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(FOUO 30/82)

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MILITARY

CHANGES IN DEFENSE BUREAUCRACY ANALYZED

Tokyo SEKAI in Japanese May 82 pp 193-196

[Article by Hajime Kawaji: "Turbulence in the Defense Agency."]

[Text] Modification of Secret Plans

When the new director-general of the Defense Agency assumed his post, the chairman of the Joint Staff Council, who stands at the head of uniformed self-defense officials, showed the new director-general into the war council room and showed him two-part top secret documents. It is said that the documents respectfully shown to the director-general, after it was confirmed that everyone had left the room and the door was tightly closed, looked old and the edges of the pages were worn and turned up.

These secret documents are an analysis of the military situation completed by the Joint Staff Council, that is, the "joint long range defense assessment" and the "joint medium range defense assessment." The long range defense assessment analyzes the military situation over a period of up to 8 to 10 years; the medium range assessment, for a period up to 2 to 5 years. Based on this, they are the basic documents describing what condition and scale of aggression is possible and in such a case to what degree would the defense forces have the ability to meet the aggression.

In particular, the joint medium range defense assessment is closely involved with the defense plan, in the sense that the chiefs of the Ground, Maritime and Air Self-Defense Forces drew up the "medium range operations assessment" based on this. The "medium range operations assessment" is a five year plan for improving the defense capability. Furthermore, the mechanism is that if the joint medium range defense assessment is substantially modified, the director-general of the Defense Agency is supposed to propose to the National Defense Council modification of the "fundamental principles of the defense plan," and in the event the fundamental principles of defense are re-examined, revision of the joint medium range defense assessment will be the trigger for it.

Both the long range and medium range defense assessments were drawn up in 1978 but both were partially revised at the end of last year. The reason

the Defense Agency formally recognized these revisions was because they were bounded to do so by the Diet. The content of the revisions is secret, of course, and the only comment made was, "it is nothing but a routine re-examination undertaken every three years."

However, revision of the joint long range and medium range defense assessments deserves attention inasmuch as the opinion, "we should take a second look at the fundamental principles of defense in response to the buildup of the Soviet threat," has become prominent withing the Liberal Democratic Party (LDP) and the Democratic Socialist Party (DSP). This will at least probably have some kind of effect on the "FY1981 medium range operations assessment" presently being drawn up (the period covered by the 1981 medium range operations assessment is from 1982 to 1986).

1981 Medium Range Operations Assessment Faces Rough Going

Prime Minister Suzuki has repeatedly asserted in the Diet that he directed the Defense Agency to include the concept of Japan's own defense in the 1981 medium range operations assessment. However, things have not progressed that simply. The Defense Agency's work on setting it up has reached a deadlock at the stage of what will be the philosophy permeating the 1981 medium range operations assessment.

One confrontation is between the Maritime and Air Self-Defense Forces, which aim at the capability to taking over in part the U.S. military's strategy toward the Soviet Union in the western Pacific Ocean, planning the strengthening of the sealanes and air defesne set-up, by highlighting the "importance of maritime and air defense in the prime minister's directives," and the Ground Self-Defense Force, which bases the nation's defense on preparing for decisive action within the country itself, planning the development of self-propelled artillery and armored divisions, citing the prime minister's strategic concept of "defense of the beaches; hedgehog defense."

There is another confrontation between the prime minister's residence, which will not allow any major changes in the framework of "the standard of the defense plan's fundamental principles" nor "defense expenditures of less than one percent of GNP," and the Self-Defense Forces and Defense Agency, for which maintaining a defense capability in response to U.S. expectations is very difficult in this framework.

Because the 1981 medium range operations assessment is a five year plan with FY1983 as its initial year, its character is such that it must be concluded and presented to the Diet by this summer when the FY1983 budget ceiling will be decided and rough estimate requests will be completed. But within the Defense Agency, the situation is such that it will not be ready on time. But it is possible it will have taken shape since it can be decided at the same time as the FY1983 draft budget if it is ready by the end of this year when the FY1983 draft budget will be decided in its final form.

On the other hand, the following pessimistic view has begun to appear. "It seems a decision on the 1981 medium range operations assessment will take until next year. If so, it will miss the FY1983 budget, but since the 1981 medium range operations assessment is an extension of the 1978 medium range operations assessment, it will not be a contradiction if, for the time being, FY1983 goes with the 1978 medium range operations assessment and the start of the plan is formally postponed until FY1983 after the 1981 medium range operations assessment has been decided.

The fact that the formation of the 1981 medium range operations assessment has been having rough going even though the prime minister personally issued directions to the Defense Agency is evidence that there is very strong pressure and resistance on the part of the faction which wants to build up the defense capability and take a second look at the fundamental principles of defense.

Significance of Intra-agency Personnel Changes

Defense Agency related personnel changes which will be the key to divining the direction of the 1981 medium range operations assessment will begin at the end of the Diet session from May through July. Depending on the results, it is possible for formation work on the 1981 medium range operations assessment to advance.

The voluntary resignation of Toru Hara, permanent deputy director, and accompanying changes at the director level, such as the succeeding permanent deputy director and Defense Bureau director, are expected in May. The view is strongly held that Defense Bureau Director Shioda, who is the person responsible for the 1981 medium range operations assessment, will move to the directorship of the Defense Facilities Administration Agency.

As for Defense Agency bureau directors level personnel, since no Defense Agency bureaucrats employed in the Defense Agency have been trained, the reserved positions are as follows: director of the Equipment Bureau, someone from the Ministry of International Trade and Industry; the director of the Health and Medical Bureau, from the Ministry of Health and Welfare; and the director of the Finance Bureau, soemone from the Ministry of Finance. And those who have come from the police forces are the councilors. The deputy director-general post, in particular, has been a post monopolized by those connected with the former Ministry of Home Affairs (Naimusho) and the police force since the Self-Defense Forces started in the past as a police force. However, with Deputy Director-general Hara, who was assistant director of the Financial Bureau of the Ministry of Finance, a Ministry of Finance bureaucrat has held the post of Defense Agency deputy director-general for two consecutive terms. It is said that the reason why the deputy director-general post was consecutively held by someone from the Ministry of Finance is because there was a change from an era when the focus was on apologizing in the Diet that the defense administration is "not unconstitutional" to an era when it is on how much defense expenditures can be grabbed; and so naturally there is a rollback of the former Ministry of Home Affairs and those coming from the police.

Fundamental Principles Faction versus Fundamental Principles Re-examination Faction.

The first on the list is Akira Shioda, director of the Defense Bureau, who is from the Ministry of Home Affairs (Jichisho) and who is connected with the former Ministry of Home Affairs (Naimusho), and it was reported that at the time Shioda moved to the Defense Agency he was promised he could follow Deputy Director-general Hara. However, with his management of the F4 Phantom improvement problem, his "lost points" are conspicuous. So, Minoru Yoshino, director of the Defense Facilities Adminstration Agency, who was director of the Mint Bureau of the Ministry of Finance, suddenly surfaced as the next deputy director-general, and it is highly probable that Haruo Natsume, chief secretary, will assume the office of Defense Bureau director after Shioda moves up to director of the Defense Facilities Administration Agency. On the other hand, in order for those from the police to recapture the post of deputy director-general after Yoshino, it is necessary that Junko Sasa, director of Personnel and Education Bureau, who came from the National Police Agency, move into the position of director of the Defense Bureau, the top directorship.

The opinion that Natsume will assume the position of Defense Bureau director is understood to have more significance than a ministerial or agency level territorial dispute over the deptuy director-general post. Natsume was employed in the Defense Facilities Administration Agency, but early on he became a member of the Defense Agency (a bureau administrator) and is actually the first among the career defense bureaucrats in the Defense Agency. Not only does this assumption of office announce the arrival of the era in which the Defense Agency bread defense bureaucrats operate the Defense Agency, Natsume himself possesses a career of having participated deeply in the policy decisions on the defense plan's fundamental principles and the "basic defense capability concept" which is its philosophy from the time he was defense section chief and general affairs section chief in the secretariat.

The 1977 edition of the defense white paper which comprehensively developed the basic defense capability concept was popularly known with the Defense Agency as the "Natsume white paper." At the conference of councilors (the Defense Agency's highest level conference) when the Defense Agency was shaken over whether to dismiss Kurisu, it is said that Natsume was critical of Kurisu and Sasa argued Kurisu's defense. Naturally, it was leaked by an official source in the defense fundamental principles faction that they wanted and hoped Natsume would become Defense Bureau director, but conversely speaking, the resistance from the fundamental principles re-examination faction can be imagined. At any rate, if the new Defense Bureau director concludes the 1981 medium range operations assessment in parallel with Prime Minister Suzuki's directions and appropriate to Japan's compact state of affairs, he may have to reduce the ramifications by being prepared to be resented by the Ground, Maritime and Air Self-Defense Forces and to be looked at disapprovingly by the hawk faction of the LDP.

Who Will Be Chairman of the Joint Staff Council

There will be substantial personnel changes in the Self-Defense Forces in July, following the personnel changes in the bureaus. The focus is the personnel change in the chairmanship of the Joint Staff Council. If Yu Maeda, chief of staff of the Martime Self-Defense Force, 73rd naval class, retires voluntarily, it is certain that Tsugio Yada, chairman of the Joint Staff Council, 71st naval class, chronologically speaking, would retire voluntarily. The chairman of the Joint Staff Council has generally been decided by rotation among the vairous chiefs of staff of the Ground, Maritime and Air Self-Defense Forces.

Consequently, since Chairman Yada was the maritime chief of staff and before him, it was Chairman Takeda, chief of staff of the Air Self-Defense Force, the Ground Self-Defense Force is insisting that naturally the next chairman should be Sumio Murai, chief of staff of the Ground Self-Defense Force. On the one hand, it is seen that Osamu Hatame, chief of staff of the Air Self-Defense Force, will voluntarily retire at the same time, and there is the deeply rooted opinion that "there m ay possibly be an example where the order was altered, and in terms of talent, Hatame should be made chairman of the Joint Staff Council. Inasmuch as the Ground Self-Defense Force would not escapte a loss of ground if the concept of Japan's defense, including the 1981 medium range operations assessment, shifts to that of placing importance on maritime and air defense, the Ground Self-Defense Force's posture, even though it says "the chairman of the Joint Staff Council is like a chairman with no representation," is that, right or wrong, they want the next chairmanship and they continue to feud with the Air Self-Defense Force.

At the time when the improvement of the F4 Phantom with bombing devices became an issue in the Diet, Hatame, chief of staff of the Air Self-Defense Force, declared at a press conference, "one of the objectives of the F4 improvement is to make it the successor of the ground support fighter, the F1 (fighter-bomber)," and disappointed intra-agency officials who tried to be evasive by answering, "the objective of the F4 improvement is strictly the improvement of its interceptor capability and it is not in order to use it as a ground support fighter." Even in the opposition parties, there were those who requested "Hatame's disposal." There was resentment toward this in the Air Self-Defense staff who said that it is strange that the defense bureaucracy which pointlessly hides the actual facts from the public is not criticized and the chief of staff of the Air Self-Defense Force, who spoke accurately about the Air Self-Defense Force's concept, based on military rationality, receives criticism. But the Ground Self-Defense Force staff holds the view that "the line about Hatame's chairmanship has disappeared completely."

