able to check disorders in flowmeters, but is able to detect disorders at other positions. This method allows microcomputers to be used for automatic diagnosis, requiring far fewer resources than for the above-mentioned algebraic calculation. Thus, it is widely applicable to parts other than the most important.

The above two methods are primarily for static observation. As they concentrate on the rationality of flow, static observation is enough. In practice, there are many plants in which attention is required to be given to abnormalities in dynamic characteristics.

For noise from rotating machines and engines, vibration from piping and combustion vibration from furnaces, vibrational and acoustic modes serve as important information for detecting abnormalities. Particularly in the case of rotating machines, acoustic modes consist of distortion waves with the number of revolutions as fundamental waves, permitting, in most cases, abnormalities to be detected through mode variations of harmonic waves. Extensive information on abnormalities can be collected by attaching acceleration type oscillation pickups to engines and analyzing the output by FFT (Fast Fourier Transformation) and examining graphic power spectra[10) 11).

One of the problems with frequency analysis is the difficulty in determining a prior: the relationships between abnormal and vibration modes. So, in most cases, an algorithm must be empirically determined for each machine under diagnosis. On the other hand, attention may only be required, for specific machines and equipment, to one or two kinds of high-frequency power, and in such cases OSI is feasible only by providing a simple band-pass filter.

Another method which has attracted attention as a means of diagnosing abnormality is time series analysis.[12) This uses as an information source random signals having no fundamental waves. Pressure, flow, temperature and other appropriate state variables detected in the plant at fixed interval $\Delta T$are sampled and the data obtained therefrom is stored in the computer. If the latest data is assumed to be x_t, and the preceding data to be $x_{t-1}, x_{t-2}, \cdots, x_{t-i} \cdots$, we can obtain x_t from:

$$x_t = \sum_{i=1}^{M} \phi_i x_{t-i} + e_t \tag{9}$$

where e_t is white noise for a mean 0. M is finite, and the current value is free from the effects of data before the M-th value. Equation (9) represents the AR model (Auto-Regressive Model). As the name implies, once coefficients $\phi_1, \phi_2, \cdots, \phi_M$ are determined, a current value is automatically determined from the past values.

The calculation methods[12)14)15)] for determining ϕ and M from a series of data are omitted, but it is important that one can represent the occurrence of abnormality by a variation in ϕ or M for data collected in the plant. With this method, too, great efforts in analysis are required to logically associate variations in the AR model with trouble in equipment. However, this method is being studied for applications in diagnosing abnormalities in atomic power plants,[16)17)] for example, and it is hoped that it will prove useful.

In addition, it is considered that vibration analysis and time series analysis have essentially the same mathematical basis. It is characteristic of vibration analysis that attention is focused on power spectra with phase information omitted from Fourier transformation, and this analysis is applicable to the diagnosis of systems having fundamental frequencies.

8. Diagnosis for Abnormality by Evolutional Algorithms

For small-scale systems, diagnosing abnormality is possible by the use of rather simple logic. For larger systems, the fixed algorithm requires enormous efforts in its design. So, an attempt is made to use computers for total control that has conventionally been performed by operators relying on "skill and experience." An example is given below, in which final judgment is always left to personnel with preliminaries assigned to computers.

This concept is shown in Fig.7. It may be assumed that the safety of each loop is assured, for example, by the method described in Section 7. Control variable x is used as a representative value to compose an input group. Input (multivariable) x is converted into output y (monovariable) by translating algorithm Ai, where y takes at the most the following four values:

$y = 0$ both safety and quality are acceptable.
$y = 1$ safe, but quality not acceptable.
$y = 2$ pre-emergent state; take prompt action.
$y = 3$ emergency state; apply emergency cutoff, and report to divisions concerned.

The translating algorithm gives the first trial answer

$$y_O = A_O [x]$$

However, the operator, at his own discretion, does not press the pushbutton switch for y=0, but presses the relevant pushbutton switch only when he considers y=1, 2 or 3. When the translating algorithm makes a different decision from the one

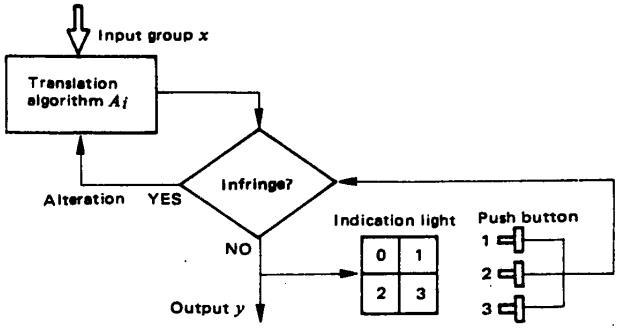

Fig. 7. Integrated Data Processing System

the operator makes, the translating algorithm is automatically revised to finally give

$$y_n = A_n[x] \tag{10}$$

In this way, A_i is trained to the level of the operators as it experiences a variety of cases so that it can monitor abnormality in place of the operator.

For mathematically training A_i, GMDH (Group Method of Data Handling)[18)19)] is applicable. GMDH is characterized by its ability to identify multivariable nonlinear functions with a rather small amount of data, and is suited to the training of A_i.

An assumed example of the result of the translating algorithm trained as described above, is shown in Fig.8 for a 3-dimensional application. Generally, the translating algorithm should meet the following requirements:

1) Input must not exceed the upper limit permitted for the plant.

2) Input must not be below the lower limit to enable reaction. (Any natural stoppage of reaction is dangerous.)

3) In respect of material balances, input must have a proportional relationship.

4) In connection with other state variables and set points in the plant, input must be within a certain distance from the set points.

In other words, it is presumed that the shape will be close to a shell structure with the corners of a multidimensional ellipsoid having the set point at the center cut off on the surface.

When the system shown in Fig.7 notices abnormality, the operator begins to make decisions. That is, machines are not yet able to perform advanced diagnosis and processing. They handle routine monitoring jobs, freeing the operators to take charge of advanced work which only they can perform. This is the principle of this system.

9. Warning Operators of Abnormality

The method described in the preceding section has a drawback in practice. Most plants are generally operated

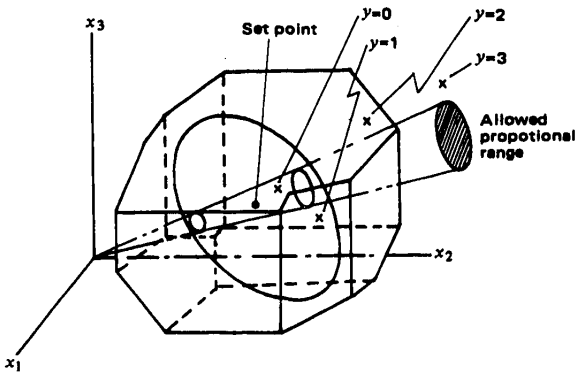

Fig. 8. Example of Translation Algorithm

safely. Therefore, it is most unlikely for a situation to occur where an emergency shutdown is required. Therefore, it takes a very long time for y to experience the values 0 through 3 in a single plant.

To begin with, safety should not be built on the basis of each plant's or person's experience of accidents. Guidelines for plant operation should be established on the basis of logic accumulated a prior: in the conviction this much safety must be certain, and analysis of disasters experienced both in Japan and elsewhere in the world. All operators and plant engineers have been in "open situations," and have made guidelines for operation by combining their own experience with information from every corner of the world.

The ability to secure safety without past experience of accidents is an advanced human function; computers can never do this. The method in the preceding section also depends, in this sense, on human ability. Is there any easier method of extracting this human ability? However skillful operators may be, they might fail to take appropriate measures in an emergency under the heavy mental burden of monitoring a large number of instruments. This section reviews warning techniques using the learning ability of operators.

Fig.9 shows multipoint display (overview display) of bar graph using CRT's. This system displays the state variables of each part of the plant as original data on CRT's. It is able to display 100–200 points. The bar graph, by nature, has no specific features. Operators watch a bar graph and judge "the plant is all right" or "such and such a section is abnormal."

In other words, operators observe the entire pattern made up of the indications of individual points and improve their cognitive ability through their own learning faculties. Presently, overview display is in wide use, almost becoming essential to instrumentation for safety. It has only the drawback of containing too many indication points to permit an easy understanding of the whole image, thus allowng local points which may be abnormal yet uninfluential on the whole system to affect understanding of the whole image.

Fig. 10 shows another display using smooth polar coordinate patterns developed by Dr. Yamazaki[20)21)]. The technique of

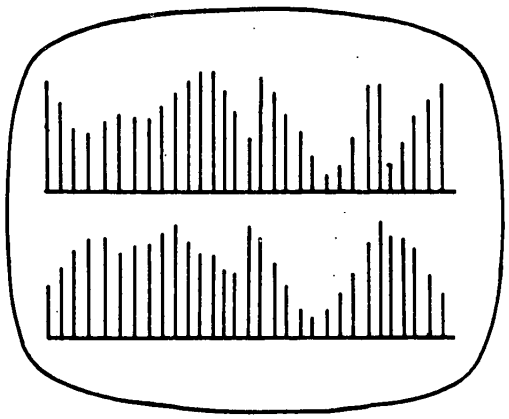

Fig. 9. Overview Display

displaying multivariables using a star graph is very old. But a whole image displayed by this method was difficult to recognize as the corners were too jagged. This method here, on the other hand, uses a continuous curve as the edge. The radii are normalized, and the display system is designed to display a neat circle for normal states. The circle distorts for abnormal states and it is easy to learn how to read images. Presently this method is applied in medical diagnosis with remarkable results, and also is expected to play an important role in plant operation. Unlike the overview display, it is able to deal with only 12 (same as clock hours) variables but this is not a disadvantage. The state variables of each part of a plant can be prereduced to several main components. Of course, an algorithm must be designed and produced for analysis of main components, since it is important for overall understanding to reduce variables.

The present writer proposes the Harmony Method,[2)] which uses a major harmonic tone for example, do-mi-so, to represent several main components. A tone is raised half a tone when any component exceeds its upper limit, and is reduced half a tone when any component exceeds its lower limit. When an operator presses a button, a harmonious chord sounds from speakers if the plant is normal. It becomes a discord if the plant becomes abnormal, alerting workers to the situation.

In short, the method aims to accelerate human learning by making workers instinctively aware that something is wrong, as with a distorted circle, in case of abnormality.

10. Conclusion

The problems of control for plant safety, particularly techniques for detecting abnormalities, have been reviewed. But, the problem of what measures to take or how to apply emergency shutoff in accordance with the results of diagnosis has been completely omitted. This is because the method of shutoff varies from plant to plant and is technically relatively simple. Instead, abnormality is occasionally seen in the failure

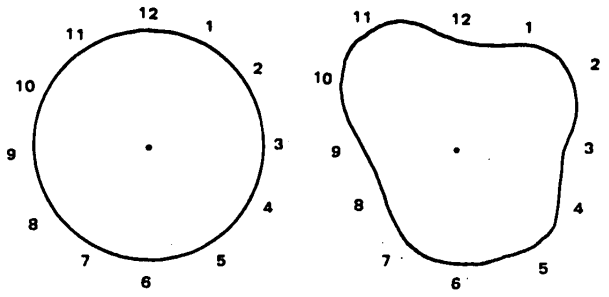

Fig. 10. Smooth Polar Co-ordinant Pattern

of shutdown values to close or safety values to open during shutoff. Conventionally, this trouble was considered to be "improbable," and not taken into account in designing. In fact, it is unreasonable to expect controls which are only operated once in several years to "work properly." Such exceptional conditions must be taken into account in designing measuring and control systems for safety to increase the reliability of the total system by means of multiple protection.

Also, interlocks very effectively prevent misoperation. However, this means has not been described here because interlock systems vary from plant to plant. But, to mention key points, interlocks today are limited to operation in instrument rooms, and are not designed for the overall plant site. This occasionally invites the mistake of freely opening and closing hand valves in the total area of the yard. Extending the interlock system will no doubt be a heavy economical burden, but the basic concept "it costs as much as is necessary to buy safety" must be recognized.

Finally, to summarize technology for detecting abnormalities some of the methods and techniques described in this paper are already in wide use, while those described in Chapter 7 and onward have been first proposed by engineers including the writer. There is, now, growing demand in society for the assurance of safety, and to meet this demand, a variety of devices and proposals must be attempted. The writer believes that efforts must be continued to "achieve higher safety" by steadily accumulating good results over a long period.

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SCIENCE AND TECHNOLOGY

SEMANTIC GAP IN COMPUTER ARCHITECTURE

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[Article by Noriyuki Kamibaysahi, Assistant Professor Faculty of Engineering, Hiroshima University]

[Text]

Introduction

This paper takes up the structural problem of the semantic gap existing in todays's computer systems and discusses a method for its solution. First, the paper analyzes the basic principles of current computer systems (method for integrating a basic computation model, the computer architecture and the language system based upon it, to set the stage for a a discussion on basic and derivative problems. Then it examines the adverse effects on the computer system environment caused by the semantic gap between the computation model assumed by men (programmers) and the computation model which is the basis of actual computer systems. Next, it introduces examples of the author's approach to their solution and discusses their effectiveness. Lastly, it presents general opinions.

A third of a century has already passed since the world's first computer, the ENIAC, was born. Innovations in computer technology and changes in the data processing system environment made during this period are drastic enough to make us feel that we are now living in an entirely different age. A glance at the period produces these examples: surprising improvements in computer performance specifications (i.e., execution speed, storage capacity, equipment scale, etc.), technological innovations for elements of computer hardware logic which demarcated computer generations ranging from vacuum tube to VLSI, the increasing importance of software and the enlargement of its scale, changes in computer system organization (from centralized control to decentralized control) and design (from gate-level design to PMS (Processor Memory Switch)-level design), and diversification and advancement of computer applications fields.

However, although technological progress has been remarkable, the basic architecture (framework) and principles supporting computer systems remain virtually unchanged from

those established 35 years ago. The basic framework refers to the architecture of the computation model, hardware, and software (operationg system and languages) introduced by von Neumann.

Recently, this architecture has given rise to the criticism from various computer science fields that a data processing system based upon it contains fundamental drawbacks which cannot be overcome only by technological innovations. A particular objection is that such a system does not reflect any software principle but only the hardware logic based upon the technological standards valid in the ENIAC era. This complaint is not overly exaggerated since the effects of a von Neumann type system upon software are not all desirable; some of them are proving to have adverse effects on software productivity and reliability and thus the entire system. This problem lays at the heart of computer systems but has been left untouched to date. With only the conventional computer system improvement method complying with the basic principles established for pioneer machines, it is difficult to build up a data processing system meeting the requirements of the 1980's. A new architecture combining hardware and software principles different from those of von Neumann is needed in the coming era.

The presence of fundamental problems not solvable merely by innovation is being recognized and their solutions are being directed at the principles of current computer systems. Fundamental questions are being presented and efforts for obtaining answers are being made in respective computer science fields. A requirement of the 1980's is the consolidation of these efforts into a new trend, the creation of a new concept (computation model), and the rebuilding of a basic computer system structure based upon the results. Example attempts already made to accomplish this task are: progress in the theory (of a new computation model and computer architecture), advancement of hardware technology (e.g., VLSI technology). establishment of new software technology fields (e.g., software engineering), and recognition of the need for avoiding software crises, etc.

Today's computer systems are loyal to the principles of von Neumann. Languages developed for them show clear traces of having complied with the von Neumann type architecture. Von Neumann type languages appeared and spread only because of the existance of von Neumann type computers; and this in turn further secured the position of von Neumann type computers, resulting in the survival of computers containing fundamental drawbacks and their becoming the mainstream of today's machines.

The biggest factor bringing about the above situation is the lack of an adequate theoretical basis for the technology-oriented development cycle of an entire data processing system. Although present computers are becoming increasingly stylish in external appearance and their specifications are continually improving, thus succeeding in deepening the impression of their high "intelligence", they contain fundamental internal contradictions.

It can be argued that the computer system design environ-

ment prevalent in the ENIAC era and today's counterpart are completely opposite. In the former, not only were software principles and applications unknown but also simplification of hardware was mandatory to minimize cost. In the latter, however, the cost of software occupies 70 to 80% of the total and the trend toward an increase in this ratio is expected to continue. Under these circumstances, simplification of hardware only results in complicating costly software. In addition today's microelectronics, represented typically by VLSI technology, provides hardware logic at a surprisingly low cost. Given these circumstances, hardware simplification and the resulting "over generality" of computer architecture is not only not useful but fatal to the total system.

The cause of the defects in current computer systems lies in the gap between the computer architecture optimum for processing a job and the low level computer architecture actually applied. In this sense, it can be said that the ultimate goal of the computer system is to minimize this gap (the semantic gap). To minimize this gap, optimization of the allotment of roles to hardware and software is important. The result is to add weight to the hardware role and prepare a better environment for software design and execution.

Before ending its introduction, this paper confirms its ground for approaches to the conquest of the semantic gap. The approaches are broadly categorized into two: one aiming at gradual improvements on the von Neumann type architecture and the other pursuing the development of an entirely new computer system architecture based upon a new computation model. The standpoints of both are very closely related in a sense. It is not sufficient to have only the latter. Nor can it be foreseen that the latter becomes the mainstream. The mainstream will be a mutually beneficial combination of both.

The following chapters present problems in current computer systems seen from the viewpoint of the semantic gap and approaches to their solution.

1. Semantic Gap

From the standpoint of a computer architecture researcher, this chapter discusses the semantic gap problem of the present computer architecture and its visible and invisible adverse effects upon software environment.

1.1. Role of Computer Architecture and Von Neumann Type Computer Architecture

(a) Computer Architecture:

First, this section defines computer architecture; the terminology "computer architecture" having recently become popular as its importance has been recognized. The fact that the concept was first introduced into the design of the IBM system/360 is of important significance. In 1964, the chief designer of the IBM system/360, Amdahl, defined a computer architecture as follows:

"A computer architecture is the attribute of a computer system seen from the viewpoint of programmers. It is a conceptual structure or functional operations abstracted from the mechanism of data flow, control scheme, logic, design, physical feasibility, etc."

In less formal terms, the definition could be expressed as:

"A computer architecture is the basic knowledge about computer hardware operations which is necessary for writing programs in a machine language (i.e., knowledge of instruction formats and kinds, addressing scheme, I/O operations, etc.)."

However, the above definition can no longer correctly express the essential concept of the architecture of a current complicated computer system. The concept has now broadened. It is generally recognized that architecture should be defined in a broader sense to grasp the framework requisites which determine the basic performance of a computer system. Therefore, the following definition may be appropriate.

"A computer architecture is the method used in the design of a computer system to construct the system through a synthetic perception of hardware and software technologies."

The method determines system attributes such as logical specifications, configuration, construction elements to be selected, data processing modes, method for allotting functions to hardware and software, and their interface level. The technology which systematically pursues this method may appropriately be called "synthetic computer system engineering." Today's objectives in a computer architecture are improvement of processing efficiency by moving software functions to hardware functions, reduction of burdens on the operating system, flexibility of the computer system structure to various processing modes, and versatility, expandability, and applicability of the system.

(b) Von Neumann Type Computer Architecture and Its Current Problems

Most of today's computers have the characteristics offered by von Neumann. The characteristics are:

(1) Stored program scheme
(2) Sequential program execution
(3) Identical treatment of data and instructions
(4) Linear addressing to storage space

Almost all commercial computers today faithfully conform to these characteristics. When judged from the standpoint of the current technology level and results of computer system research, the characteristics do not mirror those of prudent synthetic considerations for desirable system construction. They are what were selected to comply with the old technology level and solve old hardware cost problems. In fact characteristics (2), (3), and (4) only serve for simplification of hardware logic. Considerations for software logic or for essential programming methodology are not embodied in any of the above characteristics. The present structural software problems (low software productivity, abnormal enlargement of software, low processing efficiency, etc.) are not innate; software is compelled to deal with the problems although a computer architecture should deal with them.

1-2 Semantic Gap[23]

This section clarifies the nature of a semantic gap by first defining it and then describing its historical transitions in line with the current trend of programming language research.

Generally (in a broad sense), a semantic gap refers to the difference between an abstruct computer architecture or a computation model assumed by a programmer and an actual computer architecture. Semantic gaps can be classified as follows.

1-2-1. Semantic Gaps Seen in Programming Process

(a) Semantic Gap Type I

A semantic gap of this type is defined in "Advances in Computer Architecture"[1] written by Myers. It is a yardstick of the difference between a computation model provided by a high-level programming language and an actually implemented computer architecture. The yardstick is a clear basis for the complexity, reliability, and efficiency of the system software in a current computer system. Contraction of a semantic gap of this type prevents the system software (operating system, compilers, data base system, etc.) from being abnormally enlarged and thus overly complicated.

(b) Semantic Gap Type II

A semantic gap of this type is the difference between a user (programmer)-assumed abstract computer architecture and a computation model provided by a high-level programming language. It is a yardstick of the software productivity actually felt by the programmer.

One thing to be noted here is that users of conventional high-level languages (FORTRAN, COBOL, etc.) are sometimes forced to write machine-dependent programs. This means that even these von Neumann type languages cannot blind the programmers to all hardware-dependent characteristics. The next semantic gap type is introduced to explain this situation.

(c) Semantic Gap Type III

A semantic gap of this type is the total of a type I and a type II semantic gap. It is the gap between a programmer-assumed abstract computer architecture and an actually implemented computer architecture.

2-2-2. Semantic Gaps Seen From Hierachical Abstract Machines

An effective method for designing a computer system which contains both a large operating system and a data base system, is to build abstract machines one by one upon a bare machine.[13][14][15] (See Figure 2.) This method provides for reducing of the large semantic gap existing between the bare machine and that of the final abstract which is considered as an application machine.

At present, the application machine is built by software thus resulting in enlargement of the software and lowering of reliability.

2-2-3. Historical Transitions of Semantic Gaps

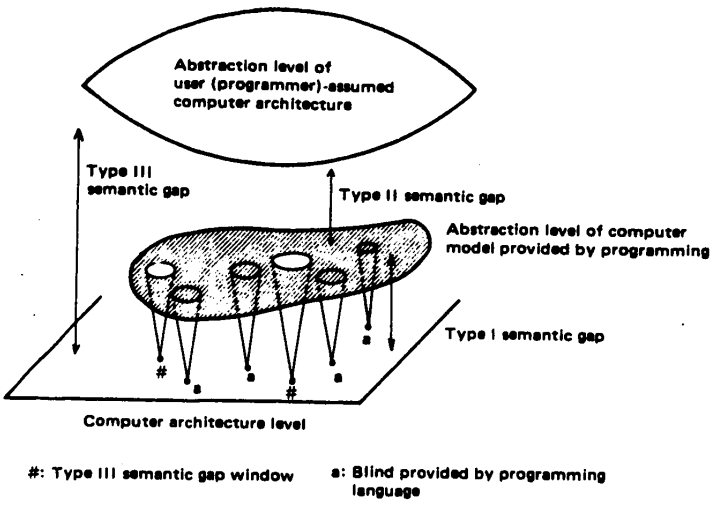

Fig. 1. Relations Between Three Types of Semantic Gap

Figure 3 shows the historical transitions of semantic gaps.

(a) User's Abstract Machine Level

The level of a user's abstract machine heightens as its applications are extended and advanced.

(b) Computer Architecture Level

Little changes have been made in the levels of computer architecture. Although many varieties of computer architecture have been proposed on a trial-and-error basis, they have hardly contributed to reducing the semantic gap. They make only the following two contributions:

i) Provision of logical address space instead of physical address space.

ii) Provision of virtual storage eliminating the need for concern over the main storage capacity.

These two free programs from restrictions on program size and storage system environments.

(c) Programming Language Level[4]

The level of a programming language determines types I and II semantic gaps.

(i) Machine Language and Assembler Language

The level of a machine language is equal to the level of computer architecture. The level of an assembler language is almost equal to it.

(ii) Von Neumann Type High-Level Languages

Programming languages called high-level languages (FORTRAN, COBOL, etc.) were introduced around 1960 and are still in use today. An objection has arisen from results of recent programming researches to calling them as high-level. The reason for this is that they lack fundamental programming methodology since they were basically premised on von Neumann type computer models (hardware logics).

(iii) "Program=Data Structure + Algorithm" Type Languages

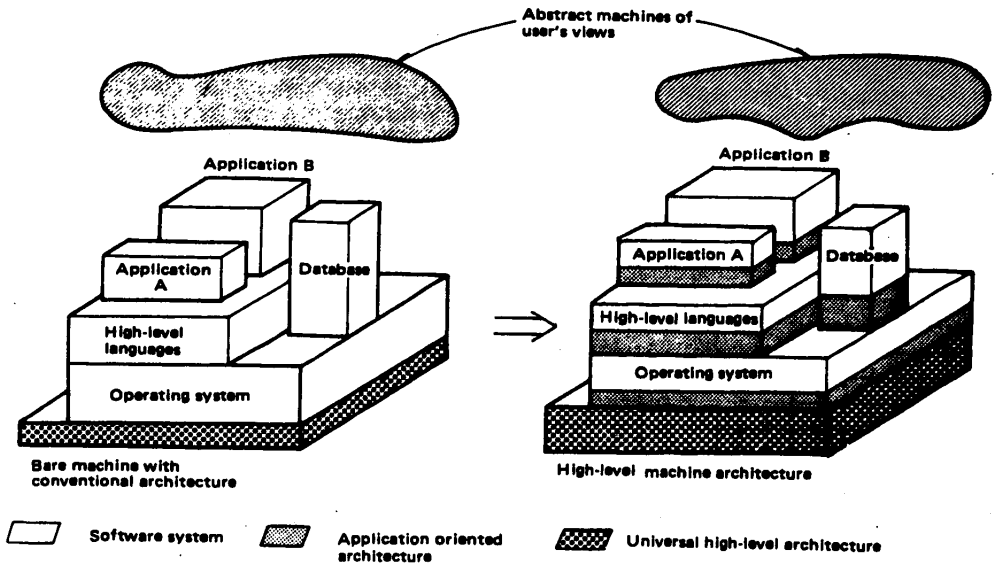

Fig. 2. Hierarchical and Abstract Machine Approach (Conventional System vs Advanced System)

Typical of these languages is PASCAL. Having the capability to define data structures, this language is appraised as it has proved that this capability is as important as program algorithm. The capability provides a clear distinction between PASCAL and the previously mentioned languages (i) and (ii) which do not distinguish data (structures and attributes) from instructions (codes). Once a data type (a structure and attributes) has been defined, the data not only allows manipulation by instructions at a high abstraction level but also contributes to improvement of compile-time error checking capabilities.