With the regular changes in July, there will not only be changes at the chief of staff level, but for the first time, graduates of the first class of the Defense Academy will be promoted to general officers. This will gradually and indirectly change the character of the Defense Agency and the Self-Defense

Forces. The appearance of general officers of the purely post-war generation who grew up under the U.S. military's education system ranks with the coming to the forefront of Defense Agency bred bureaucrats and indicates that the Defense Agency and Self-Defense Forces have reached a turning point.

Uniformed Personnel and LDP Hawk Faction

Within the confrontation of various opinions about the 1981 medium range operations assessment, there is a movement which must be given attention. There is the inclination here and there for some of the uniformed personnel to go over the heads of the intra-agency bureaucracy and link themselves directly with some of the influential LDP Diet members. That pipeline is being accomplished by high level uniformed personnel, such as former chiefs of staff who have retired.

For example, the names include Shigeto Nagano (former chief of staff of the Ground Self-Defense Force), Ryohei Oga (former chief of staff of the Maritime Self-Defense Force) and Motoharu Shirakawa (former chief of staff of the Air Self-Defense Force) at the "Japan Strategic Research Center" where Shin Kanamaru, former director-general of the Defense Agency, is employed as director. They made a proposal on defense capability increase entitled, "Proposal concerning defense capability preparations," in February last year. However, in May of last year, just before Prime Minister Suzuki's visit to the U.S., America's Heritage Foundation, which is called President Reagan's think tank, made a report concerning shortcomings in Japan's defense capability and that the defense capability should be increased. It may be said that the content of these two is exactly the same. The Japan Strategic Research Center's proposals, such as an increase in the P3C sub-spotting aircraft, building small scale carriers which can carry vertical take-off and landing aircraft, possession of a mine-sweeping helicopter force and paratroops both for land and sea operations (sea mobile land brigade and air mobile land brigade) almost coincide with the Heritage report. Since the Heritage report is a U.S. report, it quite directly enumerates the following as "a re-examination of meaningless taboos:" 1) the cabinet decision on expenditures of less than one percent of GNP; 2) non-possession of offensive weapons; 3) three principles of non-nuclearization; and 4) three principles of weapons exports.

In the midst of the drama of the Diet's handling of the F4 Phantom, the LDP National Defense Group and officials of the Policy Research Committee proposed the LDP opinion that "accompanying the international state of affairs and advances in military technology, aircraft and naval vessels which Japan cannot possess will change." Chief Cabinet Secretary Miyazawa shelved the proposal. The naval vessels which this LDP proposal pointed out and tried to open the way of having at the time of the uproar over the F4 issue are clearly aircraft carriers which are considered offensive weapons in the present government view. It has often been said that "the defense question is and echo between Japan and the U.S.," but what if the origination of the U.S. proposed request was decided in Japan and these data were decided by former Self-Defense Force officials?

Considering that the Japan Strategic Research Center's proposal closely resembles the military proposal of the 1981 medium range operations assessment, it seems attention must be given to the relationship between the LDP hawk faction and former Self-Defense Force officials.

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ECONOMIC

STRUCTURE OF NIPPON TELEGRAPH, TELEPHONE ANALYZED

Business Structure

Tokyo CHUO KORON in Japanese Autumn 81 pp 146-157

[Article by Hitoshi Hiramatsu, journalist]

[Text] NTT Buffeted by "Third Wave"

Its rigid structure is being questioned in the midst of an international information and communications battle. Can this giant survive?

Three Urgent Issues

As we enter the 1980's, which has been called the age of technology, NTT's mode of operation has been called into question. As we approach the 21st century, the central core of technological innovation will be a hybrid advanced technology composed of machinery, computers, and electronic communications. When we think about the information and communications infrastructure that will be created by means of this data communications technology and its spreading impact, the role to be taken by NTT, the monopolistic enterprise which has thus far led the way in the development of data communications technology in Japan, and the kind of technology that will be used take on an importance that we cannot ignore.

On 5 August, NTT held a public lecture meeting at the Keidanren Hall in Tokyo concerning "technology for achieving a high-level data communications system" as a "proposal for a high-level information society." A high-level information society, according to Toffler, will be characterized by expanded office automation and electronization of the home and "will change the course of history in just 20 or 30 years with a shock that will revolutionize society from its foundations." It will be "the third wave," following the agricultural revolution and the industrial revolution.

In preparation for the high-level information society to come, NTT is planning to build a high-level information communications system (the information network system of INS). It will be based on telephones, data terminals, facsimile, and image terminals. It will be built as a common network unified

by digital technology so that voice, image, and data information can be freely exchanged between the different types of terminals. Experiments are scheduled to begin in the Musashino and Mitaka areas in 1983.

This 21st century communications system is made possible by digital, optical, and satellite communications technology which has been made possible by rapid progress in electronic technology items such as IC and microprocessors. This campaign is unusual for a public corporation. NTT is trying to demonstrate the advanced technology it has accumulated and promote understanding of its new electronic communications system. NTT has achieved its two major objectives, pursued since it was organized in 1950, of completely satisfying the national demand for telephone service and providing completely automatic dial service for the entire country. Now it is pursuing this new objective for the era ahead.

However, the impact of the technological revolution leading to a high-level information system, and the high-level information society which it will create, will necessitate great changes in NTT itself. Indeed, there are indications in the form of real pressures that require specific responses from NTT. One of these signs is the issue of liberalization of materials procurement which became a focus of concern in adjusting U.S.-Japanese relations in 1979 and 1980. Second is the issue of opening communication lines, and this has become an urgent issue in revising electronic communications policies in the 1980's. Third is the slackening in growth of NTT's business income due to the achievement of balance in supply and demand and the exposure of financial weakness due to increased capital expenditures through huge investments.

Pressure To Liberalize the System

The issue of liberalizing materials procurement goes back to an international agreement made at the Tokyo round of GATT (General Agreement of Tariff and Trade). As one way of abolishing nontariff barriers for the expansion of world trade, material purchases by governments and government organizations must, in principle, be made through competitive contracts by public or private bidding, and an opportunity for equal participation in the bidding must be given to foreign enterprises. This became the greatest unsettled problem between the United States and Japan because the United States was frustrated at becoming "a weaker America" (BUSINESS WEEK) as the relative strength relationship of Japan and America underwent a change. America reacted against the growing threat of being overtaken by late-developing Japan in the strategic areas of high-level electronics and data communications.

Furthermore, NTT's procurement system, which accounts for $3 billion annually, half the total procurement by government and government-related agencies, has used a private contracting system by which it made planned orders from special partner enterprises which have accumulated knowhow through joint development with NTT. By this system, NTT, which does not have a manufacturing capability, was able to apply its research results. All equipment and parts were standardized on the basis of NTT specifications and a high level of quality was maintained by a strict inspection system. Also, the companies

were guaranteed a stable market for special-order products for NTT and were able to plan production and cut costs through mass production.

However, this was a totally closed system of development, production, and procurement between NTT and its special partners. Japan's information and communications industries formed an "NTT family" organized around the large general manufacturers of computers, semiconductors, robots, and communications equipment. In communications equipment alone, in 1979 the purchases by NTT were 40 percent of the total. Even though this was down from 57 percent in 1965, it shows that these companies have had a huge profit base in the NTT market. The influence of NTT has extended to achievements in information and communications knowhow and quality control obtained through joint development as well as in the aspect of market volume. These achievements have improved Japan's international competitiveness in data communications. The Jones Report indicated that "in order to make progress in communications technology, the technology of the future, Japan has rapidly advanced in the open U.S. Market, while holding on to its domestic market." Since this report was made, NTT has been known as the "symbol of the closed Japanese market" in the United States.

The liberalization of procurement, which has obstructed U.S.-Japanese relations and has become a political problem, was finally brought about as the GATT regulations took effect in January 1981. Purchases of peripheral equipment were completely opened up to competitive bidding. Also, NTT has opened up the path to participation of foreign enterprises in private contracts through the Track III program. Under this system, both domestic and foreign enterprises which apply for participation can be selected as partners for joint development and production of prototypes of central equipment. Continuous purchases are made of items which pass operating tests. This Track III system is causing apprehension among the friendly companies which have carried out research and development for NTT and become used to carrying out joint development as special partners. However, this liberalization of the development and purchase system is inevitable for NTT. This is because the increased need for high-level, more diversified data communications technology has naturally increased the number of different research and development areas to be dealth with by NTT. And it has made it necessary to use more domestic and foreign companies as partners in joint development and as sources of supply. In fact, even before adoption of the new liberalized system, Matsushita Denso participated in development of facsimile equipment and Motorola of the United States helped with the pocket bell.

Liberalization of procurement is also a result of Japan's success in reaching world standards in data communications technology, beginning with technology imports from the advanced countries, and then rapidly developing beyond world standards in such areas of advanced technology as optical communications and VLSI. Data communications technology is central to future technological innovation and it will have a tremendous ripple effect. Therefore, pressure to liberalize will continue to mount.

In particular, the United States under the Reagan administration is trying to fully bring out the great technical strength of the largest U.S.

communications enterprise, AT&T, which had been curbed for a long time under the antitrust act, in order to maintain relative superiority in this strategic area and increase the competitiveness of U.S. industry. Last year, the FCC (Federal Communications Commission) made a final decision on its second computer survey and approved the provision of unregulated high-level communications service if carried out through a subsidiary which had separated from AT&T. The 1981 bill concerning competition and deregulation of electrical communications proposed in the Senate to revise the 1934 communications act now in effect is also intended to remove the handcuffs and shackles from AT&T.

Looked at in this way, liberalization of the development and procurement system is a natural development in terms of improvement and diversification of information and communications technology. It could be seen as one international adjustment in the intensifying battle over technology.

Problem of Liberalizing the Use of the Network

The problem of liberalization of the data communication network also arose from the demand for improvement and diversification of data communications, a result of a technological revolution which has shaken NTT's monopolistic system. In data communications systems, computers and terminals are connected in a unified data-processing and electronic communications system which makes it possible to use computers from a distance. Beginning with the "green window" seat reservation system for the National Railways in 1964 and expanding to the on-line bank system and the Social Insurance Agency pension system, these systems have supported ever more complicated social activities and penetrated every corner of our lives.

NTT entered the data communications field, a third major form of communication following the telegraph and telephone, in 1968 with the nationwide regional bank system, the first joint-use system in Japan. Because of industry's growing desire for on-line systems, private industries were permitted to connect computers and terminals to special lines (special communications network lines) under a revision of the Public Electrical Communication Law, and NTT's data communications business was officially approved.

However, because private enterprises had their own independently managed data communications systems, NTT and KDD imposed stiff conditions on them when they borrowed the special communication lines. An arrangement by which two or more companies may borrow the lines for joint use, or allow another party to use them as a part of business, will only be allowed when certain conditions are met. In cases of joint use, an investigation must be carried out by NTT and KDD to determine whether there is a substantial relationship between the companies and whether there will be obstruction of other communications. Then special approval must be received from the minister of posts and telecommunications. For use by another party, the method of special approval is not even available. KDD will not even make the regulations for this public. Under the present communications system, electronic communications are entrusted to the monopolistic management of

NTT and KDD. Exchange of messages without changing the form of data is completely forbidden. That is why data transactions are limited to one computer and one terminal, and transactions between multiple computers and terminals are forbidden.

This is all very well in an era of single-function systems with central processing by a large mainframe computer. However, under these regulations, it is not possible to make efficient use of decentralized processing through intelligent terminals and networks and joint use of comprehensive networks, computers, data, and software by different enterprises and different types of business. It is impossible to use distribution systems connecting trading companies, manufacturing companies, warehouses and freight companies; joint research systems which join government and private universities; dispersal of the processing load to an affiliated company's computer when a company's own computer is overloaded or out of order; or the stratified processing method in which ordinary daily work is done on micropressors and intelligent terminals on the premises and large volumes of data are processed in a large computer at a center.

The industry demand for liberalization finally resulted in action by the Ministry of Posts and Telecommunication and NTT to make changes in policy this year. Message exchange and mutual connections to public lines and special communication lines have become matters subject to approval. With the exception of some negative listings, there will be general liberalization. However, with the coming of a high-level information society, technological innovation and the increasing need for diverse data communications systems will require free use of information exchanges, in the form of voice, data, and images, using multiple computer and terminals with the communications network and making joint use of files and software. This will lead to the organic integration of separate systems into a general system. Also, diverse services will be sought which make full use of the vitality of the private sector. Therefore a reform of the present communications system with its one-dimensional operation of communications will be necessary. And it probably will not stop with the use of data communication lines alone.

Weakness of Financial Base

One big problem faced by NTT as it comes under pressure to change the present system is the uncertain financial base with which it must support the technological development necessary for high-level information systems. With an annual income of 3.8 trillion yen, NTT has the highest sales of any Japanese enterprise, excluding some trading companies. With construction expenditures of 1.7 trillion yen and total assets of 8.9 trillion yen, it is the largest enterprise in Japan. The difference between income and expenditures, the figure which corresponds to profit in private enterprises, is 450 billion yen, making it a superior business organization. However, NTT has long-term liabilities of 5.5 trillion yen and its financing expenses amount to 1.1 billion yen per day (as of the 1979 accounting settlement).

If it continues to make large investments, increasing capital expenditures required to finance those investments will put pressure on income. There is a danger that the resulting increase in borrowings will then cause a further increase in capital expenses, creating a vicious circle. President Shinto, who was recruited from private industry, is known as "Dr Rationalization." He ways: "If this were a private enterprise, it would go bankrupt." Also, "It is exactly like the National Railways when it began the Shinkansen."

The problem is that the growth of telephone income, which makes up 90 percent of NTT revenues, has reached a ceiling because of a balance in the supply and demand for telephones. Furthermore, the nontelephone services which should take up the slack are very insignificant at present. While the company continued to expand under the pressure of an ever-growing demand during the period of high growth, scrap-and-build investment led directly to increased income. Now there is a greater percentage of investments which do not create income, such as equipment replacement projects for remodeling of obsolete facilities. Because the market for new services and products is still undeveloped, NTT is facing competition with private industry and there are continual cancellations and shifts of business even though, on the surface, sales appear to be rising.

In addition, the major method used to raise outside funds for NTT's investments for rapid development was the system of making the purchase of bonds obligatory for new subscribers. This was a system harldy used anywhere else in the world. Also, the term of the Telegraph and Telephone Facilities Expansion Temporary Measures Act will expire in 1982. If an extension of this system cannot be justified now that there is a balance in telephone supply and demand, NTT must diversify its sources of funds in the general bond market. And the market is likely to see problems in NTT's financial condition.

NTT's research and development projects, for example, VLSI, electronic exchange systems, and computers used for data communications, are getting larger and spreading to more advanced fields. The so-called "incubation period," from the start of research to testing, used to be 2 or 3 years. It has now grown to 7 or 8 years. There are a large number of examples of basic research which are put in the freezer with no prospects of application. Each year, 70-80 billion yen, 2 percent of business income, is used for research and development. President Shinto has stated explicitly that for the sake of future generations, this percentage will not be reduced. However, the technological prospects for data communications are not entirely clear. In allocating limited resources to the growing number of research and development areas, NTT faces the problem of how to make its research and development more efficient at a time when more originality is required for advanced technology.

Thus, the issue for NTT management is how to get through the transition from its traditional telegraph and telephone services to more diverse nontelephone services, such as high-level information services, while maintaining financial health and carrying out forward-looking investments and development of advanced technology. However, this will require a management revolution in

the business structure of NTT, which has, until now, raced forward with priority to technology and new facilities.

Going Beyond the Issues of the "Period of Transition"

As we enter a period of great change, the three problems faced by NTT demonstrate that a reassessment of the existing system of the company is beginning to take place.

However, as we approach the 21st century, looking ahead to a high-level information society, the questioning of the present system will not stop simply with reforms in business management during the transition period, such as liberalization of NTT's development and procurement system, improvements in the system for use of data communications circuits, and financial reforms. This is because data communications in the high-level information society and the process of technological innovation necessary to make it a reality, will have a wide enough impact to shake the foundations not only of NTT but the entire framework of Japan's telecommunications policies and systems.

The need for improved data communications aiming at a high-level information society will shift information processing by computer from single functions to multiple functions and from centralized processing to decentralized processing as the interdependent relationships of society grow and become more complicated. There will be a demand for communications networks in which voice, data, and image information can be exchanged efficiently through multiple computers and terminals, a system in which computers are fused with electronic communications. It is certain that the rapid progress of IC, which has increased by 10 orders of magnitude in level of integration and decreased by one half in price in 4 years time, and other technological innovations such as optical communications, satellite communications, and pattern recognition, will meet these needs and revolutionize data communications.

It is already common knowledge that this compound technological revolution, through robotronics, office automation, and an information communication system with a global network, has made possible the rationalization of industry and dramatically increased international competitiveness.

The hybrid technology of data communications has produced a highly integrated, high-growth data communications industry. But through the formation of an organic data communications system, going beyond the boundaries of single enterprises or business fields, it has led to the joining of enterprises, the reorganization of industry, and a greater refinement of the industrial structure. Also, the growth of the network of business communications and the introduction of data communications into the home, known as home electronics or media technology, will probably change the structure of regional connections and the city. A big change in the manner of life is another part of the scenario of the high-level information society.

This technological revolution will create pressure for change in the content of telecommunications service in private industry as well as in NTT. At the same time, the data communications of the future will be an intricate combination of business communications which connect many corporate activities with a variety of types of data communication, personal communications in the home, and mass communications using new media. If a variety of services are not allowed under the freedom of the private sector, there is a definite danger of unification and control of the media. The development of high-level information systems in itself will require reforms in systems and policy.

A Competitor for Both Giants

The international aspect of the high-level information business will also require a new response from NTT which until now has concentrated on domestic business. The liberalization of procurement, as previously mentioned, resulted from one form of outside pressure which broke down the wall of the closed system of procurement and NTT technology development (which reached world standards). However, the international battle over data communications technology has shown signs of intensifying to the point of being called a "technology war." As the technological gap narrows and the relative relationship of economic power changes, a readjustment is taking place among the advanced countries.

NTT concluded a cross-licensing agreement with IBM, the company which controls 60 percent of the world computer market. Then it proposed modifications in the long-standing unequal patent license agreement with Western Electric, the company with control over Bell System patents. NTT has been trying to catch up with these two giants in information and communications. Now it is gaining attention for attempting to exchange technology from an equal position.

IBM entered the field of satellite communications, foreseeing the combination of computers and communications. It noticed the communications technology of NTT, which had grown to the point of leading the world, and it approached NTT on a cross-licensing agreement. IBM has carried on a continuous "battle of the titans" with AT&T over the field of data communications. Some believe that IBM approached NTT, which has a close relationship with AT&T, as a new strategy to recover its leadership in the data communications field. In any case, IBM proposed a bilateral agreement which recognizes all rights, including the granting and sale of licenses and the right to commission production. Also, although the applicability to the world market is limited to computers (including electronic switching systems), an exchange of technology will actually take place in the global arena between the multi-national IBM and NTT.

The agreement with Western Electric was an unequal contract in which Western Electric was able to use NTT's patents for production and sales while NTT, which was not allowed to commission production and does not have its own manufacturing division, was only able to obtain technological information, and was forced to pay $200 to 700 million annually in patent use fees for manufacturers in the NTT family. The NTT proposal for revision of the

agreement asked to extend the applicable region beyond Japan and the United States, the region desired by Western Electric. It will recognize the existing right of Western Electric with respect to patents which have already been developed but aims for reciprocal rights for newly developed technology.

In the past, Western Electric transferred overseas assets to ITT because of the antitrust act and limited itself to domestic production and sales and overseas sale of licenses. However, because of the recent U.S. strategy, seeking global development of data communications and strengthening its international competitiveness, and to advance into nonregulated fields, it established an international company, AT&T International, to consolidate the Bell System's overseas operations and advance more aggressively overseas.

Previously NTT was like a younger brother, taking instruction from Western Electric. Now it has emerged as a competitor. There is no telling how Western Electric will receive this NTT proposal. However, it is certain that an adjustment of the world market is beginning with a new arrangement with the Bell System.

If we think of cross-licensing as a tool frequently used to readjust the market at a stage where the gap in technology has narrowed, for NTT the patent exchanges to be made with IBM and Western Electric are the beginning of technological exchange with leading enterprises amid serious international battles over technology. Along with joint development with foreign enterprises under the new liberalization of procurement, there will be an acceleration of NTT's research and development and greater international application of results.

The International Politics of Information Distribution

High-level information systems naturally go beyond the boundaries of single countries. In satellite communications, for example, a satellite launched by the United States at the request of Indonesia is being jointly used by ASEAN countries such as Thailand and the Philippines. France is developing satellites as strategic export technology. When the space shuttle becomes practical, the aboveground exchange network of each country may become a subsystem of a global network enveloping the earth which is controlled from satellites. What role would Japan and NTT play in such an international network? At present, this question has hardly been examined at all.

There is a rapidly increasing flow of information across national boundaries through the international network formed by the technological revolution in data communications. This distribution of international information is showing a tendency to depend increasingly on the United States, the country with overwhelming control over the network and the data base. Excessive dependence on overseas data processing leads to increased weakness and is an inevitable threat to privacy and the security of a country's politics, economics, and social activities. Therefore, there are growing regulation campaigns in the countries of Europe and the Third World.

In response, the United States advanced the idea of international rules for data communication services in the Reagan Round. In order to adjust policies to maintain a free flow of data, the U.S. Senate and House of Representatives are considering three related bills with the aim of unifying domestic policies and systems. This problem of transnational data flow (or international information flow) will surface sooner or later in multilateral or bilateral negotiations between OECD countries or in the GATT talks.