(vi) Abstract Data Type Languages

Abstract data and languages based upon it were introduced by such a splendid idea as born only once in a software engineering decade. The language employs an ideal synthetic programming methodology which piles up program modules with abstract data one above another. The abstract data has the following characteristics:

(1) All the attributes of abstract data, called data object, and operations allowed on it are defined.

(2) The object allows "information hiding" which makes it unnecessary for the user to be concerned about its physical implementation.

(3) Employing a concept called "enforcement," the object can be accessed only by predefined operations and not directly by physical expressions.

Languages of this type are CLU, Alphard, Concurrent Pascal

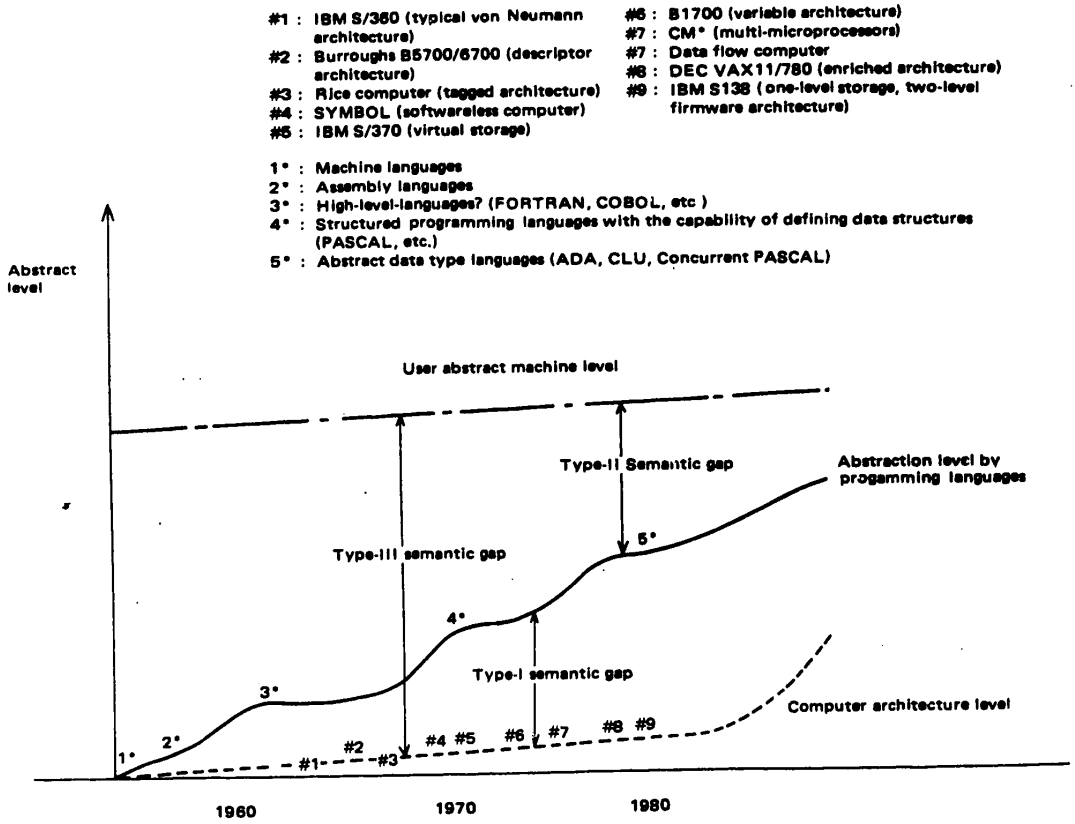

Fig. 3. Three Types of Semantic Gap

Modular, etc. ADA now being developed by the U.S. Department of Defense is a practical language of this type.

Besides the above programming languages, there are languages which make the λ calculus their computation model but discussion of these is omitted.

What should be noted here is that programming languages (iii) and (iv) differ fundamentally from (i) and (ii) in that the former have the capability to build an user-assumed abstract machine step-by-step. Although this capability of type (iii) language PASCAL is still meager, that of the type (iv) languages is excellent. One who recognizes that the essence of a programming process rests in iterating abstractions step-by-step and employing a method which supports this procedure will finally arrive at these languages.

As seen above, the basic idea of a programming language during the past one-third century made a 90-degree turn at (iii) and a 180-degree turn at (vi).

Table 1. Major Factors of Semantic Gaps

	Von Neumann type conventional architectures	Advanced computer architectures	Concepts of advanced programming languages	Abstract machine of user's view
Processing principle				
Logic	Deterministics	Deterministics, Heuristics	Deterministics	Deterministics, Heuristics Ambiguity
Control	Sequential control flow	Data driven flow	Abstract data type & functional languages	More english like more mathematical
Operation	Sequential	Parallel	Parallel, concurrent	Parallel, concurrent
Numerical processing				
Precision	Fixed	Variable	Variable	Variable
Data representation	Binary	Decimal (Synbolic)	Decimal (Symbolic)	Decimal (Symbolic)
Data object environments				
Data independency	No	Essential	Essential	Essential
Data & instruction	Identical	Distinguished	Distinguished	Distinguished
Data length	Fixed	Variable	Variable	Variable
Data structure	No	Yes	Yes	Yes
Self-defining data type	No	Essential	Essential	Essential
Addressing principle				
Addressing space	Linear	Structured	Structured	Structured
Addressing scheme	Direct addressing base	Content & context addressing base	Content & context addressing base	Content & context addressing base
Capability				
Capability & error free	No	Essential	Essential	Essential

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Note that although the programming language level has been greatly heightened, the computer architecture level remains unchanged. This situation increases the burden on software to a more and more undesirable extent. (See Fig. 3.)

1-3 Causes and Results of Semantic Gaps

This section analyzes the causes of the semantic gaps discussed in the preceding section and discusses the adverse effects of the gaps. This task is accomplished on the basic requirements for a user-assumed abstract machine and a desirable computer architecture while comparing the von Neumann type architecture with the idea of the recently advanced programming languages.

1-3-1 Processing Principles

(a) Deterministic Logic vs Nondeterministic Logic

Von Neumann type computers premise a deterministic logic. However, an advanced information processing procedure reflecting a man's thinking process or creative activity cannot generally be expressed by a sterotyped algorithm but by a non-deterministic logic[2]. Weapons indispensable for advanced data processing are a nondeterministic logic and a heuristic logic. If these are absent, an overhead of reflecting the nondeterministic logic upon a deterministic logic is produced thus causing a semantic gap. Besides, procedures such as those in pattern recognition require processing involved in ambiguity[21] From now the importance of a technique for processing ambiguity will increase.

(b) Control Flow vs Data Flow.

In a von Neumann type computer, data is processed according to a control flow which is subordinate to the control flow of instructions. However, the recent trend toward parallel processing and functional languages has proved the superiority of data flow for describing and controling parallel processing[3]. The proof is a conclusion that since parallelism and asynchronization are solely determined by data dependency, casting spotlights upon data dependency is more advantageous. In a current computer, the burden of detecting a parallel processing possibility from instructions (executed according to a control flow) through their data dependency and of guaranteeing its asynchronization are left to the system software and user. The execution environment of the computer is based upon the control flow. This situation is a typical semantic gap.

(c) Sequential Processing vs Parallel Processing:

A processing principle of von Neumann type computers is sequential processing. Jobs generally contain routines which can be processed in parallel. However, since today's computers and languages are based on the von Neumann model, these jobs cannot be expressed as they are but their straight forward expressions must be converted to sequential alogorithms. It is desirable to naturally reflect the processing characteristics of

jobs upon the execution environment. From this point of view, the principle of parallel processing is superior because it imposes fewer restrictions.

1-3-2 Numerical Processing

Computers were originally developed for scientific computation. However, their numerical processing features contain fundamental problems.

(a) Fixed Precision vs Variable Precision:

Present computers provide only the fixed precision feature because of hardware restrictions. Therefore, when a user requires a certain precision (for example, 50-digit precision is required for computation related with nuclear power), he must program a precision feature of his own. At this time, he must of course confront the problem of hardware dependency. As can be seen, even this kind of fundamental requirment is not satisfied by present computers. The harmful effects of fixed precison are subtract errors, truncation errors, and rounding errors. The variable precision feature is indispensable for avoiding these.[5][6]

(b) Error Free Computation:[6]

Present computers are based upon fixed length words as described before. This also results in subtract, truncation and rounding errors being intrinsic to the computers. The consequences of these errors are that numeric data specified by users cannot be expressed correctly in the computers and that an effective precision cannot be obtained. Therefore, for example, a user trying to solve quadratic or matrix equations must first study the theory of error, accomplish error analysis, and carefully program the results of these efforts to obtain correct answers. This means that a series of steps not central to the problem at hand is required, that the execution efficiency decreases, and that the programming overhead increases. The situation remains the same when a high-level language is used. To get rid of this semantic gap, a computer feature assuring any number of effective digits (precision) is indispensable. The feature also contributes greatly to the improvement of fraction computation.

Even in the numerical processing field where von Neumann type computers are in their element, a semantic gap due to the low-level computer architecture still exists as seen above.

1-3-3 Data Environment

This section discusses the mechanisms related with data types the importance of which is increasingly recognized in the programming language world.[1][4][5][7][8][9]

(a) Data Dependency vs Data Independency:

The concept of data independency pertains to data base processing. Data independency means that application programs accessing a data base need not be modified even if attributes and structures of the data base are modified (for example, if integer type data is changed to floating point type data). Unless this characteristic is provided, a great overhead in modifying programs must result. The minimum assurance for avoiding this requires the programs to exclude instructions accessing data structures or affected by data attributes. In a computer

architecture providing this assurance, tags and descriptors should hopefully be used; resulting in there being no more information concerning data definitions than the tags carried by the data itself. The architecture guarantees complete data independency by this means, greatly contributing to program development, maintenance, and reliability. The above concept is one of the basic programming language concepts of today.

(b) Non-Self Data Type Definition vs Self Data Type Definition:

A result of recent programming language development clearly indicates that data types are the starting point of programming. However, there is no distinction between data and instructions nor assurance of data types in present computer systems. For this reason, software reliability cannot be guaranteed during execution, data environment errors cannot be checked, and debugging functions are meager thus resulting in the creation of a large type II semantic gap.

The above problem can be solved if each data cell contains information indicating its type (attributes and structure). This self-definition capability is also a factor indispensable for the assurance of data independency described in the previous section. Furthermore, it may help the solution of the problem described in section 2-3-2 since it facilitates the expression of variable length words. The importance of the capability has long been recognized but is now reviewed from a new angle urged by apprehensions resulting from present software problems and proposals for remedial action made by recent programming languages. The most basic principle in a future computer architecture will be this data type self-definition capability. Also, the data environment must be strongly supported to fill the gap between the present computer architecture and the compuation model of a programming language.

1-3-4 Addressing and Non-Numerical Processing

(a) Linear Addressing vs Structural Addressing:

A von Neumann type computer provides linearly addressable storage space so that data with complicated structures and variable length data must be copied by instructions to the linear space for access by instructions. It is a fatal semantic gap that the storage system cannot copy the data structures by itself, since the work load is placed on user or system software thus depriving programs of productivity, causing coding errors, and hindering programming abstraction. The information hiding concept (for eliminating the need for knowing physical data object formats) described in section 2-2-2 gives a remedial measure in this regard, so does the data type self-definition capability (tags and descriptors) described in section 1-3-3.

(b) Address Addressing vs Content Addressing:

The most intimate and trite semantic gap is the one related to the data access method. It has long been recognized that for a data base processing data access by content (content addressing) is far superior to data access by address (address addressing). Although the basic principle of the former is relatively simple, because it encounters the difficulty of generalizing output formats, its realization is still awaited despite its popularity and associated lively discussion. However, the

importance of content addressing (as well as associative processing) for solving the semantic gap will increase as future computer applications proceed to sophisticated data base processing. Recently, a concept extended from the concept of content addressing and called context addressing has been proposed. This concept aims at automatic access according to contextual meanings. This function is expected to minimize the semantic gap inherent in data base processing and is thus attracting keen attention.

1-3-5 Capability

Von Neumann type computers completely lack features related to capability and protection. This fact means that they do not basically assure system reliability. For this reason, they have difficulty in sufficiently guaranteeing security, which is a more important consideration than protection.

(a) Non-Capability Addressing vs Capability Addressing:

Capability addressing assures that only the authorized process correctly accesses user-defined data structures through authorized operations. Present computers do not have this concept but provide only simple protection features functioning on main storage blocks. They entrust the main responsibility for reliability to users, who have therefore to prepare various check procedures and systems which are not essentially related with the algorithms of their problems. This situation is another semantic gap caused by the low level computer architecture.

(b) No Data Type Check vs Data Type Check:

As repeatedly stated, von Neumann type computers completely neglect functions to support a data environment. Their architecture does not prepare a means to assure the reliability of software during its execution. Hence a semantic gap arises between this architecture and the notion that provision of complete data type check functions contributes greatly to the enhancement of software system reliability, debugging efficiency, and program productivity. These functions support the data type self-definition capability described before and check:

(1) Whether a process has an access right.
(2) Whether an operation and a data type are authorized.
(3) Whether an attribute (e.g., a value range) defined by a data type is violated (exceeded).

Unless the above functions are provided at the architecture level, they have to be provided by the programmer or system software (mainly compilers). The responsibility for providing the functions is an annoying overhead on each programmer or compiler and produces an extremely adverse effect upon the system's execution efficiency. These constraints are the results of the semantic gap.

2. Sematic Gapless Computer Architecture

Based upon the analysis in Chapter 1 of computer architectures, causes of semantic gaps, and their results, this chapter discusses current approaches to a computer architecture with fewer semantic gaps.

2-1 Prerequisites for Semantic Gapless Computer Architecture

This section rounds off the prerequisites (i.e., needs and seeds) for a semantic gapless computer computer architecture and their conceptions.

2-1-1 Needs

Needs for a semantic gapless computer architecture have repeatedly been described in Chapter 1. The needs derive from the conception that in the current rush into the personal computing age, a computer with bare, mere, and superficial high performance (high speed) does more harm than good. In today's societies filled with huge amounts of information, the most important thing is to solve software problems (problems of reflecting men's intellectural activities upon computer systems). The solution requires good computers but not computers such as the above.

It can be broadly asserted that a computer architecture providing a good software environment and powerfully assuring productivity and reliability should be the next generation computer architecture.

2-1-2 Seeds

A semantic gapless computer architecture can grow from two seeds. One is the hardware technology level now typically represented by VLSI technology which is sufficient to realize the features described in Chapter 1. At the present level, the reserve power brought forth by the VLSI technology should be directed not to the pursuit of higher computation speeds but to the dissolution of semantic gaps. Although a satisfactorily synthetic methodology for dissolving them has not yet been established, establishment of methods for dissolving particular ones is fairly promising and progress has been made in the theory of its features. The seeds of a semantic gapless computer architecture are VLSI technology and a theory supporting software engineering, programming languages, and a computer architecture synthetically.

2-1-3 Basic Concepts

As outlined in the previous two sections, a semantic gapless computer architecture has its prerequisites. Future computer systems will generally be used with high level languages. Therefore, the use of these languages (i.e., abstract data type languages) in the above architecture is premised in the following discussion. Besides these, functional languages are being spotlighted but their full-scale realization will require much time because of the difficulty of their immigration to the present environment.

As described in section 1-2-3, sample attempts have already been made to fill the semantic gaps between programmers and programming languages (e.g., modularity, data type abstraction, parallel processing description capability). The greatest objective from now is to attain a reliable and efficient execution environment by consolidating the progressive and superb con-

ceptions of these new languages into a computer architecture. Approaches to this objective differ fundamentally from those toward the attainment of a conventional high-level language machine which orientates about a particular von Neumann type high-level language and thus is a von Neumann type computer. Only the basic concepts consolidated as above can truly be universal and indispensable for mechanisms of future computers.

The design of a future computer architecture requires optimum allotment of roles to hardware technology and software technology. Present computers represented typically by von Neumann type computers pay no concern to factors necessary in the software world. The fact that these computers are now the mainstream would perhaps frighten anybody.

2-2 Methodology for Semantic Gapless Computer Architecture

In the course of progress of an information-oriented society, software has long been playing the leading role of intellectual production activities. From the viewpoint of the current programming methodology, the so-called "high-level" languages such as FORTRAN, COBOL, and PL/I used at present give rise to the doubt: "How can they be at a high level?" because they cannot answer "Yes" to the following questions:

(1) Can program expressions be logically structured?
(2) Can problems be expressed using the concept of data abstraction?
(3) Are users freed from describing low level procedures which are basically irrelevant to their problems solution?
(4) Can parallel processing and its synchronization be described?
(5) Has due consideration been paid to automatic programming (e.g. for checking the eligibility of a program)?
(6) Is it unnecessary for programmers to consider hardware characteristics (word length, internal expression, precision)?
(7) Are the programming methodology and the program design compatible with the computer architecture?
(8) Are the roles of the compiler essential to the reduction of the semantic gap between the external architecture (problem expression level) and the internal architecture (execution level)?

Positive answers to these questions will lead to a tide of programming languages, that is, structured or abstract data type languages.

(a) Abstract Data Type Architecture:

An approach to a computer architecture which strengthens functions to express and manipulate data structures and attributes is introduced below. The objective of the approach is common to various other approaches to a high-level computer architecture for improving a fundamental defect of a von Neumann type computer.

The above functions provided by the so called "high-level" languages such as FORTRAN and ALGOL cannot help being found wanting. They bury the expression and manipulation in program algorithms thus providing an obstacle to structured

software design. Besides, very few current computers have a standard data structure manipulation function. The least of these computers barely support the "stack structure" indispensable for controlling the program execution environment. Reconsideration of this situation has recently awakened recogniton of the importance of data structures. To renew the basic programming method, structured programming languages such as PASCAL, CLU, and ALPHARD employ the concept of "program = data structure + alogrithms" meaning that defining data structures and attributes is as important to a program as defining algorithms. They provide language specifications requiring data structures and attributes to be defined before describing algorithms which manipulate the data. This is the philosophy of structured programming. An extension of this philosophy allows procedures manipulating the data structures to be defined in addition to the structures and attributes. By this feature, many errors which could conventionally be detected only during program execution can now be detected during program compilation. This feature is called capsulation of data structures and operations.

On the other hand, an application increasing in importance is data base processing of the non-procedure. This processing, which is one of the weakest points of a von Neumann type computer, executes procedures manipulating data structures. data structures.

As seen above, improvement of system efficiency requires provision of:

(1) Data structure expression and manipulation capability
(2) Data independency (extensive separation of data attributes from instruction attributes)
(3) Management of variable length data by the architecture

In conclusion, functions to be attained by a data structure-oriented high-level computer architecture are:

(1) Supporting structured storage space instead of linear storage space for the advanced data structure expression capability
(2) Extensively separating data from instructions
(3) Providing advanced data structure manipulation instructions

These may be attained through the use of tag and descriptor concepts. Approaches to the attainment will be fascinating since these functions supersede the basic data processing functions of the operating system of a high-level language machine.

3. Epilogue

The basic architecture of today's computers was established decades ago. At that time, important system techniques supporting the systems (e.g., multi-programming, multi-processing, virtual storage, TSS, network architecture, and data base) were not known. Frankly speaking, computer development staffs must have been unable to foresee how the utilization of computer systems would change and their applications would expand. To cope with this uncertainty, they set the computer architecture (machine instruction set) at a very low level and

mainly pursued universality to satisfy all needs, instead of paying the "high price" of coping with developmental difficulties. This approach must be compulsory when things are unknown, but entails the construction of huge software upon the low-level architecture, which is the biggest cause of today's software crises.

The crises mean that there is a great gap between the image of system designers about the design of a system and its actual computer architecture. They also mean that software is more and more complicated though hardware is simplified. For example, the objects of hardware design have shifted from gates (basic transistor circuits) through register transfer modules (RTM: IC or MSI) to processor memory switches (PMS: LSI) while greatly improving the productivity, maintainability, and reliability of hardware. The present computer architecture level corresponds to the gate design level. At this level, software development must confront a great many difficulties and requires craftsman-like skills. However, to cope with the processing overhead caused by abnormally enlarged system and application software, computer manufacturers have mostly been striving for the improvement of processor and memory cycle speeds instead of striving for the improvement or even modification (addition of instructions not conflicting with the architecture) of the weakest point (low-level architecture). (For example, since its introduction the processing speed of the IBM system/360 and 370 has been increased 100 times under the same architecture.) This approach would have been a rather natural selection under the two conditions; the rapid progress of semiconductor technology and the difficulty of developing bulky and completely new software. However, a new environment has recently been created for fundamentally reviewing the computer architecture level, as follows:

(1) From various experiences of system and application software design and implementation, the recognition of software features which should be supported with at the architecture level has been strengthened.

(2) High-performance mini-and microcomputers to be developed from now will not be restricted by existing software properties, and their architectures can be established relatively freely. They will expediently employ high level architectures to reduce their total system devleopment costs.

As summarized above, this paper explained the present situation of computer systems synthesized under the concept of semantic gaps and considered their solution.

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FIFTH GENERATION COMPUTER PROJECT

Tokyo TECHNOCRAT in English Vol 15, No 1, Jan 82 pp 29-47

[Text]

1. Introduction

Full-scale research and development for the fifth generation computer, which will be much more humanlike in its capabilities than today's state of the art computers, will begin from April of this year.

The project team has set the early 1990's as the target date for completion of a prototype fifth generation computer. In the process of R&D, interim results of this project will be incorporated in such areas as OA (office automation), CAD/CAM (computer aided design and computer aided manufacturing) and software development. The project is to be carried out under the leadership of the Ministry of International Trade and Industry, through joint study by universities, research institutes and companies, as well as foreign researchers and governmental organizations.

This project is so ambitious that there can be no guarantee of its success at this time. Only the enthusiastic endeavor of persons contributing to the project can overcome the difficulties which will confront their research efforts.

2. What Can the Fifth Generation Computer Do?

It is expected that the fifth generation computer will be able to think, make judgments and sense its environment much as humans do. It is a totally new concept in computer history. We can briefly outline its functions as follows:

1) It will be able to see and judge dimension and shape of objects and discriminate color. It will also be able to accept spoken requests and give its results in natural language.

2) It will have the ability to propose appropriate methods of solving specialized problems. For example, if supplied with the medical history of a patient, it could consult its reservoir of medical information and advise a physician on the precautions and possible treatment of the case in question.

3) When a user states his final objective and outlines a

working process, the computer will be able to program itself to achieve that objective.

4) The computer will describe the appropriate working process according to the specific requirements of a given job.

5) It will be able to detect and remedy problems within itself.

Professor Tohru Motooka, chairman of the Preparatory Study Committee for the Fifth Generation Computer, summarized in "The Proceeding of International Conference of Fifth Generation Computer Systems"* the goals of the computer project as follows:

1) To increase the levels of computer intelligence as well as their affinity for cooperation with man.

The five human senses can fulfill their functions only when backed up by the knowledge necessary to understand the information obtained through them. In order to raise the levels of computer intelligence and increase their affinity for cooperation with man, it is absolutely essential to provide these computers with knowledge related to their respective fields of application and the means for putting these to practical use. It will also be necessary to develop a computer equipped with associative inference, and learning functions to process that knowledge more effectively.

Such requirements can be met by improving man-machine interface, and further researching understanding patterns such as speech, voice, graphics, images and objects, the comprehension of daily language, and knowledge bases.

2) To process the ability to act on behalf of human beings as well as the ability to assist man in the development of unknown fields.

So that man and computers will be better able to share the burden of work related to environmental changes in our society, such as energy conservation and problems related to the aged etc.; the intelligence level of computers will have to be increased to the extent where they can comprehend the environment. So as to expand the capabilities of our sensory organs with the aid of computers; development of sensor technology, and functions such as pattern collating abilities where a computer is connected to these sensors to extract the distinctive features of what is sensed, as well as a parallel processing ability for real time processing is necessary.

3) To enable various forms of information to be made readily and easily available when necessary.

The information available through present information processing systems is highly limited with respect to the kinds, amounts and forms of information we come in contact with in our society. It is necessary to reduce the gap and facilitate instant access to a greater amount and wider variety of information. It is also important to develop a means of access which enables the easy and accurate retrieval of information needed at that time. Also important is a support system for clarifying the many vague requests made in the real world and essential

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* This article mainly refers to the proceeding metioned.

Generation Changes and Features of Each Generation

Generation	Architecture	Elements used	Processing mode (basic software)
1st generation	Von Neumann type architecture (sequential processing)	Vacuum tubes	By hand
2nd generation		Transistors	Local batch processing
3rd generation		IC	Completion of sequential processing type OS TSS and multijobbing
Mid 3rd and 4th generation		LSI	Multiprogramming processing High-level online processing
4th generation		Super LSI's	Net work Data base management
5th generation	Parallel processing architecture (data flow system)	Optimum elements used at that time (Super LSI, GaAs, JJ, etc.)	Inference processing Knowledge base management Intelligent interface
(Reference) Super (dedicated for scientific and engineering calculations)	Von Neumann type architecture (pipe line type by sequential processing, special/dedicated architecture)	High-speed element (GaAs, JJ, etc.)	Basically, the same as the 4th generation

Notes:

(1) The computer has been classified depending upon the elements used for it into generation, 1st (vacuum tubes), 2nd (transistors), 3rd (IC's), mid 3rd and 4th (LSI's), and 4th (super LSI's).

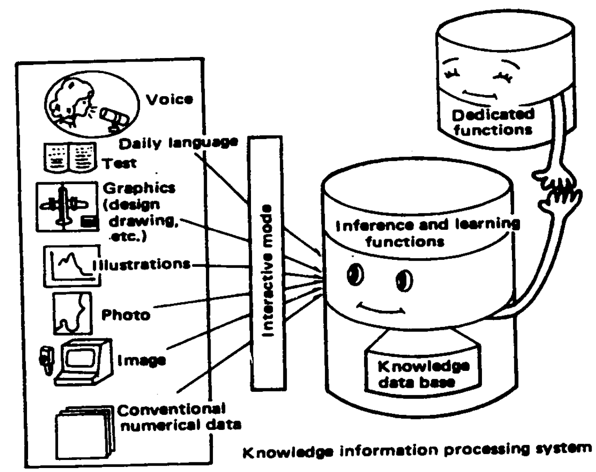
(2) Most of computers that have been developed and used for practical purposes were based on the concept advocated by John von Neumann and they are generally called a von Neumann type computer.

(3) The von Neumann type computer is characterized by sequencial processing to store a data processing procedure (program) in storage and to execute program instructions one by one in point of time.

(4) The von Neumann type computer is based on the system to make hardware structure relatively simple and fixed to obtain required functions by software. This includes a problem that software becomes complicated and large in volume if the functions become sophisticated.

(5) The 5th generation computer will overcome defects the conventional von Neumann type computers and it will be expected to appear in the early 1990's. It can be said that the 5th generation computer will be a knowledge and information processing-oriented computer system that will have an inference system to catch the essence of a problem required to be solved and to describe it for modelling and easy programming. And it will have a knowledge base system to efficiently store a large amount of data used as knowledge, with being able to retrieve it, aiming at bringing the interface between man and computer very close man's side. This realization will allow man to fully access to a high degree of computer functions through natural language processing using voice input and graphics or image processing without any knowledge of the computer, and concurrently, a great increase of software productivity can be expected for specialized programmers.

5th Generation Computer



Knowledge information processing system

technology for enabling computers to be applied to non-standardized jobs such as CAD and decision making support systems.

Computer networks which are capable of accessing distributed data bases, and knowledge bases and capable of understanding the meaning of questions and giving answers are also important.

4) Acquisition of new perceptions by simulating unknown situations.

It is expected that we will be able to acquire knowledge of unknown situations by means of large scale simulations in a variety of fields such as science and technology, management, administration, and society. Through realization of ultra-high-speed computers using high-speed devices and parallel processing, precise simulation will be made possible in fields where simulation has been impossible to date.

From the standpoint of the user, fifth generation computers should function as enumerated below:

1) Easy to use functions capable of being utilized even without professional knowledge.

Systems of this kind should be equipped with

(a) functions for the inputting and outputting of information by way of sentences, speech and voice, graphics, images and the like,

(b) functions for the processing of information in a conversational manner by means of daily language and graphs, and

(c) functions for storing common knowledge as well as ones capable of utilizing the specialized knowledge for each field of application.

2) Human substitute functions capable of judgment and decision making.

Ideally, judgments involving logic should be left up to the computer while the data necessary for important decision makings, is provided to the user.

The following abilities should be developed.

(a) functions which enable automatic retrieval of related information out of vast amounts of stored data in response to inquires,

(b) functions which enable conclusions to be drawn from inferences based on stored data when an unknown problem is given, and

(c) functions capable of learning and storing for subsequent use solutions to new problems.

3) Functions capable of flexible configurations applicable to a wide range of jobs.

In order to be able to freely select efficient system configurations responsive to various nonstandardized jobs in a wide variety of applied fields, the following are required:

(a) functions capable of constructing a system optimum for needs in question,

(b) functions capable of handling large-scale computation processing and management of a large quantity of data as desired, and

(c) functions that can easily be upgraded on a building block system to meet increased jobs.

4) Functions for facilitating programming.

Effective utilization of accumulated software and improvement of software productivity require:

(a) functions enabling a computer to write and modify its own programs,

(b) functions enabling a computer to judge and process matters of common sense without instructions from man, and

(c) functions able to cope easily with different types of computers as well as additions to existing equipment.

5) System functions which are reliable and can be used expediently.

From the standpoint of system configurations, the following are necessary:

(a) compact system functions having higher cost performance ratios,

(b) system functions capable of sophisticated distributed processing between distant points,

(c) highly reliable functions such as, functions able to recover automatically and minimize the adverse effects of mal-functions, as well as functions to facilitate verification, and system functions of high maintainability, and

(d) sophisticated functions to protect secrets.

3. Why Is the Fifth Generation Computer Necessary ?

The idea of fifth generation computers sprung from reconsideration of conventional type computers which are based on the von Neumann model. In the early days of computer development hardware was so expensive that designers tried to minimize production costs. These early machines were designed around the sequential control of stored program system as proposed by von Neumann in 1946. Designers tried to minimize the functions of computers and to use them at a high rate of efficiency to achieve better cost/performance ratios. Accordingly, today's computers have defects from the standpoint of recent technological developments in the field. These defects are:

1) Poor Ability in Non-numerical Data Processing

Today's computers are designed mainly for carrying out numerical calculations irrespective of whether they are used for scientific or business purposes, and have a minimized function to process characters or image data and the like.

Today's computers are not equipped with the necessary functions to process non-numerical data such as sentences, symbols, speech and voice, graphics, and images, etc. However computers are expected to be developed which will be capable of associative and inference processing such as pattern matching functions which deserve the name of artificial intelligence. Computers such as these will be required to widen the areas in which information processing can be applied, diversify the forms of processing, and realize information systems that have a high level of intelligence. Computers with new architectures are also hoped for which not only have increased

processing capabilities, but also can put to practical use information management such as data bases and knowledge bases. Computers with new processing functions are desired to improve man-machine interface by developing easy-to-use computers capable of being good assistants for man and to effectively extend the range of the human senses.

2) Limitation in Processing Speed and Other Capabilities Due to Sequential Control and Linear Memory Model

The performance of conventional computers has been increased largely through improvements made to their separate elements, and efforts to improve the system itself have thus far proven fruitless. However, since the high-speed operation of elements themselves has a limitation imposed by the speed of light, combined efforts from the standpoint of both elements and systems should be made from now on to improve the performance of computers. One effort made thus far in terms of systems is parallel processing. This is not only essential for large-scale numerical calculation such as partial differential equations and for simulators for various systems, but is also needed for speeding up inference and associative processings. Various parallel control systems should be put to practical use which include proposed data flow control that is basically different from conventional sequential control.

Due to the diversification of fields of application and advancements in LSI technology, the merits of distributed processing have come to be looked at in a new light. Distribution of processing can roughly be grouped into two categories. One is a regional distribution form in which processing functions and data bases are located near persons in charge so that various resources such as hardware, software, data base and the like can be shared by many through communications lines. The other system comprises distributed functions wherein processors of different kinds designed for dedicated uses are connected to each other via high-speed buses and the like, thus replacing a system having a relatively small number of processors of one kind connected to a common main memory. The former should serve as a means for realizing a huge information system designed from the standpoint of users, and the latter should be put to practical use as a means for realizing systems which meet diversified demands.

3) Software Crisis – Increase in Software Cost

The cost of software development is ever increasing, and many difficulties have been encountered in improving the productivity of such. While architecture has been proposed which can accept high-level languages with ease, and attempts have gradually been made to change OS into firmware, emphasis is still placed on the utilization of software heretofore accumulated, and old and inconvenient architecture models are followed. Efforts are required to prepare environments in which architecture suited for the new age centering around new applied fields or areas can be introduced. When software can be programmed with increased productivity as a consequence, diversified architecture will also be made possible, thus opening up prospects for future computer science and engineering.

4. Image and Concept of the Fifth Generation Computer

Fifth generation computer systems will be expected to have the following basic functions:

(a) Problem solving and inference functions,

(b) knowledge base management function, and

(c) intelligent interface function.

These functions will be realized by software and hardware systems respectively, and will be aimed at maximum scales and performances such as those which follow:

The problem solving and inference function will be aimed at a maximum performance of 100M – 1G LIPS*.

The knowledge base management function will be aimed at performance capable of retrieval of a knowledge base required for inference within several seconds, with a core data base machine having a maximum capacity of 100 – 1,000 GB.

The intelligent interface system will be aimed at making conversation with a computer through the medium of speech, graphics, and natural languages etc., a possibility as well as enabling the exchange of information in a form which is natural for man.

These functions will be combined into a single general-purpose machine having a system configuration which can meet various performance requirements in a variety of applied fields.

These functions may be arranged so as to serve as machines in which any one of the functions is reinforced, and as machines they will have a common programming language.

The fifth generation computer system will be aimed at sufficient general-purpose functions and performance requirements to realize systems for machine translation, question answering and utilization of speech, pictures and images systems which will be basic and common for a wide variety of applications in the 1990's.

The target performances of the basic application systems perceived here are shown in Table 1.

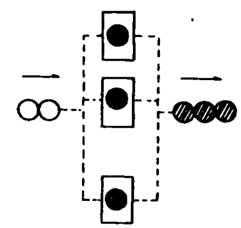
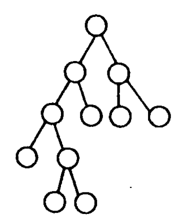
4-1. Image of the Fifth Generation Computer System

The fifth generation computer system will be considered from two different points of view in order to get as general an image as possible.

The first point of view is a conceptual view of a hierarchical structure including a human system, a modeling system and a machine system, and is centered on how the level of the man-machine interface will increase with respect to its present level.

Note: 1 LIPS (logical Inferences per Second) means one inference operation of syllogism per second. One inference operation on a present computer is considered to require 100–1,000 steps, and hence 1 LIPS is equivalent to 100–1,000 IPS (Instruction per sec).
Machines of the present generation are of approximately 10^4–10^5 LIPS.

Table 1 Overview of 5th Generation Computer System

Basic Functions of System	Conventional computer	Software	Hardware architecture	Elements	New application systems (typical examples)
Inference processing The machine itself judges and processes from the knowledge stored in the system.	CPU	Equivalent retrieval and substitution function (inference operation function) of basic software (OS) Example: If the introduction of A=(B,C) is given, the machine automatically finds B=(D,E) and C=(F,G), and processes A=(D,E,F,G). (Formerly, pre-preparation of a program was required.)	Parallel machine Inference machine with data flow architecture 	Silicon VLSI's Compound semiconductor (e.g. GaAs) Josephson junction element	• Machine translation system • Question-answering system • Voice application system • Graphics and image application system
Knowledge base function The system associates information for storage and retrieval, not simply as collection of individual data, but as "human" knowledge.	Memory and files	Knowledge base control function of basic software (OS) Knowledge data is retrieved at high speed and associated for acquisition and storage of knowledge.	Knowledge base machine with multidimentional memory (structured memory)  Memory structure in which data associated with processing is automatically extracted.	Silicon VLSI's Josephson junction memory	
Intelligent interface function The system allows realization of flexible conversational functions by natural language, voice or graphics.	I/O channel and I/O peripheral	Interface control function of basic software (OS)	Intelligent interface machine consisting of a VLSI voice processor and signal processing processor	Silicon VLSI's	

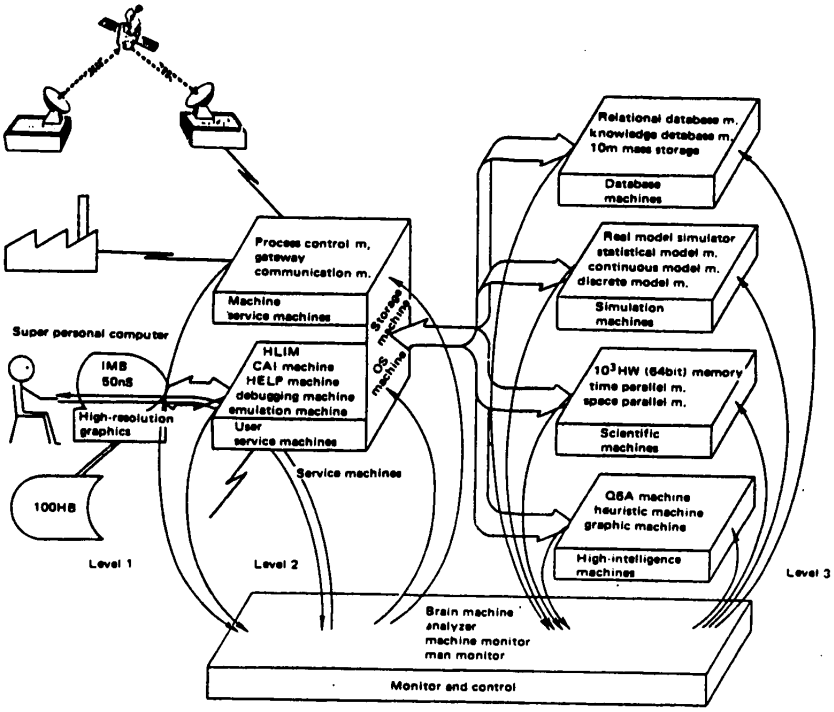


Fig. 1. An Example of the Fifth Generation Computer Systems

The second point of view deals with the fifth generation computer system more specifically, and shows how components are combined into the system as software or hardware. Since it would be difficult to describe the system in its overall configuration, it will be divided into an application system, software system, and a hardware system to provide an image of the configurations for each system.

The application system corresponds to part of the human system in the hierarchical structure described above, the software system corresponds mainly to the modeling system, and the hardware system corresponds primarily to the machine system.

The image of the fifth generation computer system can be grasped more clearly by combining the foregoing two points of view.

1) A Conceptual Image of a Fifth Generation Computer System

As shown Fig.1 the fifth generation computer system will be oriented toward processing knowledge information and will have quite a high logic capability. Its greatest feature will be that interface between man and computer will greatly approach the human level.

Conventionally, man-machine interface has been via procedural programming languages. To solve a problem with the

Table 2. Themes in Research and Development of the Fifth Generation Computer System

Basic application systems	1–1) Machine translation system 1–2) Question answering system 1–3) Applied speech understanding system 1–4) Applied picture and image understanding system 1–5) Applied problem solving system
Basic software systems	2–1) Knowledge base management system 2–2) Problem solving and inference system 2–3) Intelligent interface system
New advanced architecture	3–1) Logic programming machine 3–2) Functional machine 3–3) Relational algebra machine 3–4) Abstract data type support machine 3–5) Data flow machine 3–6) Innovative von Neumann machine
Distributed function architecture	4–1) Distributed function architecture 4–2) Network architecture 4–3) Data base machine 4–4) High-speed numerical computation machine 4–5) High-level man-machine communication system
VLSI technology	5–1) VLSI architecture 5–2) Intelligent VLSI CAD system
Systmatization technology	6–1) Intelligent programming system 6–2) Knowledge base design system 6–3) Systematization technology for computer architecture 6–4) Data base and distributed data base system
Development of supporting technology	7–1) Development support system

help of a computer, man has first had to describe, model and program the problem. Humans and computers have been able to understand each other only through programs thus prepared.

With fifth generation computer systems, however, the description and modeling of a problem will take place at interface. In other words, computers will be able to understand problem descriptions and from that express a model, and synthesize a program based on such modeling. Man will be able to communicate with computers by using speech, natural languages, pictures or images with a certain extent of freedom.

To realize such sophisticated capabilities, both software and hardware should be functionally improved. Fig.3 shows a conceptual image of such a system in which the machine system indicates future hardware. It can be understood from this Figure that the machine system has functions much higher in level than those of conventional machines. If we compare the old with the new in terms of programming languages, conventional machines use procedural languages on the basis of sequential execution, while the new machine system will use logic programming languages or program solving languages for trial-and-error logical inferences.

The modeling (software) system illustrated above will be highly effective software for such hardware and will serve

mainly to perform meta-inference functions for problem solving such as understanding problems and synthesizing programs. Since the level of logic programming languages is quite high, the modeling system can be a man-machine interface during the period of transition before the final object is accomplished. However, input processing in the form of everyday language, pictures, or images etc., in order to minimize the incompleteness and vagueness of inputs, is indispensable if we wish to allow the next stage of development.

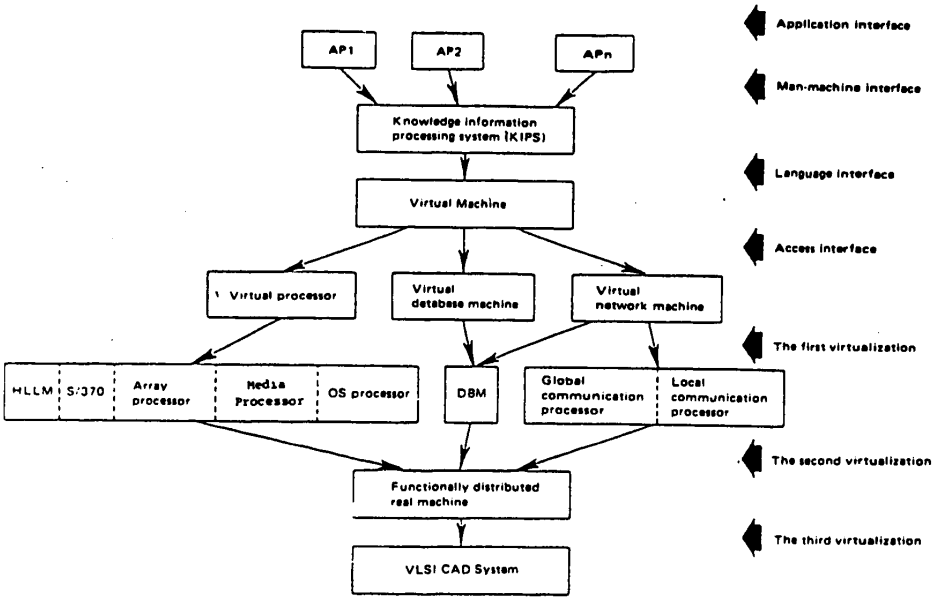


Fig. 2. An Example of Hierarchically Organized Logical Model of the Knowledge Information Processing System

Conversely, a function will be necessary to add some vagueness and incompleteness to original responses for obtaining summarized outputs.

The modeling system includes an intelligent communication system capable of understanding speech, natural languages, pictures, and images at that point when it interfaces with the human system.

The intelligent communication system itself will be realized as a sophisticated knowledge information processing system having modeling and machine systems such as described above.

The fifth generation computer system will always utilize knowledge required in series processing, beginning with inputs such as speech, natural languages, picture or images from the human system, and extending to understanding these inputs, synthesizing and executing programs around them,

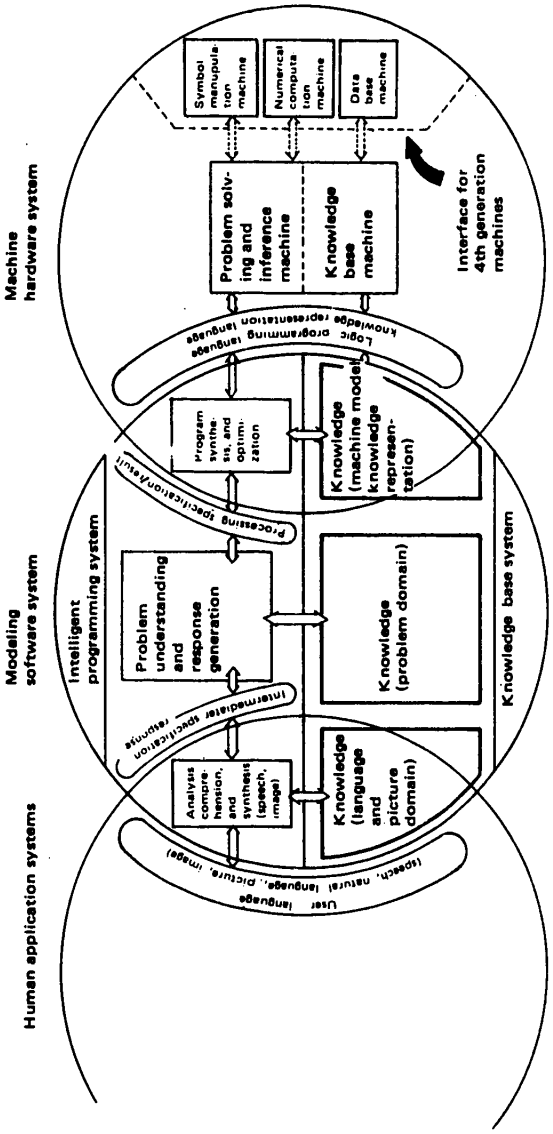


Fig. 3. Conceptual Diagram of a Fifth Generation Computer System as Viewed From the Standpoint of Programming

and generating responses. This knowledge includes a knowledge of languages, knowledge of images, knowledge of problem domains, and knowledge of the mechanisms and data expression of the machine system, all stored in a knowledge base.

With the functions of the machine system being sophisticated and amplified by the modeling system in this way, our ability to process information will be greatly improved.

2) An Image of the Configuration of an Application System

Structures common to various systems such as intelligent CAD, intelligent OA, intelligent CAI, and intelligent robots which will also be realized in the fifth generation computer system are shown in Fig. 4.

All application systems are composed of three subsystems, namely, interactive, processing and management. These three subsystems will be proportionally different from application system to application system. These subsystems are illustrated in Fig. 5, showing their mutual relationship and internal operation to clarify the various functions they perform.

Speech, natural languages, pictures, images or their combinations are used to put a question to the system. The interactive system utilizes the knowledge inherent in the language or pictures to analyze a structure (construction) and convert it into an internal (intermediate) expression such as an antomical tree. Then, an analysis is made of that meaning in context and a description of the problem is extracted from that. This, however, is incomplete due to omissions and the like. Knowledge used here about context and background knowledge, which is used at this time, is information related to the background and flow of the conversation taking place. The processing system converts the incomplete description into a complete description using its knowledge about problem domains, and generates an answer to the description. At this time, operations such as effective utilization (inference) of the knowledge of problem domains and storage (learning) or new knowledge are effected. The generated answer is then converted into a summarized answer by getting rid of unnecessary, self-evident information. Thereafter, this summarized answer is converted by the interactive system into an internal expression, which in turn is converted into an external expression understandable to man. In this way, one conversational cycle is completed. During this cycle, the management system oversees a variety of knowledge for effecting common operations of inference and learning.

3) An Image of the Composition of a Software System

An image of the composition of a software system for

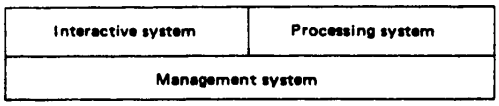


Fig. 4. System Structure

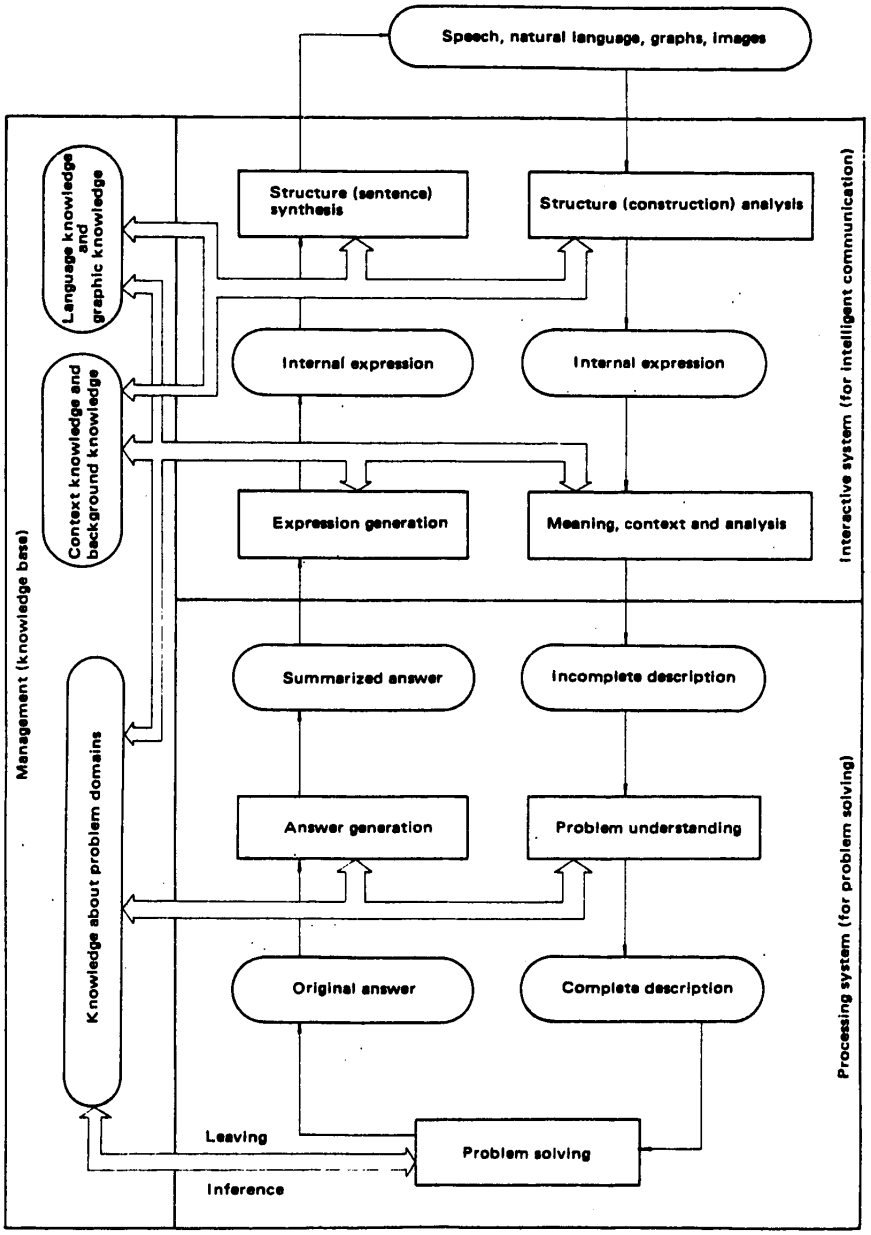


Fig. 5. Mutual Relationship and Internal Operations of the Three Subsystems in an Application System

realizing various application systems is shown in Fig. 6, the software system directly reflecting the structure of application systems.

(1) Basic software systems

These will be the core of all systems and consist of a problem solving and inference system, a knowledge base management system, and an intelligent interface system. These systems correspond respectively to the problem solving and inference machine, the knowledge base management machine, and the intelligent interface machine, and may be defined as those which cannot be constituted as hardware in realizing functions.

(2) Intelligent systematization support systems

These will be a group of systems which, in designing and producing (systematization) optimum information processing systems for various applications, will have knowledge of what is to be produced, production processes, and the like for greatly reducing the amount of work which man will do in systematization. These systems include subsystems which lead from a strict specification description language and a described specification to what is to be produced, or a

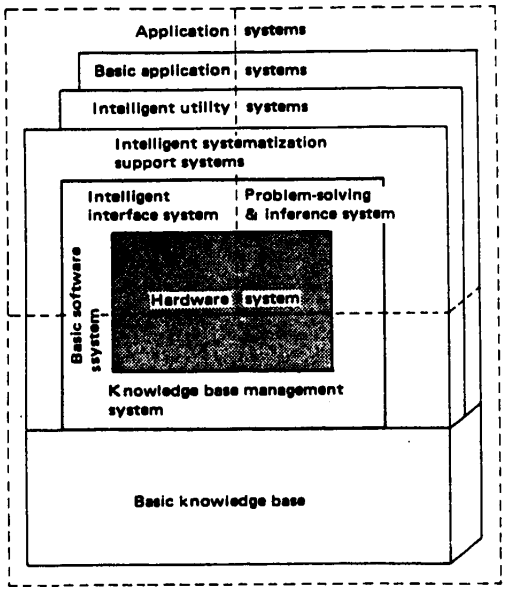


Fig. 6. Conceptual Diagram of the Composition of a Fifth Generation Computer Software System

subsystem for verifying correctness, and a subsystem for simulating operations, and the like. It also comprises three

support systems, that is, an intelligent programming system for handling programs, a knowledge base design system for handling a knowledge base, and an intelligent VLSI design system for handling VLSI chips and computer architecture.