How will NTT respond to this trend of internationalization? It has the disadvantage of being unable to make a full effort because of obstacles in the system created by its avowed commitment to domestic operations.

Factors That Have Made the System Rigid

Twenty years have passed since the founding of NTT. Aiming at a prosperous society, its objective was "immediate telephone installation" and "immediate telephone connection." The achievement of these common social goals was entrusted to NTT. NTT actively imported the results of technological innovations and rationalized and expanded its operations. Its data communications technology was 20 years behind, but it obtained technology for cross-bar switching equipment from Kellog of the United States, for parabola antennas for microwave communications from STC of Great Britain, and for coaxial cable from ISE of the United States and SH of West Germany. It imported PCM's created in France and transistors invented in the United States. In the process of absorbing and digesting these technologies to produce a domestic technology, NTT technology became much more sophisticated.

Rationalization of operations with the use of these technological advances led to rapid expansion and made economical service possible. If the second and third 5-year plans had been carried out with the technology of the first plan, they would have cost an additional 1.1 trillion yen. If the fifth plan had been carried out with the technology of 10 years ago, it would have cost an extra 700 billion yen. Stated differently, during the 25-year period of the five 5-year plans, there was a savings of 13 percent in the amount of investment. Also, NTT was able to spend more time and money than would have been possible for private industry in gathering data on details such as each solder joint and finding the causes of breakdowns. It improved reliability by a strict inspection system for quality control that would not allow a speck of dust in the factory. It achieved the world's highest rate of reliability--only one telephone malfunction per subscriber in 14 years.

Furthermore, in applying the results of development, total uniformity of parts and equipment ordered from a number of different companies was maintained, and the level of standardization achieved was regarded as a mystery overseas. It then aligned these standards with those of the Comite Consultatif International Telegraphique et Telephonique (CCITT) and made them internationally applicable. The search for this technical perfection and standardization has undeniably raised the data communications technology of Japan to world levels in a short period of time.

However, NTT's sense of mission and pride, which provided leadership for Japan's data communications, also created a closed and rigid system within the walls of that technological expertise. There have been many examples which demonstrate this. For example, NTT was late in developing and applying high-speed facsimile technology. This was partly because its guide, AT&T, had little interest in it. However, it was also because Ricoh, a company outside the NTT family, was able to use its position of freedom from NTT to import advanced technology from the United States quickly and dominate the market.

In electronic switching systems, the time-sharing system was not in favor for a time at Bell Laboratories, so NTT stuck to the space-sharing system and was unable to shift to the time-sharing system. Because of this, it was forced to make a double investment, for both systems, by communications equipment manufacturers under pressure to do business overseas. Its video telephone, following in the footsteps of Bell Laboratories and AT&T, failed because of inadequate study of users' psychology and human engineering rather than for economic reasons.

Throughout, NTT followed Bell Laboratories and concentrated on racing straight ahead to catch up and overtake Bell, so it did not have the flexibility to accurately pinpoint new needs and determine the direction of new systems by itself. As demonstrated by the lack of researchers in human engineering and the social sciences in its laboratories, it failed to make an assessment of the impact of technology on human beings and society. More than anything, the rigid posture of NTT bound up within the strictures of the present system has made it impossible for it to respond flexibly to a variety of data communications technology developments and services. Therefore, we cannot overlook the fact of the overall negative effects on data communications. For example, the restrictions on connecting terminals to the communications network have been a cause of delaying the development of terminal equipment in Japan.

Questioning of the Existing System

Previously, I wrote that NTT had a remote existence. This is partly because electronic communications is a highly sophisticated technology system and is difficult for us to understand. But more than that, the electronic communications business, entrusted to the monopoly of NTT and KDD, is hidden behind the walls of technological expertise and has become a "black box." It has become a sacred precinct, inaccessible to the outside, which was created by the hands of politicians, bureaucrats, and technical specialists.

Telephones have become a very intimate form of media. As the technical revolution in high-level information systems is about to unfold, NTT will have a central role and a great effect on the state of the telecommunications of the future and the high-level information society that it will bring about. So it will become an enterprise that is more and more impossible to ignore. Its technological development will be directed toward the solution of such social issues as energy conservation and more efficient medical treatment, education, distribution, and government administration. In addition, it will be called upon to deal with international issues such as the technological

assistance desired by the developing countries and an international division of labor with the advanced countries. Are the things about to be done desirable for us? An open forum for discussion should be sought and the public function of NTT, including the business structure of the company now being studied by the Temporary Administration Study Committee, should be examined.

Closely Related Private Companies

Tokyo CHUO KORON in Japanese Autumn 81 pp 158-169

[Article by Kenichiro Hirota, Future Technology Institute

[Text] Discussion of NTT Technology Based on Experience

The author, a previous director of the Electrical Communications Laboratory, a major position in NTT, the mecca of technological development, tells about NTT and its family.

Electronic Mecca

The word electronic is a daily commonplace. However, telecommunications technology, a major field, perhaps the central field of electronics technology, is not very familiar to ordinary people. This is mainly because the terminal equipment for telecommunications seen by most people is usually limited to the telephone. Compared to radio, television, and desk calculators, it seems very ordinary. Few people are aware of the tremendous amount of social capital in the telecommunication network that lies behind the telephone, costing more than 8 trillion yen and spanning the entire country, or of the fact that this network can carry data communications and television signals as well as telephone messages, unless there is a break in communications due to an accident. In this sense, telecommunications has an existence in people's minds similar to air.

This network is sustained by telecommunications technology. And in the history of technology, the major portion of present-day electronics technology developed as a branching off from either wire or wireless communications technology. Today as well, telecommunications technology, along with computers, is performing a "locomotive" role for overall electronics technology.

I have placed telecommunications in opposition to computers here, but technically speaking, the borderline between these two technologies is becoming more and more obscure, and it is getting difficult to separate them. Historically, of course, one application of computers has been clerical processing. However, the first digital logic circuits used were built with parts and technology for telephone switching equipment during World War II in the United States. Present electronic switching systems and computers are essentially identical with the exception of some items that I will explain later.

This situation is symbolized by the changes in the name of the Institute of Electronics and Communications Engineers of Japan (incorporated) which is made up of 28,000 Japanese electronics researchers. Beginning in the Meiji era, it changed from the Telegraph and Telephone Institute to the Electrical Communications Institute and then again to the Institute of Electronic and Communication Engineers. If the present English name of the association were retranslated into Japanese, it would be the "Institute of Optoelectronics and Communication Engineers." This probably expresses the true nature of the association.

Traditionally, the central role in this institute has been played by engineers from the Nippon Telegraph and Telephone Public Corporation, and among them, by the 3,000 researchers of NTT's Electronic Communications Laboratory (known as "Tsuken"). NTT hires about 300 university graduates from scientific or technical departments every year. This is a gathering of the best students from the various universities, and NTT is seen by people in the field as a mecca for electronics research.

The aim of this article is to examine the type of telecommunication technology held by NTT, how it ranks internationally, the background of its development, and some issues for the future.

Technology at the Top International Level

I would like to begin with the issue of the international standing of Japanese telecommunications technology.

Recently, articles dealing with telecommunication itself, rather than the general topic of electronics, have begun to appear in the popular media. This includes the problem of the isolationism of NTT technology in relation to GATT, which was hotly discussed for about 2 years until last fall, and more recently, the issue of a patent agreement with NTT which is reported to have been requested by IBM. More specifically, the internationally important research results of NTT's Electrical Communications Laboratory (Tsuken) in optical fiber communications and VLSI are frequently reported. It seems that even the ordinary citizen who has no direct contact with communications technology is somehow increasingly gaining the impression that NTT's technical level is rather high and that it has been drawing international attention.

Amid voices calling for a nation founded on science and techology and a growth beyond secondhand development, how can we rank Japanese electronic communication technology internationally? It is difficult to express quantitatively, but if we summarize the opinions of people in the field, we can say that we are leading the world in development along with the United States. In research, there are some areas, though not all, where we are beginning to surpass the United States. Overall we are evaluated as being close to the top level.

Here are a few examples that do not extend into specialized areas. First, in the area of development, there is the C-400M multiplex transmission system which NTT opened to commercial use about 3 years ago. This system can transmit 400 million bits of signal data per second (5,760 simultaneous telephone calls)

on a single coaxial cable. The American counterpart to this can handle only 270 million bits. In 1976, the Government of France stated that it wanted to use our standard electronic switching system, the D-10, and a deal was almost made. Unfortunately, the domestic industry protection policy of President Giscard d'Estaing took priority, and the negotiations were ultimately unsuccessful. However, the technology itself received high praise from French engineers. Although this is not a domestic example, 127 of the world total of 397 earth stations for satellite communications are products of Nippon Electric Company. If the stations using NEC parts are included, this number grows to 296 stations or 75 percent of the total. As a basis for this success, the technology developed jointly with NTT played a great part.

Next I will give two or three examples of results of basic research at the Electrical Communications Laboratory. In VLSI research, we developed the world's first 64-kilobit NOS memory (in 1977). Since then we have continued to produce similar top-level data, and in June of this year we produced the world's first 256-kilobit memory. In optical fiber communications, as I will explain later, we pioneered in long-wave, long-domain technology. Since then we have continuously been in a position of leadership in international scientific organizations. In another example, the basic principle of Texas Instruments' "Speak and Spell," which is also marketed in Japan, is said to be identical to the "Par Call" invented at Tsuken.

With the reader's indulgence, I am going to discuss something a little off the subject. Bell Laboratories of the United States has held the top position in the world of telecommunications both in name and in fact. It has 16,000 researchers and has produced a number of Nobel Prize winners. In postwar Japan, a "pilgrimage to Bell Laboratories" was the ardent desire of people from NTT and related manufacturers for a long time. Furthermore, the gate of Bell Laboratories was kept tightly shut. In 1958, three engineers were able to receive "training" there for 2 weeks. A similar situation persisted for a number of years after that.

However, as Japanese ability increased, the situation slowly changed. In 1966, a mutual technological assistance agreement between NTT and Bell Laboratories, undertaken at NTT's requent, took effect. When Vice President Fisk of Bell Laboratories visited Tsuken for the first time the previous year, he saw that the work going on in our laboratory was unexpectedly advanced. His new awareness was one factor that led to the agreement. After that, in contrast to the one-way relationship of the past, a number of people from Bell began to visit our laboratory. Then in 1976 a remarkable event occurred. There were more people from Bell visiting Tsuken than the other way around. It could be said that Bell had reached the point of clearly recognizing Tsuken as an equal.

Previously, I mentioned the recent cross-licensing agreement between IBM, the computer king, and NTT. This agreement was proposed by the other party and is reportedly moving toward realization.

I have given a number of examples and, in brief, it seems fair to say that NTT's telecommunications technology is first-rate internationally. Of course, as we

can see from the relationship with Bell Laboratories mentioned above, this status was arrived at only recently. There is a long history behind it which I will explain here.