(3) Intelligent utility systems

These will be a group of systems which will provide sophisticated functions to facilitate utilization of the system itself. These will be comprised of a system for maintaining transferability to transfer stored programs and data bases from existing commercial machines to a target machine, a system-explanation and education system for explaining the functions and use of the overall system and subsystems and for responding to user's consultation, an intelligent trouble diagnosis and maintenance system for automatic inspection and recovery and for guidance and consultation about inspection and repair of complicated trouble, and other systems.

(4) Basic knowledge base

Universal knowledge used by the system itself and by the users will be arranged as basic knowledge bases which are components of the foregoing systems and are employable in application systems which users will make. There are largely three knowledge bases: a general knowledge base similar to common sense; a systems knowledge base which will gather knowledge related to systems; and an applied fields knowledge base which will gather knowledge about certain applied fields. The general knowledge base includes bases of basic words of everyday use, basic sentence patterns and basic scripts, a base of dictionaries of various languages and sentence construction rules, and other bases related to natural languages. The systems knowledge base includes bases containing specifications for the system itself, such as a processor specification description base and an operating system specification description base, a language manual base, a program module base containing programs which are highly usable, and other bases. The application knowledge base includes a VLSI design technology base, a computer architecture base, a basic program base, and other bases.

(5) Basic application systems

This group of systems will be developed as basic application systems and have respective final target performances. These systems will be very valuable and will be a source of knowledge bases and sophisticated-function modules commonly usable by various application systems. The systems are largely classified as follows:

- Machine translation system
- Question answering system
- Applied speech understanding system
- Applied picture and image understanding system
- Applied problem solving system

4) Future of Hardware System Structure

(1) A profile of fifth generation computer systems

Fifth generation computer systems, covering all sizes from the small ones for personal use to the large-scale computers, will find application in various fields. These will include machines for exclusive use as well, incorporating particular strengthened functions like the existing data base machines

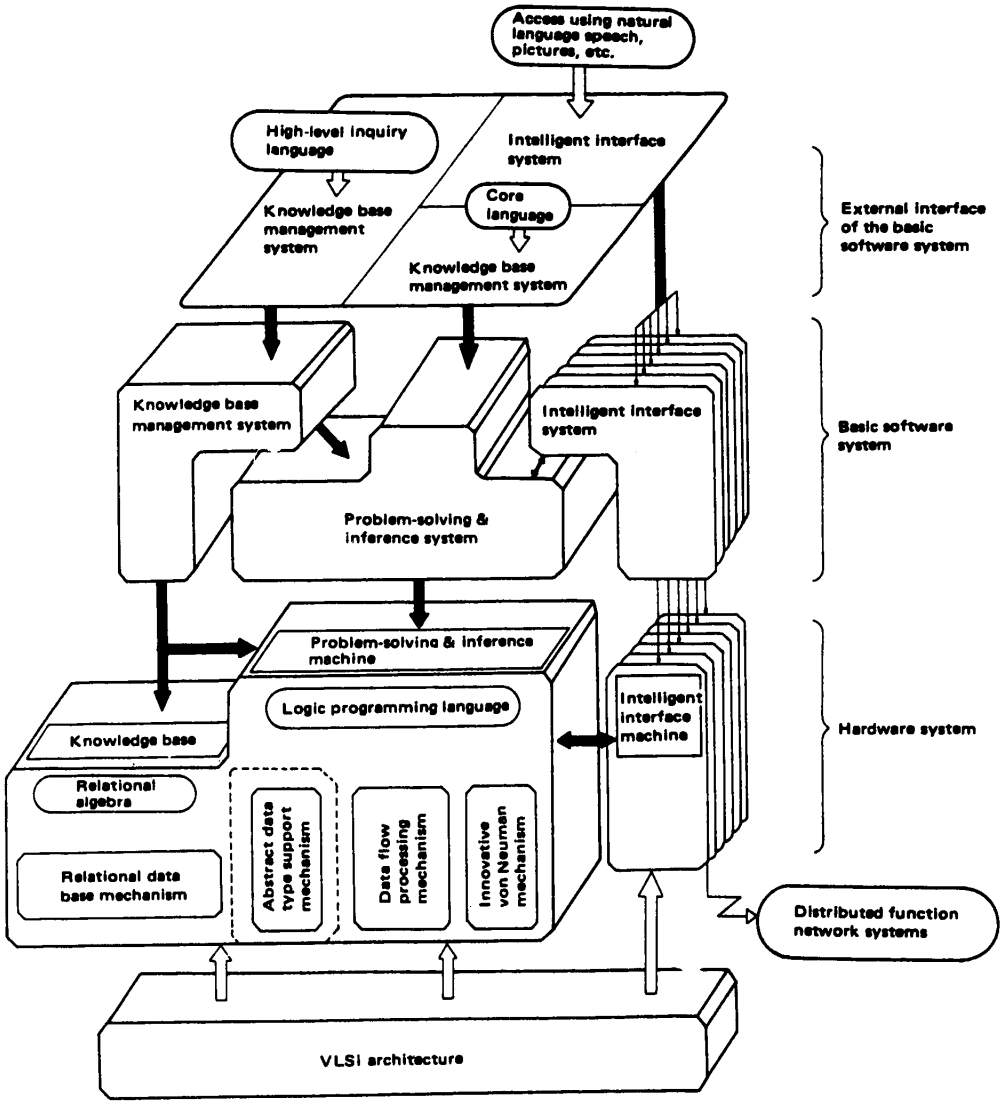


Fig. 7. Basic Configuration of the Fifth Generation Computer Systems

grouped into a community by a local network.

The computers in this community may be classified according to their abilities, but in so far as they will share a common programming language, they may be looked upon as members of a new computer family.

From the standpoint of their basic software interface, these computers shall have three functional components. These are listed below with the corresponding components (in parentheses) of existing computer systems:

(a) Problem solving and inference machines (CPU)
(b) Knowledge base management machines (Memory and filing system with virtual memory)
(c) Intelligent interface machines (I/O channels and devices)

These three components will form part of each computer system. A general-purpose fifth generation computer system will be equipped with each of these machines in substantially the same proportion, whereas a small system with the same structure will form a general-purpose fifth generation personal computer.

A computer system with enhanced problem solving and inference computer. This will find application in fields like consultation requiring professional knowledge, calling for strong ability to infer. Systems with reinforced knowledge base management function will be called knowledge base computers. Like the existing data base machines, they will be applied in fields requiring storage of 'Knowledge' in large masses.

Computers incorporating an enhanced intelligent interface function will be provided with an interface with various interactive media, speech, picture and image as well as those based on natural languages. It will be possible to use these machines independently or in combination.

Figure 7 shows a conceptual image of the general fifth generation computer configuration.

Computer functions will be available at various levels and their combinations will create a wide range of machines covering both the small personal computers and large-scale machines incorporating each function to its maximum extent.

(2) Profile of the structures of machines serving different functions

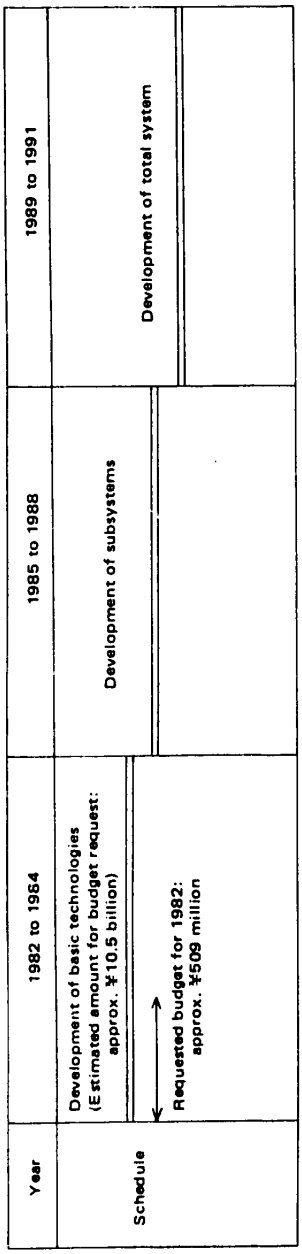
Hardware architecture shaping the functional components will be based on a combination of six machines. These are the six machines that are being studied as the likely candidates to establish the new architecture. The machines will be so combined by adopting the distributed function architecture, namely by applying modularization, adoptation, and micro-programming techniques.

For smaller computers of moderate performance, a firmware base architecture built on the innovative von Neumann technique will be adopted. Language interfaces will center on new languages of both the predicate logic and abstract data types. Thus, the results of study on both the logic programming machines and abstract-data type support machines will be made use of in programming.

For the powerful large-scale computers, data flow machines including functional machines will serve as the core technology. For the problem solving and inference computers, the execution part in the logic programming machine will use a large-scale data flow mechanism for its execution, and the knowledge base will be processed by a small-scale high-speed relational algebra machine. The relational algebra machine will use a suitable data flow mechanism for its execution.

A large-scale knowledge base computer will use as its core a large-scale relational data base machine including a relational

Table 3. Research and Development Schedule for 5th Generation Computer



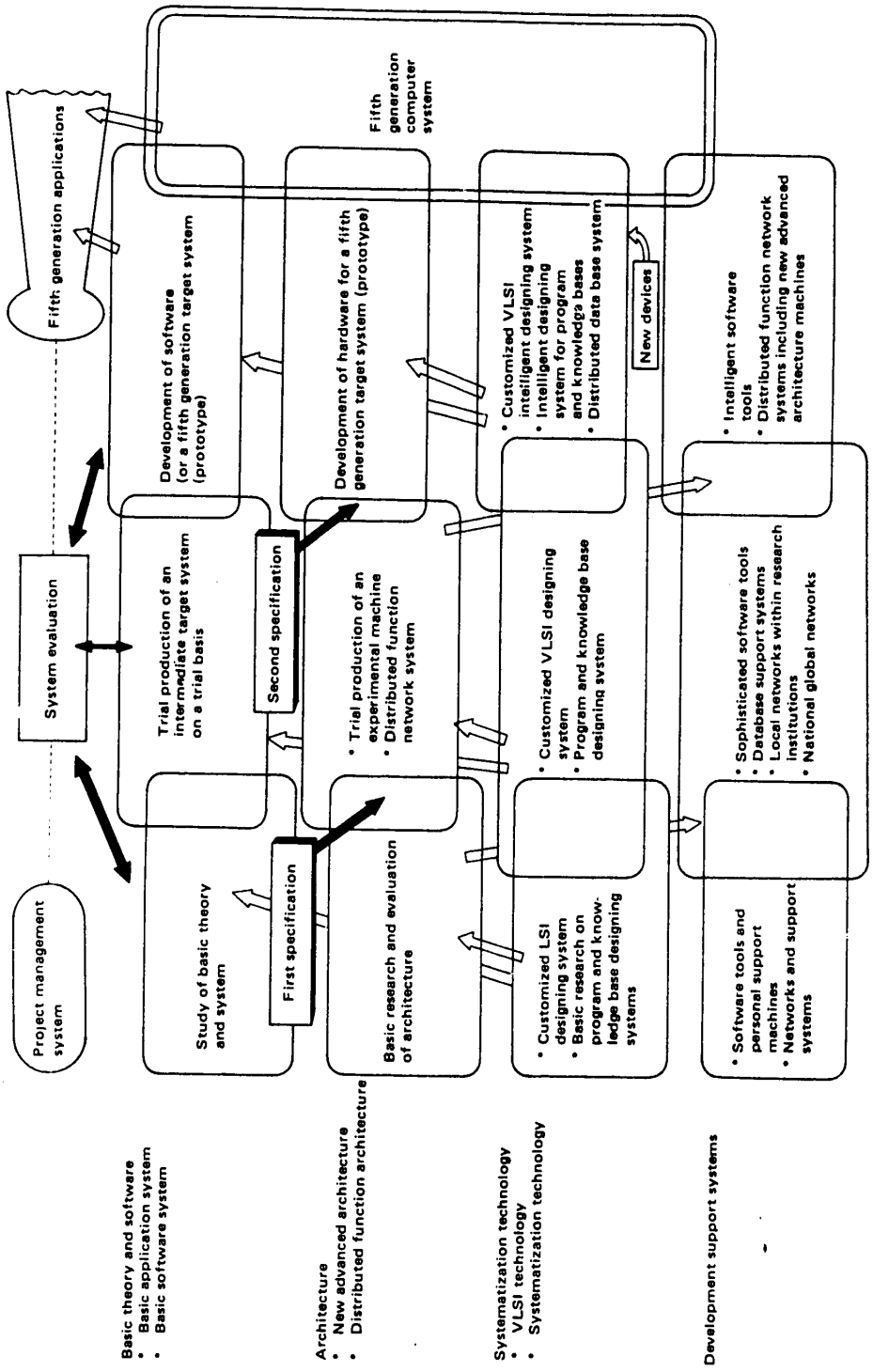


Fig. 8. Concept Diagram Showing How Research and Development are to Program

algebra machine. Results of studies on the abstract data type support machines will also be used.

The supporting hardware in the intelligent interface system will include a VLSI processor for exclusive use in speech and a signal processors. Data flow machine techniques, including functional machine techniques will be used frequently in high-speed operations.

The data flow machine will constitute the basic execution mechanism for high-speed processing, and hence should be taken up as one of the main subjects for research and development.

A number of customized VLSI's are ind spensable for the machines, and, therefore, development of VLSI-CAD to produce such VLSI's in a short period is to be treated as the most important theme from the standpoint of packaging.

(3) Macro image of the fifth generation computer structure

Fifth generation computers will be linked to communication systems to form a global network suitable for various social organizations. Potentially, each node in such a global network, that is, each computer site, will constitute a system connected by a local network to two or more computers. The local network, capable of high-speed data transfer, will connect computers of different functions, including the smaller personal computers, thus making up a general-purpose group (community).

As the macro image suggests, a fifth generation computer system will be a collection of computers serving different functions: a small, general-purpose personal computer, a knowledge base computer, and a problem solving and inference computer all connected by a local network.

In principle, the component computers will have a common programming language. These computers, therefore, will form a computer family linked by a common language even though they may be intended to serve different purposes with one or the other of the functions enhanced.

A structure of this nature will help build up a flexible computer system suitable for the intended applications. As the above suggests, hardware and software research and development for fifth generation computer systems should be carried out so as to allow them to be connected by local and global networks.

5. R & D Program

The Fifth Generation Computer Project is to be carried out over the next 10 years. (Table 3) Based on the results of three years study by the Fifth Generation Computer Study Committee, R & D will be divided into three phases. In the first 3-year phase basic technology R & D will be completed. In the second 4-year phase subsystems are to be developed and in the final 3-year phase a prototype computer will be developed as a result of total system integration. Referring to the prototype, private companies will produce their own commercial models to be put on the market.

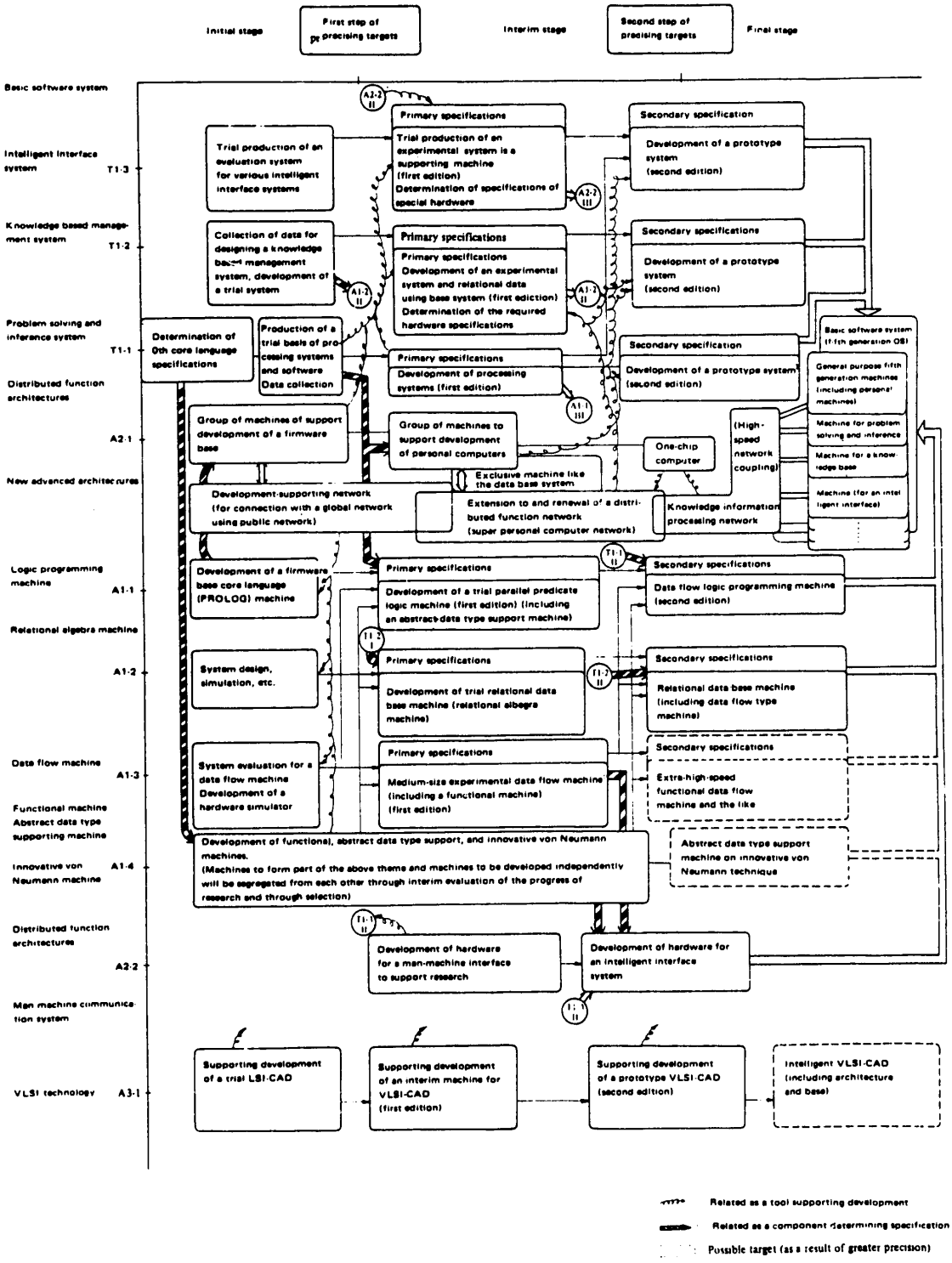


Fig. 9. Steps in Research and Development of Themes Related to Basic Software and Architectures 82

The budget for the project is estimated at around ¥10.5 billion for the first phase. For the next fiscal year beginning in April, 1982, the government has approved ¥500 million for the project. For the second and third phase some ¥100 billion will be needed.

Themes in research and development of the Fifth Generation Computer system are shown which contain six themes. The R & D are classified into four divisions as shown in Fig. 8.

The most important aspect of the project's R & D is architecture development. Professor Hideo Aiso of Keio Univeristy will head this section of the project. This section will do research on: parallel processing, efficient software production, efficient data base management, distributed function systems and mathematical and logical algorithms. Fig. 9 shows steps in R & D of themes related to basic software and architecture.

Development of a new programming language to be substituted for the conventional von Neumann languages is one of the major hurdles of the project. Logic programming languages and functional programming languages are expected to be developed and should provide parallel programming capability and program verification to improve software reliability. One of the most promising new languages is extended PROLOG, which will be designed on the basis of simple inference like a logical syllogism.

Though the major theme of the first phase will be language development, research on some basic software and hardware elements will also be carried out. A firmware base sequential syllogism machine will be developed in the first phase as a tool for parallel processing inference software. For the knowledge base machine development, the project team will begin with conventional realtional data base machine architecture which will then be developed into the final inference machine architecture.

The details of the R & D program are as follows:

1. Basic application system

A basic application system represinting functions like hearing, speaking, seeing, drawing, thinking, and problem solving will be studied and developed.

Item	Target and specifications
1-1. **Machine translation system** Results of research in documentation techniques and artificial intelligence for knowledge utilization will be combined to research and develop an integrated multi-lingual translation system.	• Number of words to be handled: 100,000 • Machine must assure 90% accuracy, and the remaining 10% is to be processed by the translators • The system must serve general purposes, computerizing all jobs from text compilation to printing of translated documents • Translation cost must be 30% or less than that of translators

1-2. **Question answering system**
Research and development of a question answering system for various specialized fileds including the intelligent CAE/CAD system, DSS, and intelligent robots.
	• An interim target to be achieved in five years is to develop a trial question answering system for limited use in particular specialized fields.
	  • Number of words: 2,000 words (Japanese)
	  • The user must provide supplementary information to eliminate ambiguity
	  • Number of inference rules: 1,000
	• The interim experimental question answering system will be evaluted, and prototype question answering systems will be developed for various specialized fields.
	  • Number of words: 5,000 or more
	  • Number of inference rules: 10,000 or more

1-3. **Applied speech understanding system** Research and development of a speaker identification system as part of a general-purpose speech responding system for input and output in machine translation, a phonetic typewriter, and a telephonic inquiry system.	• Phonetic typewriter (1) Interim target: A system with simple sentence construction data to handle several hundred to several thousand words. (2) Final target: To handle about 10,000 words with simultaneous meaning analysis, automatic error correction during speech recognition, and generate whole comprehensible sentences. • Speech responding system (1) Interim target: Handling several thousands words mainly through analysis and synthesis system. (2) Final target: Cap handling about 10,000 words, comprehending the meaning of questions, and developing a sophisticated structure to enable natural conversation. • Speaker identification system (1) Interim target: Identifying fifty to sixty speakers. (2) Final target: Identifying several hundred speakers within a practical interval.
1-4. **Applied picture and image understanding system** Development of a system for structural storage of picture and image data and effective several of such information to process intelligence.	• A picture and image data base must contain about 100,000 retrievable picture and image data items. • The system must store picture and image data including abstract delineations within a few seconds. • Picture and image data must be retrievable within 100 ms. on the average. • Interim target in the stage: about 10,000 picture and image data items to be handled and processed at about half the speed aimed for in the final target.

1-7. Applied problem solving system Development of a formula understanding system outputting an "answer" to the "problem" input, thereby solving general advanced problems. Also development of a system capable of playing "Go".	• Formula understanding system (1) Interim target: System with a knowledge base combining the performance of the existing MACSYMA with inequalities and simple equation processing functions. (2) Final target: A knowledge representation and problem solving system related to formula combining sophisticated formula manipulating algorithm. • Go playing system (1) Interim target: A system having a playing standard equivalent more or less to amateur subgrade 10. (2) Final target: A system having a playing standard equivalent more or less to amateur grade 1.

2. Basic software system
This will constitute out core of the fifth generation computer systems. A group of modules corresponding to basic information processing functions (management, processing, interaction) will be researched and developed.

Item	Target and specifications
2-1. Knowledge base management system Research and development of intelligent system management techniques to format and sotre human knowledge in a computer to utilize it and support the user in solving problems.	• Knowledge base management system (1) Interim target: Simultaneous management of rules and data, a data base access optimization mechanism, a mechanism for eliminating inconsistencies, and itnerface with an inference machine. (2) Final target: A multiple-world knowledge base, a distributed-knowledge base, learning based on inductive inference, fusion with an inference machine • Knowledge base machine (1) Interim target: Storage and retrieval of 2,000 rules and 1,000,000 data items (10^3B per one item) (2) Final target: Storage and retrieval of 20,000 rules and 100,000,000 data items (100 GB
2-2. Problem solving and inference system This will constitute the core of the processing functions in the fifth generation computers. Basic techniques will be researcher to develop a problem solving system by establishing a processing model of the problem solving and inference system and to explain its processing ability theoretically.	• Inference machine (1) Final target: Performance of about 10^2–10^3 Mega LIPS* • Coding language to solve problems must support functional and logic programming as well as object-oriented modular programming. Program modules generated will form a knowledge based software component for effective use in intelligent programming. * 1 LIPS (Logical Inference Per Second) means one syllogistic inference per second. One inference operation in the currency used by computers is considered to require 100 — 1,000 steps' Hence 1 LIPS is equivalent to 100—1,000 IPS (Instructions Per Sec.) Machines of the present generation feature approximately 10^4– 10^5 LIPS.

2-3. Intelligent interface system Research and development of a technique for flexible conversational functions and elimination of the language (including natural languages, speech and image) gap between the user and this computer.	• A man-machine communication technique based on natural language or speech data, providing an intelligent man-machine interface. • The natural language and speech system with fulfil the following target: (1) Vocabulary to be handled with cover computer and one branch of scientific and technological terminology will include specialized as well as frequently used terms. (2) The system must adapt itself to speakers and communicate with unspecified speakers. (3) The system must be capable of speech output in Japanese and English. (4) The system must identify speech signals on almost real-time basis.
2-4. Intelligent interface system	(1) Development of soft and hardware to enable smooth user interaction with the computer through picture and image media. (2) Pictures and images to be handled will be as complex as, respectively, medium small scale machine drawings, and photographs for medical use. (3) High-speed information processing to allow smooth man-machine interaction. (4) The interim target is to handle pictures and images 70% as complex as the final target. For the interim target, emphasis will be put on the method of processing rather than the processing speed.

3. New advanced architectures
Research will be made to enabled the fifth generation computer architecture to satisfy the knowledge data processing system requirements.

Item	Targets and specifications
3-1. Logic programming machine Study and development of the necessary architecture to support inferences and a computational model based on predicate logic with a power of expression approximating natural languages.	
3-2. Functional machine Development of architecture to support a functional model and programming language suitable for symbol manipulation, both based on theory	(1) Personal LISP machine To be two or three times greater than a general-purpose computer (4 MIPS) in list processing capacity (2) Parallel reduction machine To be ten times greater than a general-purpose computer in list processing capacity (3) Data flow function machine To be several hundreds to several thousands times greater than a general-purpose computer in capacity list processing

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.:.: Relational algebra machine :esearch to develop a machine architecture on handle :et operations, using relational algebra (constituting the :ore of future data base systems) as the interface :anguage.	• Number of processor elements in the parallel processors (1) Interim target: Not more than one hundred (2) Final target: At least five to six hundred • Storage capacity (1) Small capacity for high-speed operations: 10–100 MB (2) Medium capacity for medium- and high-speed operations: 100M–10GB (3) Large capacity for low- and medium-speed operations: 10–1,000GB
3-4. Abstract data type support machine Research and development of memory structure and processor functions in future computers to provide system architecture support and to modularize the vast and complex software.	(1) Development of about 100 parallel von Neumann abstract data type support machines (2) Development of about 1,000 parallel non-von Neumann abstract data type support machines
3-5. Data flow machine Research on architecture based on a data flow model oriented to parallel processing thereby achieving sophisticated parallel processing.	(1) Initial target: 16 processors with a memory of 8 MB (basic operating level.) (2) Interim target: 100 processors with a memory of 100 MB and achieving 50 MIPS (practicable use). • Processor networks: Structured to accommodate LSIs Consisting of 10^3–10^4 processors (3) Final target: An extra high-speed data flow machine, 10^3–10^4 processors with a memory of 1–10 GB and 1–10 BIPS. • Personal data flow machines 32 processors with a memory of 10 MB and achieving 10 MIPS.
3-6. Innovative von Neumann machine Development of architecture with innovative von Neumann machines retaining their original advantages and with sophisticated VLSI.	(1) Interim target: A processor with one million transistors per chip for the innovative von Neumann machines (2) Final target: A processor with ten million transistor per chip for the innovative von Neumann machines

4. Distributed function architecture
Development of an architecture to combine the VLSI architecture with the new, advanced ones using VLSI with importance attached to progressive architecture.

Item	Targets and specifications
4-1. Distributed function architecture Development of a distributed function architecture consistently assuring high efficiency, high reliability, simple use and construction, easy adaptability to future technological improvements and the different machine/system levels, and sophisticated functions.	
4-2. Network architecture This architecutre will be meant to loosely couple computer systems spaced apart. Development of the techniques to combine systems into a global network and build up a distributed information system based on the high-speed local network to be available to the fifth generation computer.	

4-3. Data base machine Development of a special-purpose machine with an architecture suitable for processing data base and capable of high-speed accessing large-capacity data bases.	(1) Experimental machines ● Capacity: Up to 100 GB ● Processing ability: 10^3 transactions/sec ● Data model: Relational (2) Practicable machines ● Capacity: Up to 1,000 GB ● Processing ability: 10^4 transactions/sec ● Data model: Relational (To support conversion from and emulation of the data base of another model)
4-4. High-speed numerical computation machine Development of a special-purpose machine for high-speed scientific and technical computation for numeric simulation to replace experiments.	● Development of processor elements (40 – 100 MFLOPS), using new high-speed devices ● Processor elements of about 4 MFLOPS will be developed. Also, a parallel processing system will be developed to simultaneously operate 1,000 such processor elements to develop an overall performance of about 1 BFLOPS. ● Head per track disk of some fifty to sixty GB.
4-5. High-level man-machine communication system Development of a system to input and output characters, speech, pictures and images and interact (intelligence) with the user	● Character (including Chinese characters) input and output system (1) Interim target: A display unit with an input function for 3000 –4000 characters in four to five different typefaces. (2) Final target: Additional functions allowing input of Chinese characters together with speech, replacement of *kana* (the Japanese syllabary) by the Chinese characters and vice versa, and meaning comprehension. ● Picture and image input and output system (1) Interim target: A tablet coordinate input device with 5000 x 5000 – 10,000 x 10,000 dots. (2) Final target: More advanced intelligent functions based on specifications laid down in the research theme for the applied picture and image understanding system. ● Speech input and output system (1) Interim target: Ability to identify 500 – 1000 words. (2) Final target: More advanced intelligent specifications as laid down in the research theme for the applied speech understanding system, including meaning comprehesnion ability and capability to party handle natural languages. ● Integrated terminal with multimedia input and output functions All the above functions will be combined on VLSI basis to develop integrated personal computer terminals.

5. VLSI technology
Development of architecture making full utilization of VLSI and processing from the component devices to fifth generation computers

Item	Targets and specifications
5-1. VLSI architecture Development of architecture to make full utilization of VLSI's characterized by about ten million transistors per chip (as are expected to be available around 1990).	(1) Interim target: Complete one-chip architecture for one million-transistor chips. (2) Final target: Complete one-chip architecture for ten million-transistor chips.

Item	Targets and specifications
5-2. Intelligent VLSI-CAD system Development of an integrated VLSI-CAD system capable of storing design knowhow for effective utilization	• An application designer should be able to design a masking pattern for a VLSI custom chip with one million transistors/chip within one month (a desired chip must be available within three months).
6. Systematization technology Consistent systematization of devices, architecture, and basic as well as applied software, and development of techniques relating to the cycle comprising system's design, development, maintenance, and management.	
Item	**Targets and specifications**
6-1. Intelligent programming system Development of a system to retrieve programs from an algorithm bank (knowledge base) according to user requirements, and synthesize a program which meets requirement specifications by inference. Furthermore, the system must verify, by a process of inference, whether the program generated meets the requirements optimally.	• System for program verification and synthesis, and program base (1) Interim target: Improvement through synthesis and conversion of programs for particular fields, minimizing data base retrieval. Development of a small-scale program base. Generation of a system to verify functions, logic, and data-abstraction programs. (2) Final target: Synthesis of large-scale programs for data base management systems, language processors, etc. Development of a large-scale program base. • System to maintain, improve, and manage programs (1) Interim target: Generation of a system to comprehend functional and logic programs. Equivalence transformation experiment. (2) Final target: A system to evaluate program performance, and a system improved through equivalence transformation. A system for correcting programs. • Consultant system for program design (1) Interim target: Basic design (2) Final target: Question answering in natural language. A system capable of offering consultation in data base management system design, data base application systems, etc.
6-2. Knowledge base design system A system with an organically contained basic knowledge base. The base must store the technical data and knowledge necessary to design, develop, and operate a knowledge information processing system, and to support creation of knowledge base systems from the basic knowledge base.	(1) Simple creation of a knowledge base system to offer consultation to specialists requiring sophisticated, specialized knowledge. (2) The knowledge base system must be designed to comprise knowledge in the form of about 20,000 rules. (3) Partial system verification at the level of metaknowledge. A large-scale knowledge base system must allow simple debugging. (4) The interim target will be to achieve 30% of the final knowledge base system target.
6-3. Systematization technology for computer architecture Architecture-related systematization technique to complete a systematized fifth generation computer.	

Development of techniques to build up virtual systems and real systems, optimization of system configuration and load balance, designing and developing a large-scale system, and techniques for high reliability.

- Data base and distributed data base systems
  Development of a data base system for the fifth generation computers, techniques for integrating and utilizing two or more data base systems, and integration of knowledge base systems.

7 Development of supporting technology
Various systems will be researched and developed to support the development of hardware and software, as well as the system as a whole.

Item	Targets and specification
7-1 Development of support systems Construction, at an early stage of the project, VLSI-CAD personal computers, computer networks, and systems to support development of a software/knowledge base.	

CSO: 4120/217

POLYMERIC MATERIALS IN ELECTRONICS

Tokyo TECHNOCRAT in English Vol 15, No 1, Jan 82 pp 48-49

[Text]

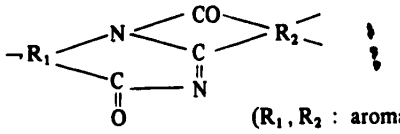
With the advance of electronics in recent years, polymeric materials have much developed, as major materials in electronics. Here, the present situation of polymeric materials is given by introducing an outline of a paper delivered by Professor Shogo Saito of Kyushu University.

1. Insulating Materials

The most important problem to be overcome by insulating materials used in electronic equipment and devices, is to realize superior heat-resistant properties.

The work in synthesizing new polymers in recent years that satisfy such is not so remarkable, but rather much developing work is along the lines of improving the molecular structures of the heat-resistant polymers already synthesized. One example is imide prepolymer having a reactive molecular end. Because this polymer does not contain volatile components such as residual solvents, it is suitable to meet requirements as a melt-curable or melt-processible heat-resistant polymer for use as an electrical insulating material. Representative polymeric insulating materials used in high-density integration of so-called microelectronics, are polyimide and epoxy resins, and so, here new trends of both of these resins are described as follows:

An interesting aspect of polyimide used so widely, is the development of polyimide isoindolo-quinazolinedione (PIQ resin) by Hitachi. The difference in chemical structure between PIQ and ordinary polyimide is that PIQ contains a ladder structure having good thermal stability in the polyimide chain.



(R_1, R_2 : aromatic ring)

PIQ film can be formed by coating PIQ prepolymer on silicon wafer material, and curing at 350°C in a nitrogen atmosphere. This film can endure heating in air at 450°C for

5 hours.

The success of PIQ as a passivation material has come as a surprise abroad, and the electronic industries in America and Europe are now investigating use of polymide materials for multilayer VLSI's. And further, a surface treating agent, such as an organosilane compound like gamma-amino-propyltriethoxy silane, is presented to improve the adhesive properties of polyimide on silicon wafer material.

As for epoxy resin, the development of improving its heat-resistance and controlling viscosity in applying it to device packages, is actively proceeding. One example is the high-molecular-weight linear epoxy resin, developed by Western Electric, which is possibly cross-linked with high density.

2. Semiconductor Materials

The success of electrofax-photosensitive materials using polymeric semiconductor materials has motivated applying the sensitisor to the polymer for laser printing. And the subject is now established as a national project. These activities are intensive, but exact information about developments is not readily available.

The following photoconductive polymers are now being studied: (1) linear π conjugated polymers such as polyacetylene, (2) polymers such as polyvinylanthrathene, which have condensed polycyclic aromatic hydrocarbons in their side chains, (3) those such as polyvinylcarbazole, which have complex cyclic aromatic compounds in their side chains, (4) polymers containing allylamine in their side chains, (5) those such as polyimide, which contain aromatic or complex rings in their main chains, and (6) charge-transfer complex polymers, which are obtained by doping low molecular compounds into the above polymers.

The photoconductive polymers developed have for the most part features of the so-called separation-type function, in which are used composite structures consisting of two phases, that is, the phase generating carriers by photoirradiation, and the other phase of drifting carriers. And further, the tendency of obtaining desired materials by polymeric semiconductors only is becoming less, whereas that by combining with other materials is becoming greater. For example, the following are the typical laminated function-separated photoconducting materials: (1) polyvinylcarbazole as a charge migration layer and amorphous selenium as a charge generation layer, (2) pyrazoline/polycarbonate (charge migration) and organic pigment such as squalilium (charge generation), and (3) 2,5-bis(4-diethylaminophenyl)-1,3,4-oxadiazole/polyester (charge migration and thioindigo derivatives (generation).

There are some photoelectric transducing materials using polymeric substances such as (1) trinitrofluorenon/polyvinylcarbazole, (2) polymeric thin film dispersed by phthalocyanines, (3) polyacetylene doped by a small amount of electron-acceptor molecules, among which polyacetylene type materials will be studied much more for future development.

3. Resist Materials

Resist is an important material in electronics, essential to the manufacture of many electronic devices, among which the VLSI is the most important semiconductor device.

Photoresist, which has been widely used for some time, has now reached its highest level, and methods of designing the material are considered as being almost fully established although there have been some slight improvements.

The current main projects in research and development tend to be for infrared (deep UV) resist, electron beam resist, and X-ray resist. Research projects expected to lead to new high-performance resists have been much reported at a meeting of the American Chemical Society last year. Main research concerns deep UV resist and electron beam resist, among which, one of the important projects is the development of materials to chemically modify esters of polymethacrylic acid, as previously.

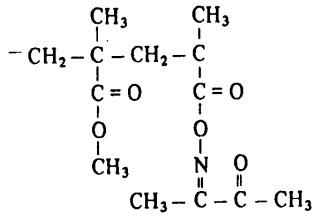
A noticeable new tendency is the bold idea of applying organic semiconductors to resist, but it will take much time to accomplish the development because of economical aspects and sensitivity.

Cross-linked polymethacrylates have been developed, thus appearing as a positive electron beam resist with good thermal stability and dry-etching property as: (1) poly(methylmethacrylate-co-methacrylic acid), and (2) poly(methylmethacrylate-co-methacryloyl chloride).

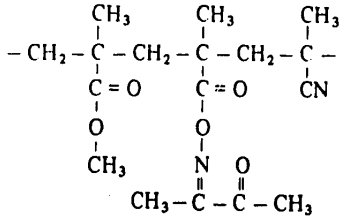
These copolymers contain comonomer units of 10 mole%, possible to be cross-linked. These are mixed and formed into a coating film, and then, by low-temperature heat treatment a weakly cross-linked resist film can be prepared.

Furthermore, binary and ternary copolymers, which contain any suitable monomer unit in the backbone of polymethylmethacrylate, have been developed and are expected to be suitable as new deep UV resist. These copolymers are as follows:

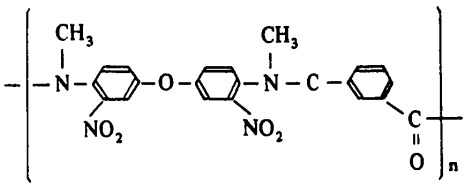
(1) poly(methylmethacrylate-co-3-oximino-2-butanone methacrylate)



(2) poly(methyl methacrylate-co-3-oximino-2-butanone methacrylate-co-methacrylonitrile)



The latter has a sensitivity 85 times greater than PMMA as a deep UV resist, and the sensitivity can be increased two or three times higher by adding a photosensitizer. And further, the following polynitroamide is receiving attention as a new deep UV resist.



IBM has plans for a new electron beam resist, using a thin film on substrate formed in a gas phase by reacting bromide with tetrathiafulvarene (TTF) which is well known as a component of organic semiconductor. Also, a negative resist is reported, using a thin film doped by CBr_4 into a new polymer synthesized by binding chemically TTF to polystyrene through covalent bonds. The following chemical reaction is used between TTF and CBr_4:

$$TTF + CBr_4 \xrightarrow{h\nu} TTF \cdot Br_X \quad (0.5 \leqq x \leqq 0.8)$$

It has been reported that a resolution of 1,000Å has been obtained by using this resist in a coating film with 6,000Å thickness.

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YAMAGUCHI SATELLITE COMMUNICATIONS CENTER

Tokyo TECHNOCRAT in English Vol 15, No 1, Jan 82 pp 49-50

[Text]

KDD's satellite communications center in Yamaguchi Prefecture is the western entrance of international communications with Japan. Since its opening in May 1969, it has been expanding as the main ground station to deal with such work as station-to-station communications, marine satellite communications over INTELSAT satellites, and tracking, controlling and testing satellites themselves.

Now the center has its own communications parties of 31 destinations in 29 countries, to which about 656 circuits are working. Further, it is now preparing to start a new marine satellite service over INMARSAT, in February, 1982. All facilities were completed in December, 1981 and the center is gaining greater importance in sharing in international communications, to and from Japan.

KDD, Japan's international communication monopoly, has two satellite communications centers: one in Ibaragi Prefecture which aims at having accesses to satellites over the Pacific Ocean and the other is this Yamaguchi center from which satellites, both over the Pacific and Indian Oceans are accessible.

The Yamaguchi center is located in the western part of Honshu, Japan's mainland, about 13km away from Yamaguchi City. This location was chosen as the Indian Ocean satellite can be directly observed with no interference from domestic microwave paths, since it is surrounded by mountains, and little noise exists in spite of being fairly near to a town center. It is also out of the occasional course of passing typhoons, and seldom experiences earthquake tremors.

The center has three main jobs -- stationary satellite communications, marine satellite communications, and tracking, testing, controlling and maintenance (TTC&M). Stationary satellite communications have 31 party destinations in 29 countries, which have been connected mainly over the Satellite IV and, now, the center is adding Satellite V over the Indian Ocean in December to which relevant facilities have already been prepared.

Marine satellite communications services have been offered to ships on the Indian Ocean since November 1978, though the marine satellite is now a private one, COMSAT. As the

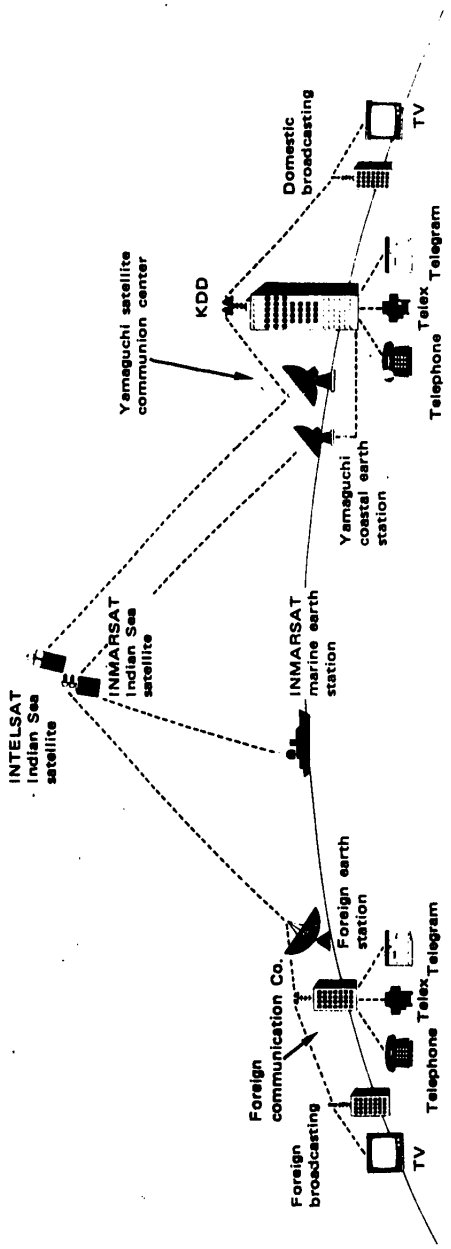

Fig 1 Configulation of INTELSAT communication system

global system of INMARSAT starts to work, the center is now preparing to switching its dealings to meet the system.

TTC&M work is shared with INTELSAT, which has launded and is operating 14 satellites. The center is one of 8 TTC&M offices for INTELSAT. It is actively sharing its responsibilities, for Satellite V that was launched in December, 1981.

The center has now eight ground stations, of which the four main ones have parabola antennae, 27.5 meters in diameter, for Satellite IV, 34-meter diameter for the Satellite V, 13-meter diameter for Marisat, and 32-meter diameter for TTC&M. Most output-power tubes are TWT's, while that for the marine satellite is only a crystron.

As for inhouse plant at the center, distinguished equipment is the digital converter of TV standard signals that is the sole one used in Japan, and other equipment is all the most advanced available.

The center's target is to offer highly-qualified communications throughout the world.

CSO: 4120/217

ACOUSTIC EMISSION TECHNOLOGY

Tokyo TECHNOCRAT in English Vol 15, No 1, Jan 82 pp 51-52

[Text]

Whenever a house collapses, caused by an earthquake, a creaking sound is always heard before it finally crashes down. Similar to this phenomenon, before any object fractures, a similar small creaking sound, inaudible to the human ear, is generated, without fail. Acoustic Emission (from here called AE) Technology, which is detection of such sounds by ultrasonic sensors and using them as an application of non-destructive inspection of pressure vessels, has been making rapid progress towards commercialization. Such vessels are quite common in the chemical industry and elsewhere.

To look at the present status of AE technology, which quite rapidly, has been gathering much attention recently, whenever an object fails, this never happens suddenly or abruptly. When a force is applied to an object, the object deforms. When the force applied exceeds a certain level, plastic deformation which imparts permanent transformation, occurs even after the release of the applied force. Around the transition boundary from deformation to plastic deformation, a small creaking sound is always generated. As this sound has a frequency of 10^{5-6}Hz, it is a kind of ultrasonic wave. And as the human ear is only able to hear sounds below 20kHz, it is unable to be detect such a sound.

Acoustic waves in AE originate from slight sideslipping of small crystal structure portions, or from extension of old cracks existing in the object of up to several 10μm, when a force is applied to it. When such a force is applied, cracks in the object keep extending, generating the creaking sound until the object visibly fails.

Therefore, if such squeaks can be caught by a special AE sensor, the real danger can be detected much earlier prior to any actual occurrence of large-scale failure of the object. An AE sensor acts as a kind of stethoscope and uses a piezoelectric component, to convert micropressure fluctuations into electrical signals. And by using two or more sensors in combination, it is possible to establish the position of cracks in an object. A crack occurring in a metal plate can be detected and the position pinpointed within ± a few millimeters. It is said that Dr. Kaizer of West Germany who, in the early 1950's, measured sounds originating in metal when a force was applied, was the originator of AE research activities. Later

on in the 1960's, actual applications of AE technology being used in inspection, in the fields of rocket, aircraft and other forms of engineering in the United States, actually started.

Recently, applications of AE technology in Japanese industry, such as in the inspection of pressure vessels, machinery surveillance in factories and elsewhere, have begun to be put into practice.

Application Example No.1

Nippon Steel Corp. has been effectively installing AE equipment for surveillance of steel plate rolling mills. As the rolls in these machines apply a rolling force of several hundred tons, even a slight crack, say, in a bearing support for a roll shaft, could lead to a dangerous accident by continuing to use such a machine without appropriate action.

However, to replace such a bearing support with a new one may take many days and it is impossible to stop a production line for such an extended period. Therefore any cracked portions are usually repaired by welding or by adding mechanical bracing. On such occasions, if AE equipment is installed, any reoccurrence of the trouble in the welded area or repaired cracks, is swiftly detected. By observing any changing status of acoustic emissions without stopping the entire production line, various methods, such as easing the force applied to the particular rolls or further repairs can be performed as timely action.

Extending of a crack which, could not be detected by ultrasonic detection equipment, can now be identified by AE and it is possible to stop a rolling mill timely before any real danger arises.

Application Example No.2

An application, as forecasting technology for gas emission accidents in mines, is also underway. Prof. Watanabe of Hokkaido University has installed several sets of AE equipment at various mines in the Hokkaido and Kyushu areas, to establish the possibility of using AE as a forecasting tool.

In mining operations, explosives are used to break out the coal from the seams, but often there are gas emissions created by the disturbance of the rockbed enclosing high-pressure gas, leading to weakened strata and landslides occurring. It is said that more than 90% of gas emission accidents occur immediately after such explosions. However, the number of immediate emissions or nonrelated or delayed emissions after blasting using explosives have been increasing.

Raising of gas pressure is caused by the remoteness of present coal seams which go deeper and deeper, some over 1,000m from the earth's surface, and such phenomena make more difficult to predict gas emissions, but according to current research, an acoustic emission from as far away as 10m from such a dangerous location can be detected. The accuracy of being able to predict a gas emission depends on the absolute probability improvement, by the installation of AE equipment. Thus the development of easily operated portable AE equipment has been receiving keen interest.

Application Example No.3

The inspection of pressure vessels used in petroleum refineries, chemical and power generation plants has been

attracting been attention as new applications for AE technology. In order to avoid possible danger, pressure vessels that receive high-internal pressure are required under various regulations, to pass regular periodic inspections. On such or similar occasions, or to verify that a newly built pressure vessel can withstand the designed pressure rating, the vessel is subjected to a higher pressure, higher than normal rating. Inadvertantly accidental bursting of the vessels can occur. This is why there is a desire to apply AE technology during such inspections to make detection early and to avoid any possible danger. In the case of using ultrasonic detection or using other technology for inspection of giant spherical tanks, over 30m in diameter, inspection may take over a month. However, with AE technology where it is possible to set a large number of AE sensors simultaneously on a giant tank, it is possible determine the presence of cracks within a day or so.

Nippon Steel has been subjecting such pressure vessels to AE inspection via its subsidary, as a contract starting 2 years ago, and it is now receiving a dozen or so requests yearly from chemical and power generation establishments.

Besides the above applications, inspection of structural objects, such as bridges and highways, monitoring for quality control in spot welding operations, much used in automobile production processes, are some of the examples of the expanding applications of AE technology.

CSO: 4120/217

POLARIZING OPTICAL FIBER

Tokyo TECHNOCRAT in English Vol 15, No 1, Jan 82 pp 52-53

[Text]

The Electrotechnical Laboratory (ETL) has developed a polarizing device using optical fiber. Attracting world attention at present, is how to use optical fiber itself as a functioning device, not merely as just an optical path, for example, by exploiting its long mutual acting distance to generate high-efficiency nonlinear optical effects or developing, say, an optical interferometer, so as to adapt optical fiber to high-sensitivity measurements.

The polarizing technology just developed by ETL will make an important contribution to using optical fiber as a functioning material. It is because to use it as such not only requires single mode fiber as the best material, but also requires the technology to control polarization status inside the optical fiber.

Conventional technology for light modulation has employed, generally, such exclusive-use polarizers as a filter slit or a prism. By such methods however, the connection between the device and transmission path develops noise and causes attenuation, which then needs compensating in various ways. And it results in the overall design being complex or causing troublesome servicing. The newly-developed method uses the optical fiber itself as a polarizing device so that these problems are now all solved.

The principle is the same as that of a metal loaded film waveguide path in that, as shown in Figure 1, a part of the fiber-optics clad layer is replaced by a metal such as Al or Au to increase loss of the pseudo-TM wave, thereby guiding only the pseudo-TE wave with low loss. This principle is more specific in terms of structure as follows: a groove is made on the quartz or acryl substrate, but only very shallow in its middle part and an optical fiber, 125μm thick, is inserted in the groove, in the middle shallow part of the groove, part of the fiber is exposed. An optical fiber generally consists, in terms of cross section, a core part which guides the light, and the cladding around it having a higher refractive index than that of the core. By this new method however, the depth of the groove is adjusted so that only the clad portion protudes. Then this portion is ground to the same flat level as the substrate's surface.