History of Autonomous Development of Technology

Before World War II, Japanese telecommunications was under the jurisdiction of the Communications Ministry along with mail, shipping, and aircraft. After the war, it was under the Electrical Communications Ministry according to the orders of GHQ. In 1952, the Nippon Telegraph and Telephone Public Corporation became independent and has remained in the same form up to the present.

Recently, there were several changes in the technology development system. During the Communications Ministry period, in terms of the present concept of R & D, research was carried out by the Electrical Laboratory and development was carried out be the Engineering Bureau of the ministry, chiefly in the Research Section.

In the Meiji era, telegraph and telephone systems were introduced a little behind those of the United States and Europe. We were especially behind in automatic telephone switching. This was finally introduced with equipment imported from Britain and Germany when telephone service was restored in Tokyo and Yokohama after the great Kanto earthquake. However, domestic production began as soon as 1935. The leadership for this domestic production was provided by the Engineering Bureau.

The technocrats in the Engineering Bureau of the Communications Ministry at the time were extremely earnest about moving from domestic production to autonomous development of technology. It is not difficult to imagine that this attitude was encouraged by a sense of responsibility for electrical communications as the nation's central nervous system, and at the time there was a strong feeling of impending troubles. The main flagbearers for this movement were the director of the Engineering Bureau, Tsuyoshi Kajii (later the first president of NTT), and the manager of the Research Section of the Engineering Works Bureau, Shigeyoshi Matsumae (later the president of the Communications Academy, now the president of Tokai University).

Matsumae developed the world's first unloaded carrier system in 1932. With Kajii's support, he overcame fierce opposition and was able to complete the Japan-Manchuria long-distance communications line based on this principle. He strongly advocated the importance of autonomy in electrical communications technology to his subordinates. Under Matsumae's leadership, for example, in 1940, an engineer named Yonezawa (later the third president of NTT) succeeded in developing the world's first very-high-frequency wireless telephone. This can be seen as one result of that leadership.

At the same time, some results were obtained in basic research in the Electrical Laboratory, but unfortunately, there were few cases which were linked directly to development. For example, in 1936, Engineer Takeo Seki (later joined Hitachi Electronics) applied for a patent which is considered the basic

principle for today's optical fiber communications. Unfortunately, the surrounding technology was not developed to the point where this idea could be further nurtured.

World War II destroyed the Japanese communications network. The largest number of telephones before the war, 1 million sets, was cut in half, and the people connected with the Communications Ministry worked feverishly to restore the system. During this period, GHQ interfered quite oppressively in Japanese communications operations. As a result, the Electrical Communications Ministry was born. In 1952, domestic operations became separate under the Nippon Telegraph and Telephone Public Corporation. As far as electrical communications was concerned, this interference by GHQ had several fortunate results.

Many of the officials of the GHQ Civil Communication Section were from the Bell System, and through the Civil Communication Section, we were able to obtain many advanced elements of both technology and management from the United States.

As a result, in the area of a research and development system, the Light Electrical Division of the Electrical Laboratory was separated with the creation of the Electrical Communications Ministry, and the Electrical Communications Laboratory was organized as an organ of the new ministry. This is today's Tsuken, and it was clearly set up after the model of Bell Laboratories.

Probably with some guidance from GHQ, the first head of the Electrical Communications Laboratory, Goro Yoshida, set "jitsuyoka" (development), as the highest objective of the laboratory, a revolutionary concept at that time. This was the principle that there is little significance in simply carrying out research and reporting it at meetings of professional associations. The important thing is to make direct use of the results in the real world. This is the significance of development.

One important function of the Technology Bureau is to consolidate the demands from all the divisions and bureaus, such as sales, facilities, and maintenance, and make a summary of the requirements of the entire company for technology. Then these requirements are received at Tsuken, and development is carried out to meet them. The results are then sent to the Technology Bureau as "technology reference materials." The contents are extremely detailed and include specifications and operating instructions for systems and equipment. The Technology Bureau draws up the specifications for procurement of materials and the methods for applying standards necessary for design, construction, and maintenance.

Research and development takes place according to this general system. However, a specific "Technology Research and Development Plan" is proposed jointly each year for this purpose by the Technology Bureau and the Electrical Communications Laboratory (technically, by the Research and Development Group representing the three Electrical Communications Laboratories). This report must then be deliberated in the head office Executive Council and be approved by the president. A progress report is made quarterly to the Executive Council. Under

this system, the items to be researched at Tsuken are recorded and are managed by the policy of the organization rather than by the predilection of individual researchers. Even in basic research, no research is allowed which is not related to electrical communications, at least in its aim.

Thus, the research and development system of NTT is marvelously well-organized. There is probably no other laboratory with the same strictness in its organized research activities as Tsuken, established, as it was, under the slogan of "development." However, not all the activities of researchers are controlled by the "Research and Development Plan" mentioned above. In some areas a great deal of freedom is allowed. Research items at a stage where 5 years or more is required before results can be sent out in the form of the technical documents mentioned above are not listed in the all-company plan. They are left to the discretion of the general manager of the Research and Development Group.

In any case, the organized research activities mentioned here have functioned as a great motive force for the business operations of NTT. Looking back on NTT's achievements since its establishment in 1952, without listing each example of research results, we find that during this 28-year period the number of subscribers grew by 40 times, to 39 million, while the number of employees only doubled, from 160,000 to 320,000 people. Furthermore, while there has been a small increase in the basic charge for telephone service, the unit charge for telephone calls has only risen slightly, from the 7 yen charged 28 years ago to the 10 yen of today. The major force behind these achievements was the modernization of facilities using new technology and the large savings in equipment investment itself made possible by technological progress. In this connection, although these figures are a little old, the equipment investment for NTT's fifth 5-year expansion plan for the period from 1973 to 1977 showed a saving of 700 billion yen when compared with what it would have cost with the technology used 10 years before.

At the beginning of this article, I gave a number of specific examples of NTT's technology. The contribution which the technology made to company operations was its greatest achievement.

I may have spent too much time discussing the research and development system together with historical reflections. Here I would like to consider the special features of electrical communications technology in some detail.

The Electrical Communications System

At the beginning of this article, I stated that telecommunications was the primary source for electronics technology. However, while telecommunications is a major part of electronics, it is not the whole. In that case, what are the special features of telecommunications? To begin with the conclusion, the main features of telecommunications are its great size as a system spread out over the entire country and the entire world, the organic qualities that integrate this system, and its high reliability. I would like, as an example, to consider the telephone, the most familiar part of telecommunications, and at present, the part which performs the greatest role.

We dial the telephone. The other party answers. We talk. This is an everyday occurrence for all of us. However, in order to be able to do this at any time and from any location, it is necessary for each automatic switching machine at telephone company stations to handle several tens of thousands of connections per hour with no mistakes and in real time. If even one of the relay amplifiers set every 25 kilometers along the long-distance call routes broke down, communication would be impossible. Also, this same kind of assurance is needed for every pairing of two telephone sets among the 39 million in service throughout the country. It will not do if a connection is made but the voices cannot be heard well. For the telephone to conquer distance, voices should ideally be just as audible in calls between Hokkaido and Okinawa as in local calls.

In order to achieve this ideal, the telecommunication facilities of Japan, which are reported to have cost more than 8 trillion yen, must be very large. But more than that, the service must be maintained by determining the functions of each of the billions of parts under a unified system design concept and making the whole function organically as if it were a living body.

This domestic system must be connected to foreign countries so that international calling is possible. It is also necessary for the domestic network to function as a subsystem of the international network. Therefore, there are international conferences almost every year with representatives of the telecommunication engineers of all countries. The issues for discussion at these conferences are the conditions for design of present and future telephone networks. These international meetings are held by the International Telecommunication Union (ITU) and its various consulting committees. The ITU, which celebrated its centennial 3 years ago, is an organ of the United Nations with headquarters in Geneva.

ITU conferences differ from ordinary international scientific conferences. They are not an occasion for reading papers and exchanging opinions. They are special conferences for determining design conditions for each country as a part of the world network. Basic conditions for the domestic system, including the sensitivity of telephone receivers, the assigning of telephone numbers, the sound volume of long-distance calls, and the assignment of wave use frequencies, are determined from a global point of view. Detailed specifications for domestic systems are then determined on the basis of these decisions. Measures are taken to ensure economy and reliability, and new technology is created.

Since the word reliability has come up, I would like to briefly discuss the reliability of technology for telephone networks.

One example is the electronic switching system. Although the electronic switching system is technically similar to a large computer, its function is limited to telephone and data switching. Therefore, it is often supposed to be much simpler than a general-purpose computer. However, there are difficulties in the function of the electronic switching system which differ from those of the general-purpose computer. These include the extremely large number of input and output circuits and the requirement for literal real-time

processing. A large switching machine must handle up to 100,000 telephone sets and it must process several hundred thousand dialing signals that come from those telephone sets each hour with no delay. Because of the nature of public communications, no momentary delay in the switching functions can be allowed.

Because of this, the design conditions for the D-10, NTT's standard switching machine, specify that the probability of occurrence of a system breakdown of 30 minutes or more is once in 20 years per machine. These conditions are about three orders of magnitude more severe than the conditions necessary for a general-purpose computer. Therefore, the component parts of these systems must have an incredible rate of reliability, within IFIT (no more than one breakdown in 1 billion hours, or about 10,000 years). However, the fact that breakdowns can still occur, such as the 8-hour breakdown in the Kobe Moto-machi Telephone Office last September, shows the difficulty of designing for reliability.

The only technology with higher reliability than that of electronic switching systems is probably the space technology used for the space shuttle. It would probably not be a good policy from an economic point of view to expect the same level of reliability in a public communications system. High reliability is unbelievably expensive. Methods of reducing breakdowns in communications within economically feasible limits will always be an issue for telecommunications technology. Our engineers will continue to make efforts.

The NTT Family

The facilities for this organic, highly reliable, and very large system that I have described are not at all the kind of thing that can be simply purchased on the open market. Therefore, all countries determine detailed specifications for the equipment that makes up the telecommunications network itself, if not the telephone sets, selects manufacturers with sufficient experience, and keeps close contact with them as they manufacture it. Furthermore, because this is the central nervous system of the nation, it is natural that in making this selection, priority has been given to domestic manufacturers.

For this reason, the Communications Ministry took great pains from the Meiji period on to nurture the growth of domestic manufacturers of communications equipment. Private contracts became systematized in 1922, and the position of the four companies that stand at the head of the so-called NTT family, Nippon Electric Company Ltd, Fujitsu Ltd, Oki Electric Industry Company Ltd, and Hitachi Ltd, was already established by 1935.

This way of thinking is not unique to Japan. The American Telephone and Telegraph Company (AT&T), which controls 85 percent of American telephones, has under it a manufacturing company, Western Electric, and Bell Laboratories, which has 16,000 researchers. It is well known how this company has carried out unified operations from research to manufacture.