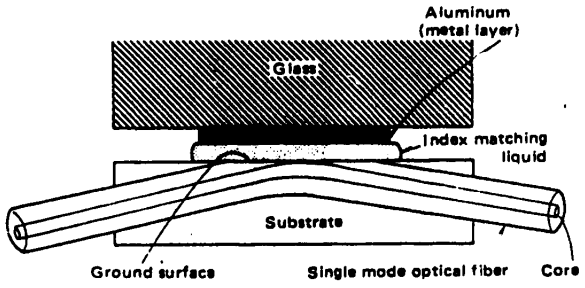

Fig. 1. Polarization Device Using Optical Fiber Developed by ETL

ETL used a wire saw to make a groove about 140μm wide but only 65μm deep in the middle portion and 50~100cm radius on a 5 x 10 x 20mm quartz substrate; then they buried a 125μm diameter single mode fiber (core diameter is 4μm) in the groove with epoxide resin and ground the exposed part. After grinding the surface, they applied oil with a matching refractive index, almost with the same refractive index 1.468 as that of the quartz substrate. Further, they positioned an aluminum plate which had undergone mirror finishing, and fixed it using a glass plate, on which in some areas, metal film had been deposited. Into this polarizing device thus constructed, ETL applied an He-Ne laser beam in the experiment. The He-Ne laser beam passed through a motor-driven rotating polarizer to undergo circular polarization, then through a Babinet compensator, then projected to the optical fiber. Next the light was divided into two elements at the polarizing device: a Y-mode element whose vector was vertical to the substrate and an X-mode element whose vector was horizontal. Of them, the Y-mode element was subjected to interference of the aluminum plate and disappeared, leaving only the X-mode alone in the optical fiber. Figure 2 shows an example of the experiment's results with aluminum evaporation.

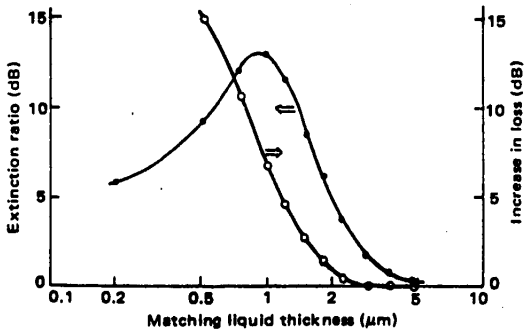

Fig. 2. An Example of the Experiment's Results With Aluminum Evaporation

CSO: 4120/217

100KW WIND-POWER GENERATOR

Tokyo TECHNOCRAT in English Vol 15, No 1, Jan 82 pp 53-54

[Text]

The Sunshine Plan Promotion Headquarters of the Agency of Industrial Science and Technology has recently announced the specifications for an experimental 100kW windpower generator. With this move Japan has officially begun development of windpower, although her activities in the field thus far have been lagging compared with Europe and the United States.

The windpower generators already developed in this country have a capacity of only a few kilowatts while those developed in other countries are much larger by comparison (see Table 1).

These small generators are used as power supplies for telegraph and television repeaters and are also used by some private citizens. Devices of this type generate AC power which is converted to DC power which in turn is used to charge batteries. This method lowers the efficiency of the generators remarkably. Considering the expense, such generators have limited application. The main reasons are the low energy density of wind power, and its large variations.

Windpower generation has not been considered important in Japan thus far because of the very large variation in wind energy due to the topography and location of the country. However, it will be possible to develop windpower generation in Japan if the amount of power generated can be held con-

Table 1. Current Status of Windpower Generators Developed in Selected Countries in Europe and the U.S. (data collected by the Sunshine Plan Headquarters)

Country	Name	Output power (kW)	Blade diameter (m)	Remarks
U.S.	Mode 1	2,000	61	In operation
	Mode 2	2,000	90	In operation
West Germany	Growian 1	3,000	100	Under construction
	Growian 2	5,000	148	Under construction
Denmark	Nive Mode 1	630	40	In operation
	TVIND	1,900	27	In operation
England	BACD/ERA	3,700	60	Under construction

stant despite such large variations. The new generator designed by the Sunshine Headquarters will begin to generate power at wind velocity above a set level, and will compensate for excess wind speed, thus keeping the amount of power generated at a constant value. The frequency of the generated alternating

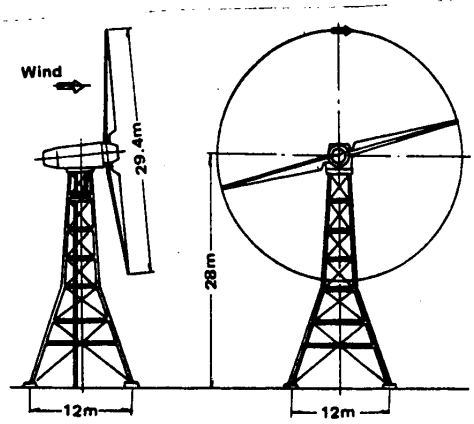

Fig. 1. Profile of 100kW Pilot Windmill

current will also be kept constant. Using these procedures, the windpower generator will be operated in conjunction with commercial power lines. In other countries this method has already been adopted.

Windmills used for windpower generation are generally of the lift type. The counteracting force type windmill, as represented by the windgauge (anemometer), which has arms supporting cup-like wind acceptors, can be used efficiently at low wind speeds but loses efficiency as wind speed increases. The lift type windmill utilizes wind energy on the same principle as an airplane's wings (greater speed produces greater lift), thus the efficiency of utilizing wind energy increases with wind velocity. Because wind energy is proportional to the cube of wind velocity, the lifting force type windmill is usually used for windpower generation in view of its efficiency.

In some windmills the rotor axis is parallel to wind direction and in others it is perpendicular. The Sunshine Plan's design employs a horizontal rotor axis and a lift type propeller.

Basic experiments on the propeller-type windmill wered performed at the Mechanical Engineering Laboratory using a 1/25 scale model for wind tunnel tests. The number of blades is usually two or three, and the test windmill used two. The use of three blades greatly increases cost while raising efficiency only a few percent and a two-blade propeller is safer considering the high frequency of typhoons in Japan. When wind velocity exceeds a definite value (high wind condition), the blades change their direction to the horizontal in relation to the ground, and adjust their angle to minimize wind resistance. When using three blades, it is impossible to hold all three

blades horizontally, thus increasing wind resistance, requiring greater mechanical strength, and causing safety problems in the event of a typhoon.

The windmill begins to rotate when wind velocity reaches 5m/s, attains the rated output at 10m/s, and stops rotating at speeds above 17m/s, for safety. To avoid variations in alternating current frequency due to changes in wind velocity, it rotates at a constant speed of 51rpm by controlling the pitch angle of the blades using a microcomputer. The pitch angle is hydraulically controlled.

As shown in Figure 1, the diameter of the propeller is 29.4m, and the height of the propeller axis is 28m. The material of the blades is GFRP. The rotational speed of the rotor, 51rpm, is changed up to 1,500rpm by a multiplier to drive the generator, which is a DC link system. Using pitch angle control and frequency control to adjust input to the DC link system, it is possible to supply stable electric power independent of wind velocity variations, to the electric power network. Miyakejima is the proposed site. If this pilot windmill is successful, the plan is to construct an experimental windmill having a capacity of 1,000kW.

CSO: 4120/217

COMPETITION AROUND VLSI'S

Tokyo TECHNOCRAT in English Vol 15, No 1, Jan 82 pp 54-55

[Text]

Hitachi, Ltd. announced on December 17, 1981 that it would begin sale of 256K-bit RAM VLSI's as samples to about 100 user companies from autumn, this year. Thus, these new units are expected to put into commercial application by the spring of 1983. The production rate will increase from a volume of tens of thousands in early 1983 to hundreds of thousands by the end of 1983.

As a result of the announcement by Hitachi, 256K VLSI's will appear on the market three years earlier than expected, and competition among the makers will suddenly intensify.

When 64K RAM's were first sold as samples in the autumn of 1980, the price of one unit was ¥20,000, but after only one year, it sharply dropped to ¥2,000. At present, the price is about ¥1,200 but it is expected to drop to ¥1,000 before long. Usually the price of IC's follows the "Learning Curve" theory proposed by the Boston Consulting Group of the U.S. which states that price drops 30% with a two times increase in production. Therefore, a high-production maker can decrease the cost per unit, and increase his profit, thereby gaining a greater market share. The higher market share in turn leads to increased production and even more favorable conditions. These are the practical conclusions of the "Learning Curve." The fact that Japanese semiconductor makers have become believers in this theory has triggered confusion in the 64K RAM market and created friction between Japan and the U.S.

When the technical considerations for marketing 64K RAM's were satisfied, Japanese makers began intensive efforts to expand production independent of actual demand. In the semiconductor industry it is generally considered that important new products are introduced about every four years. The market for 16K RAM's has continued for four years, and the greater share was held by the American semiconductor industry. When the age of 64K RAM's arrived, all the big makers of semiconductors in Japan announced that they would be suppliers of the product. Mitsubishi Electric Corp., the latecomer in the 16K RAM market, joined the group. Oki Electric Industry Co., which had no positive achievements, announced it would supply 64K RAM's. Oki Electric was followed by Sharp Corp. in April last year. All these makers

are carrying out their plans. It is natural that prices will drop with the increase of production, independent of real demand.

If the price of 64K RAM's drops to ¥1,000 per unit, the price will become comparable to that of 16K RAM's. Then, the users will naturally select 64K RAM's instead of 16K RAM's because of the better cost/performance ratio of the former. Thus, the demand for 64K RAM's has grown rapidly. As a result, 64K RAM's are now replacing 16K RAM's in Japan, and further, demand for them has been greatly expanded abroad. According to one view, over half the demand in the world is supplied by Japan. It is believed that 8 to 10 million 64K RAM's were manufactured in 1981, and over 60 million will be manufactured in the world this year. And the price per unit is approaching to about two-thirds of that of a 16K RAM. This situation is one reason for the friction concerning semiconductors between Japan and the U.S. Although the growth in demand for 16K RAM's has stopped, its production has not diminished.

The price of 64K RAM's has fallen more rapidly than was expected, so makers have not been able to gain the profits they had hoped for. A top manager in the field says that the expected profit of about ¥5 billion did not materialize. Despite the previous bright outlook, extremely hard competition in the VLSI field has put companies in a very severe situation.

It was generally believed that the market for 64K RAM's would continue for three more years, but competitive sales have just begun and every maker is trying to expand produc-

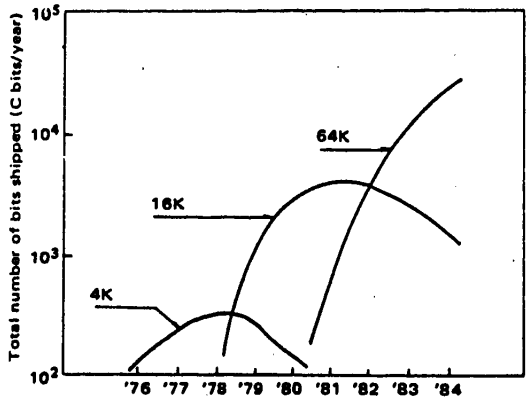

Fig. Number of Bits Integrated of Dynamic RAM's (W/W)

tion rapidly. NEC, Hitachi and Fujitsu are aiming at reaching a production scale of one million units per month by this spring, and Oki has announced that its production of 400 thousand units in December last year will be increased to 800 thousand in March. Mitsubishi Electric is planning to production 500 thousand units this spring. Toshiba reportedly will expand production equipment to raise the present monthly production of 100 thousand units to 1 million units by the end of this year. Sharp will begin production of 300 thousand

Table. IC Sales, R&D Expenses and Equipment Investment

Fiscal year	IC sales (A) (million yen)	Compared with previous year	R & D expenses (B) (million yen)	Compared with previous year	B/A (%)	Equipment investment (C) (million yen)	Compared with previous year	C/A (%)
1973	86,223	–	17,029	–	19.7	18,874	–	21.9
1974	83,404	96.7	18,532	108.8	22.2	17,695	93.2	21.2
1975	108,158	129.7	21,524	116.1	19.9	11,379	64.7	10.5
1976	164,924	152.6	24,297	112.9	14.7	35,191	309.3	21.3
1977	155,474	94.3	24,456	100.7	15.7	21,958	62.4	14.1
1978	251,881	162.0	37,997	155.4	15.1	45,932	209.2	18.2
1979	374,910	148.8	54,774	144.2	14.6	84,103	183.1	22.4
1980	547,708	146.1	69,037	126.0	12.6	136,875	162.7	24.9
1981	654,247	119.5	87,168	126.3	13.3	166,401	120.8	25.3
1982 (Planned)	827,308	126.5	112,503	129.1	13.6	216,510	130.9	26.2

Source: 1982 Electronic Industry Yearbook

units per month from April.

This expansion of production by Japanese makers is to be attained by investing 41% of their sales. Shown in Table 1 are the trends of IC sales, research and development, and investment in equipment. In 1982, research and development expenses and equipment investment are expected to amount to 13.6% and 26.2%, respectively, of sales – a total investment of 29.8%. This fact shows that the IC industry is really investment-oriented. It is feared that these active investments might result in intensified competition and excessive equipment.

With demand for 64K RAM's at the end of this year expected to exceed supply, the market is still expanding. Japanese makers have enjoyed development benefits in the new 64K RAM market. So long as the 16K RAM market in the U.S. has not diminished, Japanese makers are not infringing on the acquired market.

It may be said that Japanese makers have established a basis for existence by obtaining a greater share of the expanding market. Here is the essence of the friction in the Japan-U.S. semiconductor war.

When the market stops expanding, some makers may not be able to afford such a high rate of investment. This is reflected in the small number of enterprises, which have gone into production of 65K RAM's, compared with 16K RAM makers the worldover.

Under these circumstances, the industry was shocked when Hitachi announced on December. 17 of last year that it would begin mass-production of 256K RAM's from the autumn of 1982. Now both Japanese and American makers will have to go all out in investing in production of 256K RAM's despite the fact they have not recovered their 64K RAM investment.

While the appearance of 256K RAM's will intensify the friction between Japanese and U.S. semiconductor makers, but users will benefit by the acceleration of technological developments in the electronics field.

CSO: 4120/217

SCIENCE AND TECHNOLOGY

ARDUOUS EFFORTS MADE TO COMPLETE COMMUNICATIONS AGREEMENT

Tokyo NIHON KEIZAI SHIMBUN in Japanese 15 Mar 82 p 9

[Text] Waiting for "Voice of God?"

In connection with the work of drawing up the draft of a Public Tele-Communications Law revision bill for the purpose of liberalizing data communications, the Postal Services Ministry and MITI are continuing efforts to search for a compromise plan. With regard to the Postal Services Ministry's original schedule for submitting the draft to the Cabinet meeting on the 12th, time was earned to the extent of about one week, due to the request for the postponement of the submitting thereof to the Cabinet Secretariat. However, there is also no possibility that the talks between the administrative officials concerned of the two Ministries will develop beyond this, on a large scale. Therefore, it seems that the two Ministries will come to make final settlement efforts, while waiting for the "voice of God" from the LDP. Private users are watching the situation, from the stand that if the situation is not settled, it may result in injuring the LDP, too.

The administrative officials concerned of the Postal Services Ministry and MITI seem to have half given up their respective hopes, but they have been continuing a series of talks, in order to seize an opportunity to settle the situation, somehow or other. The reason for this is probably that if the proposed revision itself of the Public Tele-Communications Law is upset completely, and if the main cause is regarded as resting with the two Ministries, then they will become targets of public impeachment.

MITI has so far been upholding the stand that it cannot accept the Public Tele-Communications Law revision bill general outline, submitted by the Postal Services Ministry to the LDP Communications Department on Feb. 24. As for the reasons, MITI has listed the following points: (1) The Provisional Administrative Affairs Research Council's recommendation should be respected; and (2) in order to relieve medium and small enterprises and other enterprises, which cannot afford to have their own computers, and which will be placed in a disadvantageous position, when compared with the joint use of circuits by big enterprises, the liberalization

of the use of circuits by the persons concerned or the joint use thereof, including message exchange, should be carried out. MITI also says that concerning these requests, the Public Tele-Communications Law need not necessarily be revised, and that there will be no objection to the realizing thereof on the basis of a Ministry ordinance or regulations.

Kev Is Preservation of Secrets

On the other hand, the Postal Services Ministry maintains that it cannot regard message exchange, which is telegraph- or telephone-like service, as information-processing [service], set forth in the expanded interpretation by MITI. Furthermore, it has made no concessions, from the stand that in regard to telegraph- or telephone-like services, the preservation of communications secrets is absolutely necessary, and that a set-up should be established under which the Postal Services Minister can check them, in some form or other.

It is LDP Communications Department Chief MORI's tentative plan which appeared under such circumstances. The main contents thereof seem to be as follows: (1) A new bill for the purpose of a high-level communications services system, the submitting of which bill to the current Diet session has already been given up by the Postal Services Ministry, will be submitted to the next regular Diet session after the necessary preconditions, including the preservation of communications secrets, are improved; (2) MITI will co-operate in the submitting of the new bill; and (3) it will not be good if medium and small enterprises are placed in a disadvantageous position, compared with big enterprises; therefore, as "stop-gap" steps to be taken until the Diet passage of the new bill, measures will be taken to preserve communications secrets, while on the other hand, permission will be granted for message exchange under the use-by-others system, within a certain fixed scope (wider under the present draft), through confirmation by the Postal Services Minister. The Postal Services Ministry is said to have decided to "concede on" (accept) the MORI tentative plan. However, MITI has still not accepted the proposed [system for] "confirmation by the Postal Services Minister." The talks between the administrative officials concerned are deadlocked.

Under this situation, however, the LDP, which has mediated between the two Ministries, will eventually have its ability to govern as the responsible party questioned. That is why Policy Board Chairman TANAKA presented a request, asking, "Is it impossible to have the MORI tentative plan contain contents which are slightly more acceptable to MITI?" So far, it is not known what is meant by the plan which MITI can accept. However, the Postal Services Ministry is determined to uphold the proposed [system for] "confirmation by the Minister," to the last. The problematical points can be said to have become clear, between the Ministry and MITI which is planning to prevent the arising of such a situation.

Even if the two Ministries reach a compromise, the incorporation thereof in the Public Tele-Communications Law revision bill will not be realized in time for the submitting of the bill to the Cabinet meeting, slated for the 19th, because it is necessary for each Ministry to conduct checks, once again. Therefore, it will come about that the remaining point of compromise will be to revise the Ministry Ordinance or Regulations. In regard to the problem of whether it will be possible for the two Ministries to reach a compromise, within the next two or three days, the proposed liberalization of data communications has entered the stage where it will be settled at the last moment.

CSO: 4106/94

SCIENCE AND TECHNOLOGY

REVISION OF POSTAL SERVICES AGREEMENT REACHED

Circuit Use for 'Others' Approved

Tokyo NIHON KEIZAI SHIMBUN in Japanese 16 Mar 82 p 3

[Text]

The Postal Services Ministry and MITI on the 15th reached agreement on a Public Tele-Communications Law revision bill calling for the liberalization of data communications circuits, [the work of drawing up the draft of which bill] had been having hard sailing. The two Ministries accepted the "judgment," formed by LDP Policy Board Chairman TANAKA who has been making co-ordination efforts. In regard to high-level communications services, which were regarded as a focal point, the contents of the judgment are as follows: (1) Under certain conditions, "others' use" of circuits, which use will be accompanied by the use of telephone-like services, will be approved only as to medium and small enterprises which have close business connections; (2) this will be a provisional tentative step to be taken until a decision is reached on the way of the use of circuits as a whole; and (3) as regards the overall liberalization of high-level communications services, the Government will formulate a conclusion quickly. As a result, the amending of the revision bill, as called for by MITI, will be given up, but in line with the purport of the judgment, the Postal Services Ministry will revise its Ordinance, so as to pave the way toward use by medium and small enterprises. However, in regard to the contents of the "certain conditions" which are all-important, [the judgment] calls for postponing the reaching of a conclusion. The problem has thus come to an "iridescent end." Due to the agreement reached between the two Ministries, the revision bill will be incorporated in the administrative business simplification and rationalization bill (package bill calling for readjustment of items which require approval or permission) which the Administrative Management Agency is preparing now. The Cabinet, at a meeting, slated for the 19th, is scheduled to decide to submit [the revision bill] to the current Diet session.

In regard to data communications, information will be processed through the direct connection of computers and communications functions, as in the case of the National Railways' Green (TN: First Class Ticket)

Windows and the banks' on-line systems. They are said to be the third communications, after telegraph and the telephone. Under the Public Tele-Communications Law now in force, a net of various restrictions is put up over the use of such data communications services by private circles. Therefore, the removal of these restrictions or revision of the Law has been sought since several years ago.

With regard to the demand for liberalization, centering on industrial circles, the Postal Services Ministry had originally planned to cope with it through revision of the existing Law and also through the enactment of a new law (data communications law) which will permit private circles also to offer high-level communications services in which network communications services will be extended, with the values of information enhanced through the processing thereof with the use of computers. But the new bill contained such contents as to call for the establishment of a new approval or permission system. Therefore, MITI, which has demanded overall liberalization, showed repulsion. The enacting of a new law was thus given up, and negotiations were continued on the revising of the remaining Law now in force.

However, in regard to the revising of the Law, MITI, which sought the liberalization of high-level communications services, called for approving "others' use" of data circuits, which are now placed under strict restrictions, as in the case of the use of telephone services, as a measure toward medium and small enterprises which cannot have their own computers. Thus, it took the stand of securing the virtual liberalization of high-level communications services. On the other hand, the Postal Services Ministry emphasized that partly from the standpoint of communications secrets, it cannot approve the large-scale liberalization of "use by others" only through revision of the Law now in force. [The problem] thus had hard sailing. In the end, it was decided that the revision bill will not include that part, due to the TANAKA judgment. It was also decided that the form of approving it as an exception will be taken, in accordance with a Ministry ordinance.

Under the revision bill, moreover, the "joint use" of communications circuits by two or more companies will be liberalized in principle, if they are to be used between enterprises which have business connections with each other. Message exchange, in which telephone-like services will be used, will also be approved if it is to be carried out between enterprises which have close business connections with each other. It will thus become possible to establish new communications systems, for example, between manufacturing industrialists and retailers, between tourism enterprisers and hotel-keepers, and between transportation enterprisers and warehousing enterprisers.

Moreover, concerning the connection of public communications circuits, specific communications circuits, and public communications circuits (public-specific-public connection) which will become indispensable

for private information and communications enterprisers to offer information-processing networks, it will become an object for the application of an individual approval system, on the grounds that there is fear of its causing the utilization of services similar to telegraph and telephone services which are the regular services of the Nippon Telegraph and Telephone Public Corporation (NTT). It was also decided that the connection of public communications circuits with specific communications circuits (public-specific connection) will not be approved, either, in the case of carrying out message exchange.

As regards the liberalization of data communications, the Second Provisional Administrative Affairs Research Council (Chairman: Toshio DOKO), in its recommendation concerning the readjustment or rationalization of tasks which require approval or permission, also says as follows: "State restrictions should be eliminated, as far as possible, and efforts should be made to use the originality and ingenuity of private circles to the maximum." Moreover, the recommendation says as follows: (1) Liberalization should be carried out, with the exception of the system for carrying out message exchange (use of telephone-like services), with an unspecified large number of persons as the objects; (2) in order to clarify the minimum necessary scope of restrictions, a negative-list formula should be adopted; and (3) in regard to mutual connection using computer circuits, the standards for granting separate approval should be clarified in case the granting of such approval is necessary.

Under the revision bill, however, high-level communications services will be approved only toward medium and small enterprises alone. Moreover, the bill will be submitted to the Diet, with the conditions also left unclarified. The "TANAKA judgment" calls for the quick reaching of a conclusion on the overall liberalization of high-level communications services. It can also be said, however, that the problem has been settled in the form of retreating to a considerable extent from the purport of the Research Council's interim recommendation.

Gist of Policy Board Chairman TANAKA's Judgment

1. Measures should be taken to approve the transmission of communications by others under certain fixed conditions, limiting it only to communications to be used for medium and small enterprisers who have close business connections.

(1) Procedures should be established on the basis of the spirit of administrative reform.

(2) The scope of communications should be studied through co-ordination with NTT.

(3) This step should be regarded as a provisional, tentative step to be taken until a conclusion is reached on the new way of the whole utilization of circuits for use by others.

2. In order to materialize the above-mentioned measures, co-operation should be obtained among the Administrative Management Agency, the Postal Services Ministry, and MITI.

3. In connection with the way of the overall liberalization of the utilization of circuits for use by others, I want the Government to make efforts to reach a conclusion quickly. In that case, MITI should make a response with sincerity, when the Postal Services Ministry takes necessary and rational legal measures.

The Postal Services Ministry and MITI have agreed on the liberalization of data communications. This has made it possible for medium and small enterprisers alone to use high-level communications services, though with conditions attached to it. In this connection, however, it is insufficient for the medium and small enterprisers to have mere business connections with each other. For example, [the establishment of] certain fixed capital relations between the two sides will become necessary.

In concrete terms, it will become possible for medium and small enterprises, which have such close connections with each other, for example, to transmit immediately to the other medium and small enterprises information as to inventory control, the issuance of orders, and the transportation of manufactured products through the use of networks established by private information and communications enterprisers. However, with regard to the concrete contents of such operation and the scope of communications, the "TANAKA judgment" also says that "studies should be conducted through co-ordination with NTT." Thus, the problem seems to have been left to future negotiations for revision of the Postal Services Ministry and MITI ordinances.

However, in regard to the agreement between the two Ministries this time, medium and small enterprises, which do not have capital relations with each other, will virtually not be permitted to use high-level communications services. It has been decided that it will be left to the work of revising the Law next year or after. In that meaning, the use of data communications circuits may be said to have been placed under a "limited liberalization" [system], in regard to the revising of the Law this time.

Liberalized Data Communications

Tokyo NIHON KOGYO SHIMBUN in Japanese 19 Mar 1982 p 11

[Text]

Three Government offices, that is, the Postal Services Ministry, MITI, and the Administrative Management Agency conducted consultations with LDP Administrative and Financial Affairs Research Council Chairman Ryutaro HASHIMOTO on the 18th, in order to decide on detailed points as to the liberalization of data communications. As a result, agreement was reached to decide on the general outline of the contents of a revision of the Postal Services Ministry Ordinance for the purpose of carrying out the proposed liberalization, by the 19th when a Public Tele-Communications Law revision bill is expected to be decided at a Cabinet meeting. Moreover, agreement was reached on the following points in the form of Chairman HASHIMOTO's arbitration award: (1) In deciding on the detailed points, the Postal Services Ministry should sufficiently accept the views of MITI and the Administrative Management Agency and decide on the concrete contents quickly; and (2) a new law concerning the use of communications circuits by others should be studied at the new Tele-Communications Deliberation Council to be set up within the Postal Services Ministry.

As regards the framework of the Public Tele-Communications Law revision bill, Policy Board Chairman TANAKA submitted his judgment, and generally put an end to the Postal Services Ministry-MITI confrontation. But the phraseology was not clear; therefore, it was hoped that co-ordination would be carried out between the two Ministries, in connection with the contents of the revision of the Postal Services Ministry Ordinance, accompanying the revising of the Law. On the same day, moreover, MITI revealed that [the problem of] measures for the prevention of computer crimes will be left to deliberations at the Industrial Structure Deliberation Council Information Industry Department.