Three years ago, this same United States pressed for the opening up of NTT in connection with the government procurement issue at the Tokyo round of the

GATT talks. It asked that communications equipment be opened up to international competitive bidding. As I have indicated, AT&T was actually filling its own needs independently and not using competitive bidding at all. However, because it is a private company, it was not subject to the GATT proposals. European companies were excluding communications equipment from GATT as a basic principle. Considered in this light, the U.S. request was naturally seen as unreasonable by communications people.

In spite of this, people inside and outside the government in Japan took a very detached attitude toward this problem. Some sectors of the media turned the problem inside out. They expressed indignation at the monopolizing of NTT orders by the 200 odd companies, led by the four companies mentioned above, which make up the NTT family. Not even waiting for the U.S. demand, they demanded liberalization inside Japan.

As I said at the beginning of this article, the telecommunications network cannot be seen and its structure is difficult to understand. With respect to the GATT problem, it is regrettable that NTT did not make an attempt in ordinary times to obtain general understanding of the social significance of the network using "Japanese language" instead of "NTT language."

As I have repeatedly pointed out, the special features of the telecommunications network are its great size, its organic qualities, and its reliability. Another feature that should not be overlooked is the fact that, because it extends to every part of the country, it is impossible to rely on a manufacturer in case of a breakdown. It must be possible to repair and operate the system with NTT's own personnel.

Because of this, it is necessary for NTT engineers to thoroughly understand every feature of the parts and every detail of the software. In other words, we cannot allow any black boxes. However, NTT does not have a manufacturing capability and even the researchers in the Electrical Communications Laboratory are not conversant with all the details of manufacturing technology. The manufacturers, on the other hand, cannot possibly know all there is to know about the design conditions for this huge network. Therefore, the fastest way to develop a large-scale system like the electronic switching system is to have researchers from Tsuken and design personnel from the manufacturing companies sit down at the same table for discussion. This is what is known as joint development.

Since the days of the old Communications Ministry, although there may have been greater or lesser involvement depending on the piece of equipment, there has been some form of joint development with the manufacturing sector, especially the four companies mentioned. As a result, the so-called NTT family was formed. It is fair to say that it was created because of technological necessity for the large-scale system described above.

Although it may be repetitious to say this, the joint development system set up between the major communications enterprise and manufacturers is not unique to Japan. As a result of the GATT problem, the door has been opened, formally, for joint development with foreign manufacturers for rather important

facilities. However, because of the nature of the telecommunications network, great care should be exercised in actually carrying this out.

The Future of Autonomous Research and Development

Toward the first of this article, I stated that NTT's technology was on the highest level in the world in the area of development. In the area of research, it is close to the top. Furthermore, we can be congratulated on arriving at this point in such a short time after World War II, starting from the level of a semideveloped country, from the international viewpoint. However, it is probably necessary to take a more sober point of view. For a long time after the war, Japanese industry was ruled by the custom of secondhand development. "The seeds of development are in foreign countries. We can just take them and make products with the world's best performance." Has telecommunications been an exception?

If we make a fairly strict evaluation, it seems best to say that it was not an exception. Particularly during the period up to 1965, NTT was busy trying to catch up with the performance of Bell Laboratories, which was regarded as the world leader in telecommunications. Even though it produced many small items of technology that were worthy of attention, the model was always Bell Laboratories in system development objectives such as electronic-switching systems or multiplex transmission.

The research and development system of NTT which I have described was certainly the most effective system possible during this period of secondhand development. As a result, NTT was able to perform like a good student in the area of development. However, because of excessive emphasis on practical applications, basic research was shunted off to a corner for a time. This is indicated by the fact that the name of the "Basic Research Department," which had a tradition going back to the old Electrical Laboratory, actually disappeared for about 10 years.

Looking back, it seems that 1966 was a banner year for Tsuken. For one thing, the previously mentioned technological assistance agreement with Bell Laboratories went into effect. Another event was the reactivation of the Basic Research Department (present personnel: 200 people). The former event marked the end of a phase in the catching up process. The latter can be seen as the start of original development. Tsuken furiously and one-sidedly pursued practical applications, and recently it has begun to realize that it has reached an impasse.

Generally speaking, in any field of technology, large amounts of original technology cannot be produced simply by creating an organization. Fortunately, however, in the 15 years since the Basic Research Department was reestablished, there have been several good results. Among them were at least two world-class achievements.

One was the "Par Call" principle of synthetic speech jointly invented by Itakura and Saito in 1970. I have mentioned that the "Speak and Spell" machine produced according to this principle is being marketed all over the world.

The other achievement was in optical fibers. I have already mentioned that the original invention for optical fiber communication was made in the old Electrical Laboratory. However, the invention which anticipated the form of today's technology was, unfortunately, made by Cowe [phonetic] of Great Britain (in 1966). In response to this, Norihiko Mizushima of Tsuken made a theoretical analysis and made the first prediction, in 1975, that the domain through which light could physically pass most easily would be a long-wave long domain greater than 1 micron in wavelength. This was verified by a joint research team made up of researchers from the Electrical Communications Laboratory and the manufacturing companies. Since then, Japan has continued to hold a top position in optical fiber research, recognized at home and overseas.

From these results, we can probably say that Tsuken research has begun to move, if only in some areas, toward original development.

Even in the field of telecommunications, a more active effort to develop original technology will be required. For this, the unique NTT research and development system which I have described in some detail in this article will probably be forced to undergo some changes. Here I would like to point out two problem areas.

One problem is the research repertory--how wide a range must be covered in electronics technology to provide sufficiently for the future of telecommunications. By law, NTT has a mission of providing public telecommunications services. In compliance with this, the Electrical Communications Laboratory has been quite scrupulous in not pursuing research or development in areas not directly connected to communications. As a past example in computer research, Tsuken developed the Musashino No 1 in 1958, and it was considered revolutionary for its time. However, work was stopped because it was not considered a part of the laboratory's main duties. Work on it finally recommenced in 1968, when data communication operations were approved by the Diet. Another example concerning computers is the fact that the science and technology supercomputer does not appear on the Electrical Communications Laboratory agenda because it is not actually related to communications. Today, however, when the boundary between communications and data processing is gradually becoming blurred in terms of pure technology, it would probably be a good idea to include at least the architecture and parts of the supercomputer in basic research. This is just one example, but essentially, I am afraid that if we do not expand the categories of research, we will have reason to regret it in the future.

Another problem is related to joint research done with the manufacturers. During the period when the goals of systems to be developed were clear and it was certain that the products would be adopted by NTT, the manufacturers could rely on future purchases, and because of this, it was easy to carry out joint research. However, now that the expansion of the telephone network has reached a fairly complete stage, the new services to be offered by NTT have not yet taken concrete form. Of course, the INS (Information Network System) advocated by Vice President Kitahara seems to anticipate a rather large range of services. However, because it involves such a wide range, it does not seem to offer any clearly attractive development objectives to the manufacturers at present.

Unlike the catching up period, the period we have entered is one in which we must choose our own objectives, and the role of NTT, as leader of the entire telecommunications industry in Japan, including the manufacturers, has taken on more and more importance. In proposals for new systems, greater emphasis should probably be put on basic research. In this respect, we can say that the time has arrived for some reforms in the practical development-oriented research and development system.

Use of Brain Power Collection

Electronics has spread its effects to all industries, and it is certain that it will have the position of a major basic industry in Japan from now on. Within this industry, telecommunications technology will continue to play an important leadership role because of its level of sophistication and reliability. Fortunately, as I have stated in this article, Japanese technology in this area is on a very high level internationally.

However, it we look over the entire field of electronics, not just telecommunications, the mass production technology, with high reliability and low cost, may be first rate, but most development is secondhand. Even many VLSI's are still manufactured with American equipment. In the area of technology trading with foreign countries, there is still an overwhelming excess of imports from the United States. This is exactly the opposite from product trade. Of course, this is one reason for the friction in trade. We hope that electronics, as a basic industry, will be able to break out of this situation as soon as possible.

However, there are limits to the ability of the private sector, in terms of spending and risks, to undertake all development of electronics technology as it becomes further miniaturized and more sophisticated. It is often reported that ripple effects from military and aerospace development in the United States make a great indirect contribution to technological development in this field. For a similar reason, while NTT will naturally continue to focus upon its own business, because it is a public enterprise, it should use part of the large collection of brain power at Tsuken to provide assistance in fields where the burden is excessive for the private sector.

Interview With NTT President Shinto

Tokyo CHUO KORON in Japanese Autumn 1981 pp 170-179

[Interview with NTT President Hisashi Shinto by Hitoshi Hiramatsu]

[Text] From a 'Geocentric Theory' to a 'Heliocentric Theory'

Will the 180-degree change in consciousness succeed? A discussion with the president brought in from private industry and known as "Dr Rationalization."

Two Objectives

Hiramatsu: I have heard leaked reports of "Shinto statements" during your 7 months in office as president of NTT, and my interest in NTT has grown. Today I would like to have as wide ranging a discussion as time permits.

Shinto: Well, a public corporation has certain characteristics that make it different from a private enterprise. In fact, after being here for a half year, it seems that there is a growing gap between what I say and any concrete action within NTT in response to it. Lately I am feeling that I may be accused of being all talk and no action (laughter).

Hiramatsu: Oh, that's probably because you are concerned with a revolution in consciousness. It is natural for such a gap to exist at a turning point.

There are many issues facing NTT during this period of change. Today, I would like to ask about NTT's role in relation to data communications technology, which is held to be the centerpiece of a technological revolution that will occur between the 1980's and the beginning of the 21st century. Data communications technology will have a great impact on future industry, daily life, and society. The way it is handled will have a great effect on our future. It naturally has a strongly international character, and we can expect more intense international competition in the area of technological innovation.

I believe it is appropriate to give high marks to NTT for its role so far in developing Japan's data communications technology. From now on, this technology is likely to become more diverse and complex. I would like to ask what you think about the state of data communications and the objectives and issues of NTT's research and development.

Shinto: It is just 7 months since I came here, so you should regard what I say as what I have learned by cramming during that time. At any rate, what NTT is considering now is a switchover of the entire communications network from an analog to a digital system.

Right now, some circuits especially prepared for linking computers are digital. However, if the entire system is made digital, then the same transmission technology can be used for sending telephone voice signals, computer signals, and image signals. The signals could be converted into sounds, images, or computer data depending on the capability of terminal equipment, so the system could be used in many different ways. Our next objective is to change the system so that it can be applied flexibly to a wide range of uses over the long term.

Another goal is to change our present communications network, made of copper wire, to an optical fiber system in order to meet the increased demand for new communications.

Even if things go well, it will take 15 or 20 years to carry out both of these objectives together. However, we have already acquired the basic

technology necessary for this within NTT. The problem is how to finance it. Can we come up with the funds soon enough to respond to the rapid changes in society and prevent any inconvenience to the public? This is what I take to be NTT's basic path for the future.

Hiramatsu: Since NTT was established, it has had a long-term technology plan based on 5-year plans in order to eliminate a lag in telephone communications and build up an automatic telephone network throughout the country. And now you will also make an ultra-long-range plan....