The gist of the HASHIMOTO arbitration award is as follows:

1. In regard to others' use of [data circuits] for use by medium and small enterprisers who have close business connections,

(1) Co-ordination with the Nippon Telegraph and Telephone Public Corporation (NTT) on the scope of communications should be hastened, and a conclusion should be obtained by the time Diet deliberations start,

(2) In order to approve the transmission of communications by others, the minimum necessary procedures should be established, while consideration should be given to maintaining communications order on the basis of the spirit of the proposed administrative reform this time,

(3) Omitted (TN: Omitted by the newspaper, not by the translator),

(4) Concerning the overall way of circuits for use by others, efforts should be made to reach a conclusion, as early as possible, and the above-mentioned provisional measures should be re-viewed completely at the stage where a conclusion will be reached.

2. In connection with the forms of joint use and use by others in the Public Tele-Communications Law revision [bill],

(1) With regard to the forms of joint use and use by others and the forms of the connection between computers and of the connection of public circuits and specific circuits, efforts should be made, so that the free use of circuits can be secured if it is for data-processing purposes, as in the case of message exchange through the use of half-way computers or terminal communications which will be accompanied by data processing,

(2) The public-specific-public connection should be approved under an individual approval system, if it is for data-processing purposes, and as to the forms to be approved, efforts should be made to make them known through the adoption of contents and formulas, which are as easy to understand as possible,

(3) As regards the above-mentioned detailed points, the Postal Services Ministry should continue sufficient discussions and co-ordination with the Administrative Management Agency and MITI.

CSO: 4106/94

SCIENCE AND TECHNOLOGY

BACKGROUND OF COMMUNICATIONS AGREEMENT

New Uses of Circuits

Tokyo NIHON KEIZAI SHIMBUN in Japanese 17 Mar 82 p 3

[Text]

It has been decided that the Public Tele-Communications Law revision bill calling for the liberalization of data communications will be finally submitted to the Diet after being decided at a Cabinet meeting, slated for the 19th. When compared with the Law now in force, the revision bill approves large-scale liberalization as to the "joint use" of data circuits by enterprise groups. However, in regard to "use by others" which will open the way for the use of high-level communications services by private circles, it does not call for the overall removal of the strict restriction framework. It seems that discussions on the liberalization of circuits, which discussions have been left out, will become a focal point also during Diet deliberations. This paper probed into the tasks left behind toward the use of circuits, the way for which use will be opened through revision of the Law, for the first time, and also toward the complete liberalization thereof.

"Group" Restrictions Eased

Restrictions on the joint use of specific communications circuits by enterprise groups will be removed on a large scale, due to the revision bill this time. Under the Law now in force, enterprise relations, in which joint use will be permitted, will be limited to the "considerable business connections," prescribed by the Postal Services Ministry Ordinance, including connections, for example, (1) between manufacturing industrialists and sales companies, (2) between manufacturing industrialists which have close transaction connections with each other; (3) between banks, and (4) between aviation companies and tourism companies. In other cases, [such joint use] will not be approved, even if there are close connections, from the standpoint of capital alignment or physical distribution. It is necessary to wait for the Postal Services Minister to grant individual approval.

Also, in regard to the standards provided for in the Ministry Ordinance, approval will be granted in the case of [joint use] between manufacturing

industrialists and sales companies, and approval will not be granted in the case of [joint use] between manufacturing industrialists and warehouse companies, which keep their products in custody, or between those industrialists and transportation companies, which transport their products, no matter what close transaction connections the manufacturing industrialists and the companies may have with each other. Such an imbalance was pointed out.

Under the revision bill, these points will be corrected, and [joint use] by enterprises, which have been continuing transactions with each other, will be liberalized in the case of its being accompanied by data processing, irrespective of the type of enterprise. For example, Automobile Sales Company A is showing good business results, and stockpiles at its branch offices become insufficient. Under the present system, in that case, Company A knows about the fact through the use of specific circuits between its Head Office and the branch offices, and asks Transportation Company B for transportation from its plant, and not through the use of such circuits. However, under the revision [bill] this time, Company A can have specific circuits for joint use also with Company B, and an accurate transportation control system will come to be carried out.

In that case, moreover, message exchange, in which the circuits will be used in the same way as in the case of telegraph or the telephone, will be approved, if the two sides have "close business connections" with each other, as can be seen, for example, in the following points: (1) One of them holds more than 10% of the other party's capital, (2) the amount of transactions is equal to over 20% of the total amount, and (3) they have business tie-up relations with each other. Warehouse Company B (TN: sic) can transmit order slips to the branch officies. This means the granting of approval for message exchange which "is banned in principle."

Doubts About Effects of Establishment of Special Exceptions

It is "use by others" which means that specific circuits, leased by information-processing companies, etc., from the Nippon Telegraph and Telephone Public Corporation (NTT) or the Kokusai Denshin Denwa (Telegraph and Telephone) Company (KDD), will be offered for data communications between or among a plural number of customers. Under the Law now in force, a production, sales, and inventory control system can be established only with regard to manufacturing companies and sales companies and other customers who have business connections. Under the revision bill, however, other companies, which have transaction connections, can be incorporated in such a system. With this, it will become possible to establish a physical distribution cycle of manufacturing, warehousing, transportation, wholesale, and retail, with an information-processing company (computer center), which has its own computers, as the nucleus, as far as use by others is concerned.

In the case of use by others, however, message exchange will be banned in principle. The judgment, given by LDP Policy Board Chairman TANAKA

on the 15th, also only approves the establishment of an exception, saying as follows: "Under certain fixed conditions, approval should be granted, limiting it to medium and small enterprises which have close business connections." This step has been incorporated as a measure to relieve medium and small enterprises which cannot secure the separate or joint use of data circuits. However, doubts are already being expressed about the actual effects of the establishment of such special exceptions.

"If as 'close connections' as in the case of big enterprises are to be sought of medium and small enterprises, it will rather bind the special nature of the medium and small enterprises which tend to exercise their originality and ingenuity. This will become a problem, from the standpoint of forming a flexible industrial organization" (Policy Concept Forum Standing Sponsor Hajime HIROTA). From the standpoint of users, the following view was expressed: "The scope of medium and small enterprises is not clear. Communications are not connected with the problem of whether the amount of capital is large or small. Both joint use and use by others are a transformation of separate use. No differentiation should be made in regard to liberalization" (Tele-Communications Users Consultative Council Chief of Secretariat Mikito KONO).

In this connection, the Postal Services Ministry rebutted as follows: "In regard to the revising of the Law, it is impossible to remove restrictions beyond this, in order to preserve communications secrets." It also explained that due to the establishment of such a special exception, the extending of mail-box service, one of the high-level communications services, will become possible, thus opening a way for the future. This is mail-like service in which periodic business-letters will be sent simultaneously to various customers. However, if strict conditions are imposed, then rather big gaps will probably arise between the possibility of "should be possible" and its becoming connected with implementation.

Establishment of Public Circuits Network Will Become Possible

Moreover, in regard to the mutual connection of public communications circuits and specific circuits, which connection was strongly requested by big companies which have branch offices and operation offices on a nation-wide scale, the "public-specific" connection will be liberalized under certain fixed standards, though it is now under a separate approval system. The "public-specific-public" connection will be shifted to the separate approval system, though it is banned. Consequently, in the case of big companies which have their own respective computers installed at their head offices in Tokyo and also at their branch offices in Osaka, it will become possible to connect specific circuits, which will become "arteries," between the computers in Tokyo and Osaka and to establish public circuits networks, which are equivalent to "capillaries," between each computer and the operation or branch offices. Also, in that case, however, overall liberalization will not be carried out, and the "public-specific-public" connection will be placed under the Postal Services Ministry's surveillance. Message exchange will also be left banned.

The Present Public Tele-Communications Law and the Revision Bill

	Present Law	Revision Bill
Joint use	Approval shall be granted only to manufacturing industrialists, wholesalers, and other enterprisers who have business connections. Message exchange shall not be approved.	Business restrictions shall be abolished, and [joint use] by enterprises, which have continuous transactions connections, shall be free. Message exchange between enterprises, which have certain fixed capital connections, shall also be free.
Use by others	Business connections between customers are necessary. Only for data processing between customers and information-processing companies. Connection of information-processing companies to customers' computers is possible. Message exchange is impossible.	Business restrictions shall be abolished. Establishment of terminal communications between customers, which establishment will be accompanied by data processing, is possible. Connection to computers is possible. Message exchange is impossible (in the case of some medium and small enterprises, approval shall be granted under certain fixed conditions.)
Mutual connection	Public-specific connection shall be placed under a separate approval system. Public-specific-public connection shall be banned.	Public-specific connection shall be approved under certain fixed standards. Public-specific-public connection shall 'be placed under a separate approval system.

It is certain that this marks one step forward, when compared with the Law now in force. However, in regard to the way toward high-level communications services which are all-important, "limited" liberalization will be carried out. Therefore, the possibility is strong that its effects on informationized society will only be "limited," too.

Test for Efficiency

Tokyo NIHON KEIZAI SHIMBUN in Japanese 18 Mar 82 p 3

[Text]

There is no other example which was more difficult to understand than the contents of the Postal Services Ministry-MITI confrontation this time as to a public Tele-Communications Law revision bill. That is because technical terms, which are unfamiliar to the general public, were used, and also because intangible "things," such as computers, communications, or information, were dealt with. But it is too hasty to try to settle the confrontation between the two Ministries, regarding it as a mere struggle over jurisdiction, between Government offices. When tracing back to the original starting point of the confrontation, we will come into collision with two options as to whether information-processing services, which will appear, one after another, due to the progress of technology, "should be developed, being left to the free originality and ingenuity of private circles," or whether they "should be restricted, with importance attached to their public utility."

Charter Flights for Information

In order to make the problem easy to understand, let us replace communications circuits by roads. It was the Nippon Telegraph and Telephone Public Corporation (NTT) which had so far constructed roads called public circuits (telephone lines) or specific circuits, while fulfilling the role of a transportation enterprise for transporting freight called information. It is the Public Tele-Communications Law and the Postal Services Ministry which exercise control over the contents of such roads and transportation.

However, computers and other types of low-priced electronic equipment and apparatuses appeared. It is good to consider this equipment and apparatuses to be machinery and appliances for processing, treating in advance, and packing freight (information) to be transported along roads called circuits, so that it can be used as soon as it arrives. That is why data communications, which connect computers and circuits, are called "added-value communications services," though the telephone and telegraph transmit information as is, without processing the contents thereof.

Therefore, enterprises and information-processing services enterprisers, who have computers, that is, machines for packing and processing information, came to lease circuits from NTT, in order to promote the efficiency of their transportation services. This is a so-called charter flight for the transmission of information.

In this connection, the "joint use," which has become a problem in regard to the revision bill this time, means a charter flight or an exclusive road to be used jointly by a plural number of enterprises, such as food companies and refrigerator companies. The revision [bill] this time calls for carrying out liberalization to such a considerable extent that various kinds of information can be transmitted through the use of the circuits.

On the other hand, "use by others" refers to the form of the use of circuits, centering on the information-processing services enterprises, and it can be likened to local transportation business. It is business in which information as to an unspecified large number of persons will be transmitted through the use of circuits leased from NTT. When compared with the joint-use [formula], strict restrictions are still imposed on the method of packing the freight to be transported and the destinations thereof.

Procedures for the Future Irisdescent

MITI, which wants to promote the development of the information industry, centering on computers and software, would like to develop new services and demand through liberalization of the use of circuits. On the other hand, the Postal Services Ministry is taking the stand that communications services are strongly of a public-utility nature, and that even in order to preserve communications secrets, it is impossible to ease restrictions. This was the basic point of the Postal Services Ministry-MITI confrontation this time.

In the end, with regard to LDP Policy Board Chairman TANAKA's judgment this time, the Postal Services Ministry only approved liberalization to the minimum extent which is conceivable. As to through what procedures the remaining liberalization problem should be settled from now, it was only decided that "the Postal Services Ministry, MITI, and the Administrative Management Agency will co-operate with one another." Thus, an "iridescent settlement" was reached, without showing any concrete direction.

What is the liberalization of what remains? It means a field which is called high-level communications services. The focal point is whether exchange between the data communications systems of different enterprises will become possible through the establishment of networks which will connect a plural number of computers to the communications circuits of NTT. As for computers, the words to be used will differ, according to the manufacturer or the age when they are produced. In order to connect them, it is necessary to go through a computer which is

equivalent to an "interpreter." If high-level communications services are liberalized completely, it will pave the way toward establishing new information-processing services business which will regard it as its task to act as such interpreters. The reason for this is that as a result of the free use of the charter flight of circuits, it will become possible to establish a new line of business in which information of Company A will be interpreted and transmitted to Company B. In that case, it will become unnecessary for various enterprises to have overlapped data. This will also have many points of advantage, from the standpoint of the national economy.

No Conclusion Will Be Reached until after One Year?

In the US, such restrictions have already been eased. Also, in Japan, the Provisional Administrative Affairs Research Council has clarified its direction, to the effect that liberalization should be carried out, as far as possible. In Japan, however, the problem of liberalizing such a field has been left to future co-ordination between the Postal Services Ministry and MITI which are still in a deeply-rooted confrontation.

So far, a direction has not been decided as to whether high-level communications services should be restricted through the enactment of a new law (plan of the Postal Services Ministry), or whether such services should be liberalized in principle through a further revision of the Public Tele-Communications Law (plan of MITI). It is said that "a conclusion will reached at least one year hence" (MITI leader).

Whether it will really become possible to use computers efficiently, depends on how such co-ordination will be carried out. Therefore, in order to prevent the Postal Services Ministry-MITI confrontation from ending up in a mere struggle over jurisdiction between Government offices, "it is necessary to consider what meaning the liberalization of high-level communications services will contain, from the viewpoint of the national economy" (big information-processing services company leader).

The form of treating or processing information is quickly spreading, accompanying the rapid progress of electronic technology. In order to guide the industrial structure in the direction of concentrating knowledge, it is wiser to recognize the free originality and ingenuity of private circles and to maintain the way toward securing the appearance of low-priced services through the market mechanism concerning competition. The time has come for considering the information-processing problem calmly, with the general settlement of the Postal Services Ministry-MITI confrontation as a turning point.

CSO: 4106/94

LIBERALIZATION OF DATA COMMUNICATIONS UNSATISFACTORY

Tokyo TOKYO SHIMBUN in Japanese 18 Mar 82 p 5

[Text]

-- It is good that co-ordination within the Government has been generally completed, in regard to the liberalization of data communications. But the liberalization is limited, and the contents are insufficient. The Government should make further efforts to carry out overall liberalization along the line of the Provisional Administrative Affairs Research Council's recommendation --

The problem of liberalizing data communications, concerning which problem the co-ordination of views between the Postal Services Ministry and MITI has been having hard sailing, has generally come to an end, in the form of a "judgment" by LDP Policy Board Chairman TANAKA. On this basis, a Public Tele-Communications Law revision bill is expected to be submitted to the Diet after it is decided at a Cabinet meeting, slated for the 19th.

The gist [of the revision bill] is as follows: (1) Under certain fixed conditions, the transmission of communications by others shall be permitted, limiting it only to [communications] for use by medium and small enterprisers who have close business connections; and (2) however, this shall be a provisional, tentative step, and the Government shall make efforts to reach a conclusion quickly, in regard to the overall liberalization of use by others. In other words, the focal point is that approval will be granted, though conditionally, for private enterprises' participation in the field of "high-level communications services," which have not been permitted so far, and in which communications by others will be transmitted through the use of circuits leased from the Nippon Telegraph and Telephone Public Corporation (NTT).

Anyway, this may be said to be a measure which has advanced by one step, only from the viewpoint that a new way has been opened as to high-level communications service.

As for the contents, however, it is limited to medium and small enterprises, and moreover, vague restrictions are imposed, such as "close business connections" and "certain fixed conditions."

That is probably because a political compromise was pressed to be reached in the form of a judgment by the LDP, with regard to the Postal Services Ministry-MITI confrontation. However, this is really a limited liberalization. Even when viewed from the standpoint of the Second Provisional Administrative Affairs Research Council's interim recommendation, the contents cannot but be said to be extremely insufficient.

Under the draft Public Tele-Communications Law revision bill, drawn up by the Postal Services Ministry, the "joint use" of communications circuits by two or more companies will be liberalized in principle, if they are to be used by enterprises which have business connections. The problem is that strict restrictions will still be maintained as to "use by others," in which private information-processing service companies will let their customers use communications circuits which they lease from NTT.

This will prove markedly disadvantageous for medium and small enterprises which cannot have their own computers, when compared with big enterprises which will enjoy benefits, due to the liberalization of joint use, and which cannot help sub-leasing the communications circuits leased by information-processing enterprisers. That is why MITI demanded the large-scale liberalization of "use by others," as a measure toward medium and small enterprises. It was thus in confrontation with the Postal Services Ministry.

The urgent problem of revising the Public Tele-Communications Law has been settled, due to Policy Board Chairman TANAKA's judgment. However, the reaching of a conclusion only has been postponed, with regard to the problem of how to carry out the liberalization of high-level communications services, which problem was regarded as a very big focal point.

In regard to the overall liberalization of data communications, it will probably be necessary to impose restrictions on the private circles' extending services similar to telephone service or to take measures to preserve communications secrets. However, there are doubts as to the Postal Services Ministry's way of thinking, to the effect that liberalization cannot be carried out any further unless the State holds the power to grant approval or permission through the enactment of a new law.

On that point, the LDP's written judgment says, "MITI should make a response with sincerity, when the Postal Services Ministry takes necessary and rational legal measures." However, new legal measures should be studied carefully.

We want the Government to carry out co-ordination from now, in line with the Provisional Administrative Affairs Research Council's recommendation calling for the adoption of a negative-list formula (for carrying out liberalization in principle and also for clarifying the minimum necessary scope of restrictions).

CSO: 4106/94

SCIENCE AND TECHNOLOGY

FREER DATA COMMUNICATIONS SEEN

Tokyo SANKEI SHIMBUN in Japanese 18 Mar 82 p 10

[Text]

The fact may be appreciated that the pending problem of liberalizing data communications has generally come to an end, and that it has been decided that the situation will advance toward liberalization, though with conditions attached. However, high-level communications services in question have only been limitedly liberalized. In order to make data communications more fruitful in the future, it is necessary to make efforts in the direction of carrying out further liberalization.

In regard to the liberalization of data communications, the Postal Services Ministry and MITI were in confrontation over the problem of to what extent the scope, in which private circules can freely use circuits for data communications, should be expanded. Thus, it has been having hard sailing. While clarifying the direction of approving the proposed liberalization, as a general principle, the Postal Services Ministry had been taking the stand that it would be necessary to carry out restrictions. That is why it seems to have come into confrontation with MITI which was trying to avoid the imposition of restrictions, as far as possible.

Therefore, it was impossible to take necessary legal measures, and it was feared that a situation might occur whereby the liberalization of data communications would be delayed on a large scale. With regard to such a confrontation between the Postal Services Ministry and MITI, LDP Policy Board Chairman TANAKA started mediation efforts, and put an end to the problem in the form of a judgment. This may be said to have been timely, particularly because the deadline for the submitting of a bill is close at hand.

According to the "TANAKA judgment," (so-called use by others), in which data communications circuits in the field of high-level communications services will be leased from private information enterprisers under certain fixed conditions, and in which they will be used, will be approved only as to medium and small enterprises which

have close business connections. Besides the above, it calls for making efforts to reach a conclusion quickly, with regard to overall liberalization. This is the gist [of the judgment]. At the present time, this is a realistic option. In that meaning, it can be said to have marked one step forward. However, it probably cannot be denied that it is far from liberalization in the true sense of the word.

It is true that it is very distant from the liberalization of data communications, set forth in the Second Provisional Administrative Affairs Research Council's recommendation, which calls for the liberalization of data communications circuits, with the exception of message exchange (use of services similar to telephone services) in which an unspecified large number of persons will be regarded as the objects, and the curbing of restrictions to the minimum necessary extent if they are to be carried out. The recommendation also calls for the adoption of a negative-list formula and the clarification of the standards for granting individual approval for mutual connection.

In that meaning, it will probably be necessary to develop the liberalization of data communications further, from now. The position of the step this time should be defined as a process leading to such large-scale liberalization. With this, a period must not be put to the problem of liberalizing data communications.

Under a situation whereby the unification of information and communications is being promoted further, the liberalization of data communications is indispensable for establishing a high-level informationized society. It is impossible to hope for the development of the economy and society, from now, without securing the development of informationization. From this standpoint, it is hoped that in order to walk the road leading to "freer data communications," the Ministries and Agencies concerned will strengthen co-operative relations among themselves, from a broader viewpoint, without sticking unnecessarily to their own respective positions.

CSO: 4106/94

PLANS FOR URANIUM ENRICHMENT PROTOTYPE PLANT FIRMED UP

Division of Expenses

Tokyo DENKI SHIMBUN in Japanese 3 Feb 82 p 1

[Text] The division between government and the private sector has generally been settled for construction expenses of about 65.4 billion yen on the uranium enrichment prototype plant (production on the order of 200 tons SWU annually) which has been under study by the Science and Technology Agency and the electric power industry. Regarding the construction cost, in substance: 1) the Power Reactor and Nuclear Development Corporation, principally responsible for construction, will borrow 25 percent (about 16.5 billion yen) in the private market, with the government and the private participants jointly guaranteeing the debt; and 2) of the remaining 75 percent, the private sector will provide capital of about 25 billion yen, slightly more than half. The private power companies have not yet formally made a decision, and since the Science and Technology Agency is still considering general questions including the problem of location, it will be some time before a final settlement is reached, but the hurdle of the division of government and private burdens has been crossed.

Details Still To Be Worked Out Regarding Power Companies, Manufacturers

The uranium enrichment prototype plant is a facility to follow the Okayama Prefecture Ningyotoge pilot plant and is aimed at improving the technology of mass production by centrifugal separators, confirming its economic viability, and moving toward making it commercial. It is expected to produce about 200 tons SWU per year of enriched uranium using 20,000 centrifugal separators. The construction budget has been estimated at 65.4 billion yen, and the division of the cost of construction between the government and the private sector has been a problem.

The Atomic Energy Commission and the Science and Technology Agency have considered even this prototype plant as being eventually included among commercial plants for which private power companies will be primarily responsible, and have argued that, in the light of budgetary problems, the private sector share of the construction expense should be more than half. In contrast, the private power companies have been inclined to resist taking more than half of the burden, since the Power Reactor and Nuclear Development

Corporation will be responsible for developing the prototype plant and its development will be under government direction, and have held to the view that the 10 power companies, including the Japan Atomic Power Company, should, as an appropriate degree of cooperation, assume a burden of 25 percent.

In the budget for 1982 the Ministry of Finance has allotted 960 million yen for development of the prototype plant, and has thus by means of the budget established preconditions for determining the ratio of government to private support. However, since the difference between the government and private proposals was large, it was expected that it would take a long time to settle the matter.

To deal with this, the idea recently emerged that the Power Reactor and Nuclear Development Corporation should borrow a portion of the construction expense in the private market and repay it from the proceeds of the sale of enriched uranium. It is considered that it would be possible to borrow 25 percent of the construction expense, some 16 billion yen, and that this could be guaranteed by the government and the private companies.

Thus the issue became the division between the government and the private companies of the remaining 75 percent, about 49 billion yen, and the views of the government were accepted, with the private sector taking a burden of about 25 billion yen, some 1 billion yen more, and the government assuming 24 billion yen.

Provisionally setting the private portion at 25 billion yen, the private proportion of the 65.4 billion yen construction expense amounts to about 38 percent, about 9 billion yen more than the 25 percent proposed by the power companies. Since the manufacturers of the centrifugal separators will also assume part of this, such a percentage does not seem to be something that the private companies cannot accept.

On the other hand, since in this division of burdens the private sector is taking more than half, by however, small a margin, once the portion to be borrowed by the Power Reactor and Nuclear Development Corporation is put aside, while direction will continue in the hands of the government, this agreement on the division of burdens is of such a nature as to make it easy to persuade the Ministry of Finance.

It is necessary to work out the details of the method of guaranteeing the loan of the Power Reactor and Nuclear Development Corporation, as well as the division of the private capital among the power companies and manufacturers, and a final decision has yet to be reached, but in general the proposal has become solid.

'DENKI SHIMBUN' Editorial

Tokyo DENKI SHIMBUN in Japanese 4 Feb 82 p 3

[Editorial: "Making Uranium Enrichment Japanese"]

[Text] Ningyotoge on the border between Okayama and Tottori Prefectures is already piled with snow. A white building to be seen only about 300 meters from the tea house (rest house) at the pass is the uranium enrichment pilot plant of the Power Reactor and Nuclear Development Corporation.

Within the pilot plant several thousand centrifugal separators quietly revolve, making enriched uranium from natural uranium. This plant, which has been in partial operation since 1979, was completed and all centrifugal separators installed last autumn.

The enrichment of uranium requires very high technology, and since the gas diffusion process used heretofore requires great amounts of electricity, so much that it has been said that "enriched uranium is canned electricity," Japan and many other countries have relied on the United States.

In Europe, Britain and France carried out enrichment by the gas diffusion method, and later, Britain, Germany, and the Netherlands developed centrifugal separators through a cooperative entity called Urenco and have progressed through a pilot plant to the construction of a proper plant and commercial operation. The requirement for electric power in the centrifugal separation method as compared to the gas diffusion method is about one-tenth as high and it is, moreover, superior in the matter of expansion in accordance with demand.

In Japan, too, in 1972 the Atomic Energy Commission designated as a national project the experimental development of uranium enrichment by the centrifugal separation method to the extent of building and operating a pilot plant, and took the first step along the path of an autonomous nuclear fuel cycle through domestic uranium enrichment.

Enrichment technology comes under the Nuclear Nonproliferation Treaty and control of information is strict for all countries, which has encouraged development of autonomous national technologies.

A subcommittee on Japanese uranium enrichment of the Atomic Energy Commission deliberated from the end of 1980 through August of last year and presented a report to the Atomic Energy Commission concerning means of promoting domestic uranium enrichment in this country after the pilot plant. The subcommittee chairman was the late Inoue Goro, deputy chairman of the Atomic Energy Commission, whose memorial service was jointly conducted by the Chubu Electric Power Company and the Power Reactor and Nuclear Development Corporation on 15 December last year, and its membership consisted of authorities from the government, academia, and industry.

According to the conclusions of the subcommittee, the objective is to begin operation of a commercial plant between 1985 and 1990, and the uranium enrichment industry should be run by private enterprise. To prepare for a commercial

plant it is necessary to have a prototype plant. It is appropriate that the state lead the drive to plan the prototype plant, with the direct cooperation of private enterprise.

As a move toward the establishment of private commercial uranium enrichment, in the spring of last year a Uranium Enrichment Preparations Office was set up within the Federation of Electric Power Companies. The Power Reactor and Nuclear Development Corporation and three centrifugal separator manufacturers are presently working on plans preparatory to construction of the prototype plant.

However, it is said that it is impossible to set a date for the commencement of construction of the prototype plant due to difficulty in resolving financial questions such as the allocation of construction costs.

The cost of construction of the prototype plant is set at about 65 billion yen, and in the interest of early commencement it is at present considered realistic that the Power Reactor and Nuclear Development Corporation should be responsible for construction and operation, while the private sector, which will have charge of commercial plants, will cooperate closely.

Should the negotiations between the government and the private sector not be resolved and the construction of the prototype plant delayed or suspended, what will happen? The development of centrifugal separators and the technology of their mass production will continue, as before, centered on the Power Reactor and Nuclear Development Corporation.

However, the manufacturers of centrifugal separators have already had a great decline in work related to uranium enrichment with the completion of production of the centrifuges used in the pilot plant; their factories and equipment are idle and their technicians are awaiting the start of the prototype plant, feeling that one day is like a thousand years.

The three manufacturers, in order to gain the advantages of mass production of centrifugal separators and to achieve the capacity to compete internationally, have prepared for concentrated production for the prototype plant through establishment of a jointly owned subsidiary company, and are prepared to shift smoothly to the construction of commercial plants afterward, but if the interruption in work continues, there is the danger that these plans will be frustrated, and that the technology and human resources amassed over a long time and at considerable expense will be dispersed.

Concerning the supply and demand aspect of enrichment, there is the view that because of substantial delays in worldwide plans for the generation of electricity using atomic energy, at present supply is greater than demand, and for at least 10 years ahead world supply will meet demand completely, so there is no need for urgency.

Japan at present, with not only a long-term contract for enrichment services with the United States but the recent conclusion of a contract with France for an adequate amount, feels secure with guarantees, through long-term contracts, for at least the next 10 years, so there is the aspect that it is difficult to feel any urgency about domestic enrichment.

If, however, both for domestic and foreign consumption, we do not show some actual results in domestic uranium enrichment, including showing prospects of making it economically viable, through construction now of something on the scale of the prototype plant, then several years hence when we may wish to construct commercial plants this may be difficult to realize.

During such a period the majority of technicians presently connected with enrichment would change to other fields, large enrichment plants in countries with natural uranium resources would be committed to joint operations with Urenco and the Americans, and also the level of enrichment technology, once seen as able to place us alongside the most advanced countries in a space of 10 years through the national project, would have again fallen greatly behind, and Japan's plans for the production of enriched uranium would come to naught, isn't that true?

Furthermore, if we fail to skillfully take success in development following the Atomic Energy National Project to the final stage of creating an industry, then the methods of promoting the development of atomic energy and the very structure of industry will be subject to severe reflection and investigation.

Attending the memorial service for Inoue Goro, chairman of the Japanese Uranium Enrichment Subcommittee, who had strongly urged the necessity of the early construction of the prototype plant through close cooperation between government and private industry, and while praying for his happiness in the next world, I made earnest petition that the day would soon come for the establishment of a new form of motive energy and the nuclear fuel cycle, which was the dying wish of this man who worked for the development of autonomous technology and the elevation of Japanese industrial capacities.

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SCIENCE AND TECHNOLOGY

TOYOTA STRENGTHENS POSITION THROUGH STRATEGIC MERGER

Tokyo BUSINESS JAPAN in English Mar 82 pp 21-23

[Article by Shozo Hochi, Editor-in-Chief, Business JAPAN]

[Text] TOYOTA Motor Co. (TMC), headed by Eiji Toyoda, the world's second largest auto maker, and Toyota Motor Sales Co. (TMSC), the main dealer for Toyota Motor headed by Shoichiro Toyoda, recently announced at a joint press conference in Nagoya that they have signed a memorandum for merger. The companies will be merged on a fifty-fifty basis on July 1. The name of the new company will be the same as the current manufacturer, Toyota Motor Co., Ltd., and its annual sales are expected to reach more than ¥4 trillion. TMSC was established in 1950 as the main dealer for TMC after having been separated from the latter in order to alleviate a managerial crisis at a time when Japan's auto industry was not yet fully developed. While maintaining close connections, the two companies have been benefitting from the advantages of the separation as the demand for motor vehicles increased worldwide. However, conditions affecting Japan's auto industry have changed as auto manufacturing has reached a stage of maturity. Furthermore, competition among auto makers throughout the world for the small-car market, particularly between Japanese auto makers and their U.S. counterparts including General Motors (GM), have intensified. The proposed merger is intended to cope more readily with the intensified competition and to strengthen the company's position in the world car market as the second largest maker.

The memorandum for the merger also states that though both companies will be merged on an equal basis, for legal procedures, TMC will absorb TMSC and take over the latter's personnel. The rates of capitalization in the new company and allocation of posts for directors will be decided through discussions between the two companies. Both will hold general shareholders meetings in the middle of this May for shareholder approval of the merger. It is most likely that the president of the new company will be Shoichiro Toyoda and the chairman Eiji Toyoda.

Detailed procedures for the merger have been examined and discussed by a committee established immediately after the announcement of the merger. The formal signing of the agreement was to be made at the end of this March.

As there are gaps in stock prices and assets between the companies, the ratios of capitalization in the new company are expected to amount to one for TMC against 0.8 for TMSC. However, if both companies hold to the principle of equality, the ratios will possibly become fifty-fifty. In that case, TMC shareholders may be granted gratis shares. The new TMC will also take over TMSC's current borrowings totaling as much as ¥120 billion as well as such unprofitable divisions as housing, according to the leaders of both companies including President Eiji Toyoda of TMC. They have thus brought to a halt speculation concerning the establishment of a separate sales financing company, and

separating the unprofitable divisions of TMSC as subsidiaries.

TMSC was separated from TMC and established as a sister company in 1950, as mentioned above, in order to receive joint financing from several banks to overcome the managerial difficulties of TMC. They have been closely cooperating with each other and succeeded in making TMC the second largest auto maker in the world after GM. However, Shotaro Kamiya, honorary chairman of TMSC who was the first president of the company, died in December 1980. Then Shoichiro Toyoda, who was vice president of TMC, became president of TMSC last June. At that point, many people involved in the auto industry began predicting that the companies would merge after Shoichiro Toyoda had served for a while as TMSC' president.

The merger was expected to materialize some time in 1983. However, since the Japanese auto industry has undergone drastic changes in recent months due to trade friction with advanced industrial countries and other international factors, and effective measures to cope with these serious problems were required, the proposed merger of the two companies materialized much earlier than expected.

Established in August 1937, four years before the outbreak of the Pacific War and a month after Japan invaded China, Toyota Motor Co. produced 9,800 cars in its first year of operation. During more than a decade after the establishment – including almost four years of Japan's hostilities with the Allied Powers – the company produced mostly trucks for military use along with some passenger cars. Although World War II terminated in August 1945, the company was not able to start regular operations immediately. The world's car market was dominated by U.S.-made cars. There was no way for any Japanese car maker to wedge itself into the world car market at that time. One reason was obvious: technical levels of Japanese auto makers were not high enough to compete with U.S. car makers.

The opportunity for moving into the world market came when Japanese manufacturers succeeded in producing small cars with high fuel efficiency, particularly after the first oil crisis in 1973. Even before that year, a large number of Japanese passenger cars were exported to many regions of the world. However, explosive sales of Japanese cars did not start until oil prices were continuously hiked by oil producing countries.

Followed closely by Nissan Motor Co., TMC assumes top place among Japanese auto makers. Based in Toyoda City, Aichi Prefecture, TMC is now capitalized at ¥107 billion and staffed with 48,757 workers. TMC produced 3,220,000 cars last year with sales totaling ¥3,506,400 million. As of June 1981, its annual recurring profit amounted to ¥227,500 million. TMC enjoys top position in both sales and profit among all manufacturing enterprises in Japan. It boasts that it is free of borrowings, and its net assets amounted to as much as ¥1,098,400 million at the end of last June.

As for Toyota Motor Sales Co., it was established in April 1950. Located in Nagoya, its capital amounts to ¥23,717 million and its staff totaled 5,161 as of the end of last September. TMSC's sales reached ¥3,590,200 million with a recurring profit of ¥57,800 million as of March 1981. The expected sales of the new TMC will amount to some ¥4 trillion because current sales by TMC of auto parts being sold to its related companies will be added to the above-mentioned TMSC sales. The net assets of TMSC amounted to ¥273,800 million as of last September.

In 1969, TMC produced 1,470,000 cars and assumed fifth position among world auto makers. In 1972, the company's output exceeded the 2-million level. In June 1979, its aggregated exports since its first export shipment in August 1957 exceeded 10 million units. TMC's aggregated output finally exceeded the 30-million mark in December 1980, assuming second place only after GM.

The proposed merger is a result of the judgment of both companies that the current separate setup is not strong enough to cope with the competition for the world's small-car market. General Motors is now spending as much as $40 billion to develop small cars. GM's target is said to be aiming for a 25% share in the world market including the market for small cars. For this effort, GM is mobilizing all the strength and facilities of its sub-

Table 1. Comparison of Leading Auto Makers

	Toyota		Nissan	GM
	TMC	TMSC		
Capital (¥1 bil.)	100.7	23.7	84.6	171.6 ($780 mil.)
Sales (¥1 bil.)	3,506.4	3,590.2	3,016.2	12,694.0 ($57.7 bil.)
Recurring profit (¥1 bil.)	227.5	57.8	166.1	-167.2 (-$760 mil.)
Employees	49,000	5,000	[illegible].000	746,000
Output (units)	3,220,000	–	2,584,000	4,750,000

(Note) As of June 1981 for TMC, as of March 1981 for TMSC and Nissan, as of December for GM.

sidiaries and related companies scattered throughout the world. If GM's strategy is successfully developed, even Toyota will have to face extremely difficult problems.

Toyota's long-term strategy is called "Global 10" reflecting its goal to secure a 10% share of the world market, enough to make its base in the world car market firm enough to survive despite GM's powerful challenge. TMC has already established a share of more than 8% of the world's car output. Toyota has so far been successful through establishing a unique rationalized production setup concentrated in only one area (Aichi Prefecture) and exporting inexpensive but high-quality cars to almost every country in the world.

In the 1980s, however, "the small car war" will be waged on a worldwide scale and protectionism in the auto industry is likely to develop into a serious problem. In fact, Japan's car industry has been forced to restrict its exports to such industrially advanced regions as the United States, West Germany, Britain and other European countries. Even developing countries are striving to establish an auto industry as a key industry for their industrailization. They are already urging that more parts produced in their own countries be used in Japanese-made car bodies.

The current separate setup of TMC and TMSC is satisfactory for the production and overseas sales of finished automobiles. With a view to advancing into the world market from a strategical view point, however, this setup is no longer either effective or efficient. While TMSC has been active in promoting its international strategy, TMC has not been necessarily in agreement with all of TMSC's programs. For example, TMC has been somewhat cautions in promoting its international strategy, such as establishing loal factories in overseas markets.

In fact, Toyota has been approached by foreign car markers on several occations for tieup deals, but no deals have ever been successfully concluded because of this cautions attitude projected by Toyota. The proposed merger, however, is definitely intended to unify both companies in international strategical operation.

On the domestic front, except for sub-compacts, Toyota succeeded in increasing its domestic market share by 1 point to 38.3% last year. Meantime, Nissan's share levelled off and remained at 29.1%. Toyota has as its target the sales of more than 2 million cars domestically by 1985. Toyota believes that if this share is achieved, it can hold firmly to the leadership in the domestic market. With the current separate setup, however, it is felt the goal will be hard fo reach.

But their views have not always been in agreement. When Nissan successfully created a boom for turbo cars and Toyo Kogyo succeeded in selling a great number of its highly popular Familiar models, TMC criticizedTMSC for its lack of effective market re-

search efforts, and TMSC complained that TMC was concentrated only in producing cars inexpensively and overlooking the need to develop new cars to meet market requirements. It is true that the separate setup put a barrier to the flow of information between the two companies.

The proposed merger is definitely intended to overcome such problems and to establish a firm base for future operations both at home and abroad.

The table provides a comparison of the world's three major auto makers -- Toyota and Nissan in Japan and GM in the U.S.:

At the time of this writing, one leading newspaper in Japan reported that Toyota Motor Co. has decided to build a passenger car assembly plant in the U.S. The location of the plant will be somewhere in the midwest and the plant's yearly output will be 200,000 to 250,000 units. It will be completed in 1985 or 1986. The reason Toyota has made this decision is that it feels trade friction will never be mitigated, and restrictions placed on Japan's car exports will be further strengthened without hope of their being lifted. With the merger of TMC and TMSC nearing, Toyota seems to have tried to impress the world with a strong image of the new-born TMS.

As for other Japanese auto makers, Honda Motor is now building an assembly plant for passenger cars in Ohio for completion at the end of this year and Nissan Motor is working to complete a new factory for trucks in Colorado. According to President Eiji Toyoda of TMC, it intends to expand its sales in the U.S. by having a production base in that country. Major parts including engines will be transported from Japan for the time being, but TMC will try to raise the rate of parts to be procured in the U.S. In the future, TMC will make the plant a completely integrated factory which will also produce engines.

TMC has been unresponsive to frequent approaches from UAW (The United Auto Workers Union) and groups related to the U.S. Congress for establishing plants in the U.S. In addition, though TMC was continuing negotiations with Ford Motor Co. for joint production in the U.S., no fruitful results have been seen. The negotiations have been frozen since last year.

In the new plant to be built in the midwest, many industrial robots are expected to be used for the uniformity of car quality and the rationalization of production.

Along with these moves of the Japanese auto makers, major Japanese auto parts makers also have decided to move into the U.S. for local production.

The location of Toyota's new factory in the U.S. should be a place where the labor situation is better than in Detroit, the center of the U.S. car industry, no far from the Northern part of the U.S. where many auto parts makers are concentrated, and should be along the Mississippi River because auto parts will probably be transported from Japan in the beginning of the operation.

According to an interim account settlement for Toyota Motor Co. for the current annual term ending this June, its sales have increased by 12.9% to ¥1,870,588 million, a record high. With its merger with TMSC nearing, this account settlement is a crowing glory for TMC as this is the final account settlement to be made by TMC as a single company. TMC's recurring profit registered ¥140,740 million, up 36.8% and the second highest in its history Its profit showed an increase of 16.1% to ¥66,488 million, the third highest ever recorded. For this fiscal year, sales are expected to register ¥3,800 billion, recurring profit ¥227,500 million and profit ¥132,700 million.

During the half-year term as mentioned above, TMC's output and domestic sales accounted for 742,200 units, up 6.9%, while its exports totalled 799,072, down 9.4%. If both are combined, TMC's total sales amounted to 1,541,272, down 2.2%. Its output also decreased by 2% to 1,540,968 units. Despite the decreases in output and exports, TMC was successful in increasing profits because it raised export prices and enjoyed other favorable factors.

The new Toyota Motor Co. will be accommodated in a new building currently under construction near the Korakuen Baseball stadium in Tokyo. The construction was started in February 1980 on a site of some 7,900 square meters at a total cost of some ¥18 billion. The building with five basement floors and 19 floors above ground will soon be completed, to serve as the new Tokyo office for the merged company. □

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SCIENCE AND TECHNOLOGY

MOONLIGHT PROJECT SUCCEEDS IN RECYCLING ENERGY RESEARCH

Tokyo BUSINESS JAPAN in English Mar 82 pp 89-93

[Article by Takehiko Shimura, Technical Official, Agency of Industrial Science & Technology]

[Text] SOME 60% of Japan's energy consumption is accounted for by industries. However, about 50% of the industrial energy is simply dumped into the environment in the form of exhaust gas or warm waste water without being fully utilized. In Japan, it is an essential task from the standpoint of economizing energy consumption to recover this tremendous quantity of waste heat and to recycle it in an effective way.

Development of entirely new technologies is required for the efficient utilization of waste heat, since existing technologies are not capable of recycling such waste heat in an economically feasible fashion.

Based on this concept, research and development of new technical systems to utilize waste heat was started in fiscal 1976 as a quasi-large-scale project for the purpose of developing technologies to recover and utilize waste heat from factories and plants including steel mills. Along with the initiation in fiscal 1978 of the "Moonlight Project" which is intended to develop new technologies to cut energy consumption in general, the former project was absorbed into the program.

We would like to introduce in this article some technical aspects of some new heat pump systems which have been developed as a part of the research and development of new technical systems to utilize waste heat.

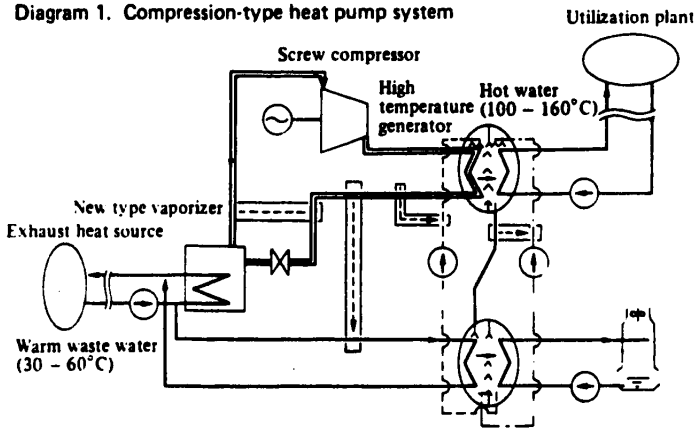
Steel mills discharge huge quantities of warm waste water of comparatively low temperature. If we succeed in raising the temperature of heat energy contained in such warm waste water to a level of 100 - 150°C, expanded applications will be made possible in both our daily living and in industries. Production of hot water of about 90°C and cold water of about 5°C from warm waste water will pave the way for regional air conditioning.

Accordingly, research and development of a new technical system have been conducted to work out a compression-type heat pump system and an absorption-type heat pump system. The compression-type heat pump system is designed to recover heat energy from the warm waste water with a temperature of 30 - 60°C discharged in large quantities from factories and plants and to obtain hot water with a temperature of 100 - 160°C which is most suitable for rational utilization in the community. The absorption-type heat pump system, on the other hand, is mainly intended for regional air conditioning. These two pump systems will be described in some detail below.

Compression-Type Heat Pump System

The objective is to develop a compression-type heat pump system to generate hot water or steam with a temperature from 100° to 160°C utilizing heat from warm waste water with a temperature of 30 ~ 60°C with a capacity of at least 1,000 m^3/h. Thermal efficiency as expressed by coefficient of performance (COP: the ratio of generated heat to drive energy) should come to over three in the

Diagram 1. Compression-type heat pump system



case of most exacting condition, namely: the production of steam with a temperature of 160°C.

In order to realize a high-performance heat pump system conforming to the above-mentioned specifications, a system has been adopted to raise temperature with a compressor on the low-temperature side and through the principle of exothermic absorption of the solution of lithium bromide (LiBr) on the high-temperature side of the system (Diagram 1).

Research and development were started in fiscal 1976. The development of all components was finished by 1979, and a pilot plant driven with a diesel engine was assembled from these components in 1980. Running tests of the pilot plant were conducted in 1981. The feasibility of the warm waste water drive system and the cascade compressor was studied as systems meeting the diversity of waste heat sources. Basic technologies are briefly outlined below.

Screw compressor – Production of a temperature of 55°C was sufficient for the previous heat pump system for air conditioning. Temperature inside the compressor chamber stayed at 60 - 70°C. However, the present system requires the generation of a temperature of about 110°C at the compressor outlet, so that the temperature inside the compressor chamber rises to 110 - 120°C. Hence, freon (medium) and oil are expected to decompose through heat and mutual reaction in a conventional compressor of the oil-seal type. This has led to the development of a screw compressor adopting a liquid jet mechanism with separate channels for sealing and lubricating oil and for freon.

New type vaporizer – In general, warm waste water is assumed to be polluted and corrosive. Therefore, the system envisions new-type vaporizing equipment adopting the principle of flash vaporization of the warm waste water conducted to a low-pressure chamber. The low-pressure steam produced in this way heats from outside and vaporizes the medium rising in the vertical pipe system. Thus heat is transferred from waste water to the medium.

High temperature generator – As the heat pump system to be developed has high temperature raising capacity, the condenser adopts the exothermic system using a solution of lithium bromide instead of the previous simple shell and tube type. This enables temperature raising of 20 - 50°C. The so-called counterflow heat exchanger is applied in the absorption and condensation process in order to enhance temperature raising characteristics.

Others – A warm waste water drive system dispensing with an outside heat source and a flash-type high temperature generator featuring high resistance against pollution and corrosion have been developed to meet the high diversity of industrial waste heat and utilization conditions. In addition, a compressor-type heat pump with a cascade system has been perfected, featuring

an oil jet on the low temperature side and a liquid jet on the high temperature side.

Pilot Plant

A pilot plant combining all the components was built on trial to establish the technologies of a heat pump systems for gaining high-temperature water from 100° to 160°C from waste water with a temperature of 30 - 60°C.

The total energy-saving type pilot plant (with an output of 450,000 kcal/h) is one-twentieth in size as compared with an actual plant and is driven by a diesel engine (Photo 1). As a result, a 100% thermal efficiency (the ratio of developed heat to heat input of the diesel engine), corresponding to COP = 1, has been obtained for temperature generation of 160°C. (COP = 3 for the axial drive power of the compressor) This performance basically corresponds to the original target value. It has been confirmed further that thermal efficiency reaches 170% for 110°C temperature generation.

Thus the pilot plant has been found to develop the performance originally aimed for in the project. In addition, components such as the compressor, high temperature generator and condenser can be used singly as a heat pump system. Some are already being operating in this way.

Absorption-Type Heat Pump System

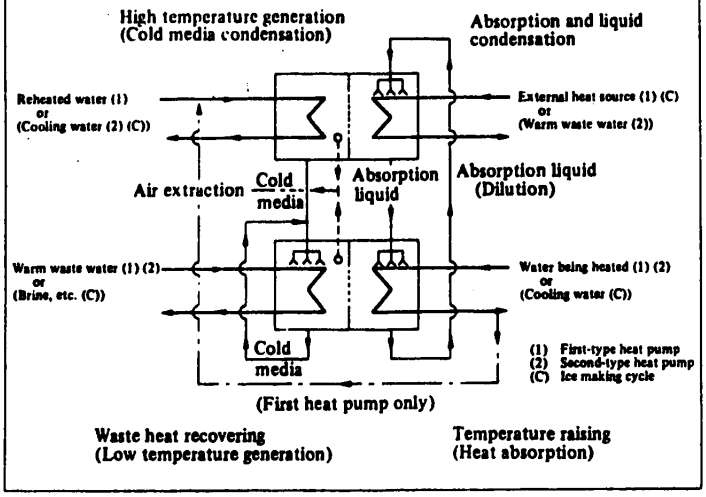
The design of the first-type absorption heat pump called for the recovery of waste heat of 30 - 60°C to obtain a temperature of 70 - 95°C with COP of 1.67 for the single stage type and 2.0 for the double stage type.

The design of the second-type absorption heat pump system called for a system which is operable when the temperature difference between the cooling water and the waste heat is considerable. A COP of 0.5 was aimed at for single stage operation, 0.25 for double stage operation and 0.75 for high-efficiency type, with a target temperature of 135°C.

The design of the ice-making cycling machine called for the production of ice with its large latent heat by means of an absorption heat pump cycle. Target temperature of minus 10° to minus 15°C and COP of over 0.36 were envisaged, respectively.

First-type absorption heat pump system – This heat pump system (Diagram 2) follows the concept of the conventional absorption-type hot and cold water dispenser. However, there were numerous problems to be solved including the corrosion by lithium bromide and overall thermal balance in view of the higher operating temperature. The research consisted of repeated construction and remodeling of trial equipment with an output of

Diagram 2. Absorption-type heat pump system



30,000 to 350,000 kcal/h. The above-mentioned original target was completely attained when research and development were finished in 1979. This system is actually operating at present in dyeing and other plants (Photo 2).

Second-type absorption heat pump system – Research and development started with the selection of an ideal combination of cold medium and absorption liquid. Various experimental equipment was built and remodeled in the course of research. Water was adopted as the cold medium and lithium bromide solution as the absorption liquid. Mathematical formulas to calculate the final temperature depending on various temperatures of warm waste water and the cold medium were worked out. After a series of preliminary experiments, a pilot plan one-twentieth of actual size was built to establish a design concept for the actual plant, the evaluation of heat conducting performance and the analysis of operating characteristics. The results showed that the originally intended performance can be achieved. Hot water of 80°C was successfully obtained from warm waste water of 60°C and cooling water of 15°C.

A temperature raising system was also constructed on trial to obtain high-temperature water. Hot water of 90°C was successfully produced from warm waste water of 50°C. In addition, control methods to ensure operating safety and anti-crystallization steps were studied.

The research covered the system to obtain hot water of over 100°C as well as a system capable of producing steam. Trial equipment succeeded in producing steam of 115°C from warm waste water of 95°C and cooling water of 32°C with COP at 0.57.

Ice-making cycling machine – The development started with the search for a cold media and absorption liquids which do not freeze at a temperature below 0°C in order to obtain a brine of the same low temperature. Various combinations were tested with trial equipment. Researchers finally succeeded in producing a brine of −14°C with COP at 0.38.

Results of Studies

When we compare the fuel consumption of a conventional boiler system with a heat pump having the same performance as the pilot plant used for a regional warming plant with a capacity of 10 gcal/h, it is calculated that the latter system can economize about 1,106 kl of fuel oil per year assuming that hot water of 120°C is obtained from warm waste water of 60°C and that the plant operates 2,000 hours per year.

A first-type absorption heat pump system with a capacity of 64,800 kcal/h, which is already operating at present, can save 48 kl of fuel oil per year in cases where it is used to obtain not water of 57°C from warm waste water of 35°C.

Thus I have introduced the outlines of heat pump systems developed under the "Moonlight Project" of the Agency of Industrial Science & Technology. As mentioned earlier, some systems have already reached the practical stage and are in actual operation. They are expected to disseminate steadily in the future to counter rising costs of energy. ◘

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