Shinto: It will probably be necessary. Right now we are at a turning point. By 1982, the telephone network will reach every corner of Japan. The growth of telephone subscriptions has reached a ceiling. Therefore, our previous objectives will soon be met completely. From now on we will have to make basic qualitative changes on an expanded scale.

Not Going To Increase Borrowing

Hiramatsu: The biggest problem in achieving these new goals is how to raise the huge amount of money for investment through sound management.

Shinto: That is correct. Our ability in this area will determine how many years it will take.

Hiramatsu: However, if we actually look at NTT finances right now, it seems that the enterprise is close to death. With less than 4 trillion yen in income, it labors under a debt of 5.5 trillion yen. Furthermore, the "expansion law," under which subscribers were obligated to purchase NTT diversifies its methods of financing, so the bond market will require a sound financial condition.

Shinto: That's right.

Hiramatsu: Not only that, until recently, new investments for scrap-and-build projects led directly to increased income. The need for nontelephone services is unclear, and investment will not necessarily lead to higher income.

Shinto: Therefore, what I am saying in the company is that, regardless of what anyone says, I will not increase borrowing. I will only renew old loans.

Hiramatsu: By not increasing borrowing, do you mean to reduce the scale of investment?

Shinto: Even without expanding borrowing, we have 1.5-1.6 trillion yen of our own funds which can be put into investment in the immediate future.

Hiramatsu: Depreciation and equipment fees?

Shinto: Right. Therefore I am saying that for the time being, we will keep investment within these limits.

Hiramatsu: Does that mean at least during the sixth 5-year plan?

Shinto: No, just for a while. At least while I am in office.

Hiramatsu: During that time, 1.5-1.6 trillion yen for investment?

Shinto: According to my commonsense, even though we keep talking about the information industry, I do not believe that there will be a demand as large as the talk would have it. I am saying that for the time being, we should concentrate on the areas where there is an actual demand.

In previous facilities planning, the thinking was that it did not matter if investments were somewhat uneconomical. Because of what would happen in 10 or 20 years, we should act on a big scale now to avoid having to do twice as much later. I am telling people to give up these luxurious standards for decisionmaking. Of course, we should avoid duplication of effort, but there is no reason to discuss what will happen 20 years from now. If we work according to present conditions, now that the demand for telephones has levelled off, we should be able to do just fine with this much self-financing. This will not lead to any inconvenience for society.

Hiramatsu: Considering the nature of the public corporation, this kind of thinking is not in their line, is it?

Shinto: Not at all (laughter). However, no matter what anyone else says, I will not budge on this point. They bring up the public responsibility of NTT at every opportunity, but if the financial base is destroyed, how can we fulfill our public responsibility? If we go ahead with the present way of thinking, expanding borrowing every year by 300-400 billion yen, the debt will be 10 trillion yen in no time. We would have to borrow more money to pay interest on the debt. Isn't that the reason for the present insolvency of Japan? Isn't that why the National Railways are bankrupt? Since the public responsibility cannot be fulfilled that way, they say they'll raise the rates, raise taxes, and cut welfare and social security. Do you want NTT to end up like that too? Right now I'm doing a lot of this kind of criticizing.

Hiramatsu: This relates to the problem of the financial base. Income has reached a ceiling, and Japan stands out among the advanced nations as the only country where this has happened. It seems to me that this is because the system and policies have not been flexible enough.

Shinto: The old Public Telecommunications Law was obeyed too strictly. Right after I took office, I told everyone that even if they tried to resist liberalization of the communication network, it would be impossible to resist. If we do not get rid of these restrictions quickly, NTT's income will not go up. You're building a fence by yourself that keeps your income from expanding. That's ridiculous. Although your income grows by less than 4 percent per year, your expenditures grow by 6 percent. Isn't it clear that the difference between income and expenditures is a minus 2 percent or 80 billion yen a year? To rectify this, the Public Telecommunications Law should be radically rewritten as soon as possible. I talk about this persistently

within NTT, and I have made a request to the Ministry of Posts and Telecommunications to submit a bill in the next session of the Diet.

Hiramatsu: Liberalization of the communication network has been debated for the last 10 years.

Shinto: More than 10 years.

Hiramatsu: For NTT, it should be fine if the lines are used freely and traffic (volume of communications flow) increases, shouldn't it?

Shinto: Yes. But now it is building a fence.

Hiramatsu: However, if the network is opened up to private enterprise, there is the argument that "cream skimming" will occur, that good income sources will be taken away by the private sector.

Shinto: Therefore, I am saying that we should specify what should be limited and make a law for liberalization of all other areas.

Hiramatsu: Then specifically you are proposing that certain rules should be accepted by the communications industry on message switching or added value communications?

Shinto: Yes. It would take the form of a clear negative list, and everything else would be left free. It should be made so that demand for nontelephone services can grow easily. Then while discussing the various issues, we could provide equipment corresponding to the demand. Otherwise, if we continue as is, the gap between investment and income will grow even wider.

Pushing into the Area of Communications

Hiramatsu: It is a fact that restrictions in the system and policies have obstructed the socialization of data communications technology. At the same time, when we consider the further diversification of needs, isn't it necessary to remove these restrictions and also make NTT more open and create a more diverse research and development system.

Shinto: I feel that very strongly. I've been saying this over and over to the people inside NTT, and they have generally come to accept it. NTT has been totally enveloped inside the system of the Ministry of Posts and Telecommunications. However, the world has changed and the hardware manufacturers, the information industry, is under the Ministry of International Trade and Industry. Therefore, MITI created the Machinery and Information Industries Bureau. NTT, the president himself, will have to move into MITI's area, as necessary, and actively sell NTT's technological development capability.

Recently, we held the first regular conference related to trade.

Hiramatsu: Trade?

Shinto: Yes, because it is necessary for us to work internationally. Therefore, we have decided to make the first contact with the Machinery and Information Industries Bureau in the last part of August and work with them regularly.

At any rate, unless we provide easy access to NTT, there will be a ridiculous situation. I have known the new chief secretary, Ogura, for a long time. I told him to handle things at MITI and I'll take charge at NTT. This arrangement seems to be working.

Hiramatsu: As a concrete example...

Shinto: Essentially, we are purchasers of equipment, so we must open up to a wider range of suppliers, not just the NTT family. Also, we must become more international. Therefore, we must provide them with information or they will not know what to do with NTT. They will not be able to come up with the good ideas necessary. We must open the necessary information. With a system where what we are doing is hidden and nobody can know anything about it, we cannot expect anyone to cooperate with us.

Hiramatsu: This same sort of thing has been said before. However, the restrictions of the present system took priority, and it was not carried out.

Shinto: If we do not change our position 180 degrees, NTT will go way into the red. That sense of crisis was lacking until now.

"Post-Family" System

Hiramatsu: A liberalized system is also being called for internationally. However, NTT is under the restriction of the Public Corporation Law which says it is a domestic enterprise. During the administration of the first president, Kajii, a foundation known as the Overseas Technical Cooperation Agency was created to serve as a tunnel organization. However, I think it would be unable to fulfill the role in an age of international technological cooperation.

Shinto: There is an organization called JTEC (Japan Telecommunications Economic Cooperation (foundation)). It can be done freely through the action of this organization. I do not think it is necessary to make special changes in the system now. The problem is people. If the NTT people change their thinking and their response to the job of the JTEC people, there will be no problems. Some NTT people can be temporarily loaned to JTEC as necessary.

Hiramatsu: There are also talented people among previous employees.

Shinto: Yes, many. It is not necessary to be limited to the present personnel.

Hiramatsu: These organizations are related to the developing countries. What about "cooperation" with the advanced countries.

Shinto: Well, fortunately, an agreement was made recently between the U.S. and Japanese Governments for that.

Hiramatsu: For material procurement?

Shinto: Not only material procurement.

Hiramatsu: Joint development with both domestic and foreign companies?

Shinto: If we carry it out seriously, and if we open up to the other side so they can work seriously, I believe that agreement is sufficient. After that, everything depends on how it is carried out.

Hiramatsu: It will be difficult until NTT gets used to it. From the beginning, NTT has claimed that liberalization is not compatible with public telecommunications operations.

Shinto: This is rather strange. NTT has a mistaken conception of being above everything. In a closed society. In this frame of mind, no system would work.

Hiramatsu: In this new open system, I understand that you have given out homework to everyone to reexamine all systems, from development to production and sales.

Shinto: That is because until now everything has been done with the NTT family. However, because the agreement was made between Japan and the United States, we have a clause prohibiting us from working with the domestic NTT family as in the past.

Hiramatsu: At least, there must be no discrimination between foreign and domestic companies.

Shinto: In that case, even when the laboratory is looking for a partner to carry out joint research, it will take much more time and trouble than before. The laboratory people are getting irritated about this, so they are requesting construction of a prototype production facility as part of the laboratory organization.

Hiramatsu: Now that you mention it, there has been talk of creating a prototype production facility for VLSI.

Shinto: So I am asking them to wait a little. I am also aware of the problem, but even if a prototype shop is built, there is no guarantee that things will go well. I gave them a homework assignment to think until the end of the year about how to do this without inconvenience and without reducing the speed of research.

Hiramatsu: In other words, there is no change in the policy of not directly having a production capability?

Shinto: I believe it is wrong for us to have one. Therefore, I think of three categories of research methods for Tsuken (Electrical Communication Laboratory). One is research for modification of existing hardware or production of new hardware. Another is research for improvement of elements which have a decisive effect on the hardware at hand. The other is research in basic materials for use in the elements we use. It is necessary to think in terms of these three stages. And it is desirable to have technological cooperation at each stage.

Hiramatsu: Recently, AT&T of the United States is actively moving into overseas markets with AT&T International. Of course, NTT can only go international with technological cooperation.

Shinto: As you say, NTT cannot enter foreign markets by itself. The things produced under technical cooperation between NTT and domestic manufacturers which are competitive may go into the international marketplace. In a typical development for Japanese industry, during the 3 years that have been spent dawdling in negotiations with the United States, the situation has changed completely.

Hiramatsu: What do you mean?

Shinto: The amount of exports has become far greater than the amount of supply to NTT.

Hiramatsu: However, the private sector had many difficulties to overcome since "export specifications" were completely different from "NTT specifications."

Shinto: However, this is the typical approach for private sector work. The private sector can make a vigorous response in order to make sales.

Satellites and Big Projects

Hiramatsu: Actually, from the private sector's point of view, what is expected of NTT is a long-range development plan for the future of data communications and public systems--for example, satellites....

Shinto: Actually, there are two exceptions to my principle of not increasing borrowing. One is orders for the data communications network on a national scale where expenditures and income will clearly cancel each other out. The second is communications satellites. For these two things, I am saying that I will borrow money.

I say that the communications satellite network and the present NTT network can be compared like airplanes and trains. Therefore, if NTT did not create the lines used for public communications with the use of communications satellites, we might be all right today and tomorrow, but in 30 or 40 years we would be in a sad situation. I also say that there is plenty of danger that it will become difficult to maintain the public character of the network.

Hiramatsu: The problem is that satellites are a new network, right?

Shinto: I believe that we are entering a period when we must move quite quickly in both technological development and policy decisionmaking.

Hiramatsu: That time is closer than people think.

Shinto: I agree. That is why I am in such a hurry.

Hiramatsu: However, the next problem is what to do with the system.

Shinto: One thing that surprised me upon coming here was that this is not being considered seriously in the Ministry of Posts and Telecommunications or in the Diet. The time has come for them to get serious.

Hiramatsu: You said that another exception to your rule was data communications on a national scale. Specifically...

Shinto: For example, there is an attempt to link all the financial institutions in the country. Then there are things like the national network of the Meteorological Agency and the air traffic control system.

Hiramatsu: That's right. There was some discussion in NTT about the Meteorological Agency network, wasn't there?

Shinto: I told everyone to come up with ideas and prepare a plan for getting orders so that the budget of the Transport Ministry could be used. Essentially, the Transport Ministry handles most of the work related directly to meteorology such as the Ports and Harbors Bureau, the Ships Bureau, the Civil Aviation Bureau, the Meteorological Agency, and the Maritime Safety Agency. Right now, only the ground system for the Meteorological Agency has been constructed. Items related to meteorology in the air could be handled in connection with the air traffic control system. For the sea, the Secretariat's Technology Section has started a maritime survey. If these things are all connected, one good system will be created.

Hiramatsu: A total system.

Shinto: The Meteorological Agency will use part of the system and the Civil Aviation Bureau, the Ports and Harbors Bureau, and the Maritime Safety Agency will all use parts of the system. I am saying that this can be done.

Hiramatsu: You will not stop with only the Ministry of Transport, will you?

Shinto: We will connect up with the Fishery Agency and then the Ministry of Agriculture, Forestry, and Fishery.

Hiramatsu: There is one more, the Self-Defense Agency.

Shinto: No, no that's taboo (laughter).

Hiramatsu: In short, you will actively move toward large national projects, data communications systems as foundations for society.

Shinto: This is not profitable for private businesses. It is something that NTT's data group must do.

Hiramatsu: There is also the CATV network which America has and Japan does not. If a network is not possible, CATV will be stopped at the present stage of small, separate stations.

Shinto: If we use optical fibers, CATV would be simple. If it becomes digital.

Hiramatsu: Technologically, that's correct.

Shinto: If the investment can be recovered in a reasonable period of time from CATV income, there is no reason not to do it. I am saying we will borrow money. However, I am saying that we will not increase borrowing to make an outright investment in the name of public responsibility.

The Meaning of the Greater Public Good

Hiramatsu: Finally, the reexamination of the management system now being undertaken by the temporary study committee.

When NTT was organized as a public corporation, it was stated that it would use the good elements of private management as much as possible. Up to the present, at least, it has done the opposite. Of course, in arguing about the management system, it is necessary to sort out the advantages to be gained from using private management and what can be done by modifying the present system without using private management. However, the debate over the management system has serious repercussions, especially for research and development. What is your position on this?

Shinto: Recently, in the Diet, I was asked what I thought about the idea of private management. I stated then that I was not in a position to say whether I favored or opposed it or hoped for private management or not. That is something for you to decide. However, if the stage of serious discussion were reached, I would, as a concerned party, take the responsibility of providing the necessary reference materials for discussion. That is what I said. Although we are involved in this, we are not in a decisionmaking position.

Hiramatsu: That may be true. However, it is a fact that after becoming president, you have come to have many doubts about the manner of operation of the public corporation.

Shinto: I have very many doubts (laughter).

Hiramatsu: Could you be more specific?

Shinto: The problem is how to get efficiency from this huge organization. There are several different possible responses. If a two-dimensional, narrow public enterprise is what is wanted, that is one possible kind of operation. But if, as first principles, we want to lead the world in technological development capability, make the fee for telephone service the lowest in the world, and meet new demand, and then do other things with our remaining strength, then there is a manner of operation appropraite for these objectives.

Therefore, I am telling the temporary study committee to begin by saying what the world is demanding of NTT in the process of examining the business structure of the public enterprise. I have said that I will provide reference materials to indicate what form may be best for that direction. However, we are not in a position to say this is what should be done or this is what we want.

Hiramatsu: In order to provide good service at a low price, freedom should be granted to the enterprise and efficient management should be expected. This was argued when NTT was first organized as a public enterprise.

Shinto: The first article of the Public Corporation Law has the words "universal and fair." If "universal and fair" becomes defined too narrowly, the system will break down.

Hiramatsu: If there is something wrong with "universal and fair," what is your view of public responsibility?

Shinto: I did not say there was anything wrong with it. I am asking whether that should be emphasized or whether a more broadminded view of public responsibility should be emphasized.

Hiramatsu: What do you mean by a broadminded view of public responsibility?

Shinto: To operate with the primary objective of promoting the economic activity of society. With this kind of capability, the financial base can be made sound. Then it is not what everyone would call "universal," but we should pay careful attention to the social welfare aspects and investigate it carefully. That is my kind of public responsibility. If we destroy our financial base, what kind of public responsibility is that?

Hiramatsu: However, isn't a wider debate necessary on public responsibility? At least until recently, NTT was not understood well enough.

Shinto: Yes, until recently. However, it will be explained clearly. I will take responsibility for that. It is clear that we cannot cope with the present situation with NTT's previous ways of thinking. However, it has already changed a lot.

Hiramatsu: In any case, it is necessary to put an end to the "geocentric theory" that NTT is an absolute institution in data communications.

Shinto: We have already moved to a "heliocentric theory."

Interview With Vice President Kitahara

Tokyo CHUO KORON in Japanese Autumn 1981 pp 180-186

[Interview with NTT Vice President Yasusada Kitahara by Hitoshi Hiramatsu]

[Text] Hope for Success in International Data Communications War

The famous vice president, who produced the "INS concept" and has devoted himself totally to the telecommunications field, is asked about NTT's technology development system.

A New Relationship With the Two Giants

Hiramatsu: I got the impression on a recent trip to America that since the Reagan administration took power, aiming for a "strong America," the United States is putting a lot of effort into data communications as a strategic area. Of course, it's the same in Europe. The intensified technology war between the advanced countries over this strategic field and technological cooperation, which is significant in international readjustment in this field, will be a matter of concern from now on. Therefore, I thought I would like to reexamine the role of NTT in terms of the international aspects of data communications, the core of the emerging technological revolution.

Kitahara: What you say is certainly true.

Hiramatsu: Recently, a cross-licensing agreement was made between NTT and IBM. Also, the patent licensing agreement between NTT and Western Electric (WE), which was known as an unequal treaty, will be revised soon. According to one way of thinking, this is a phenomenon showing that there is a great increase in the provision of technical expertise by NTT. It also signifies that NTT has emerged as a competitor with these two giants in the world marketplace.

Kitahara: With respect to the WE agreement, we had a lot to learn, at least until now. Therefore, rather than saying that it was "unequal" or whatever, I am grateful that WE let NTT use that many patents so freely.

Hiramatsu: However, you are paying royalties, right? It isn't quite right from the viewpoint of reciprocal noncompensated granting of licenses.

Kitahara: There were many things that were not quite right from the time the agreement was first made (laughter). However, there was nothing we could teach them, so there was no use in putting up a front. That was how it was.

Hiramatsu: What are some specific examples of knowhow supplied by WE?

Kitahara: One example was the cross-bar switching system. We received that in complete form including drawings. Of course, the manufacturers paid a license fee.

Hiramatsu: Was knowhow included?

Kitahara: Yes, we also received the knowhow. Even the production plants were shown to employees of NTT. Even the maintenance system was shown to us. So we were taken good care of. We were like children (laughter).

Recently, however, as you say, in VLSI research and development and optical technology, Japan is probably running ahead of the pack. If things remain as they are, we cannot avoid the scorn of the people. Therefore, from now on, when we obtain patents, we have made a proposal to do it with cross-licensing.

Hiramatsu: That proposal suggested that the range should be expanded beyond Japan and the United States.

Kitahara: That's right.

Hiramatsu: This is related to the problem of international reorganization. Another development is that AT&T International recently opened an office in Tokyo. It seems that it is aiming at the Chinese market. But there is also reason to believe that it is aiming at joint development with NTT.

Kitahara: This is a domestic problem in the United States. There were various problems between AT&T and ITT, and as a result, AT&T was given permission to operate overseas. It first moved into Iran, but eventually it decided to enter the world market in earnest under the name AT&T International. Once its position became clear, more areas of competition emerged. And we decided that cross-licensing was necessary.

When the present agreement was made in 1965, AT&T was blockaded inside the United States, so there were no such problems. I think we have been fortunate to do as well as we have during the last 15 years without trouble. However, from now on, as you say, AT&T will enter upon the world stage. So will Japanese manufacturers. Therefore, we must arrange things so that when NTT patents are used, we can also use corresponding American patents.

So, in answer to your question about our relationship to AT&T International, from the long-range point of view, we would like to do research and development in which NTT and AT&T work together as one.

Hiramatsu: The cross-licensing agreement with IBM is bilateral, isn't it?

Kitahara: This agreement will probably be formalized when the IBM vice president comes in September. This is probably the first time that IBM has made a cross-licensing agreement with a government organization.

Joint Research Requires Give and Take

Hiramatsu: With reference to the joint development you have just mentioned, the material procurement liberalization agreement "Track III" will open up development and equipment orders to foreign companies in an extension of the private contracting system. Is it possible Bell Laboratories and Tsuken might work together on the development of long-range projects, for example, an automatic translation machine?

Kitahara: Yes, it is possible. I do not think it is a dream.

Hiramatsu: Have there been any proposals from Bell?

Kitahara: Not from Bell. However, we have informally expressed a desire to work on such projects.

Hiramatsu: For example?

Kitahara: For example, development of a single-mode undersea cable using optical fibers. American products are used in 70 to 80 percent of the world's oceans. This research and development would be advantageous to their side as well. As you know, the best fibers right now are those made in Japan, but relay equipment is an American specialty. With this thought in mind, I am sounding out the New York office informally.

Hiramatsu: With the opening up of material procurement, there has been a great change in the environment surrounding the previous development and production system of the NTT family. There are still some problems remaining, but what is your view concerning the ideal state of the future development and production system?

Kitahara: There are many difficulties to be solved before realistic solutions can be found to this problem. In Europe, all countries have several trial production companies. However, we are not thinking of having a production company. I believe it is impossible. It is nonsense when, as today, the private sector is so fully developed.

Therefore, as a method of expanding the range of things that we have developed, or for which we seek cooperation in the process of development, we will ask companies which are suited to a certain type of research to continually carry out research above a certain level. Furthermore, we will try to maintain fairness as much as possible in this. The patents obtained through this process now are, of course, being publicly announced, and I believe that these patents, including knowhow, should be made public.

For example, the development of VLSI technology has been carried out between NTT and three other companies. The biggest problem in joint research is balancing give and take. For this purpose, it is necessary to align the standards of development to some extent. Therefore, we must continually keep track of information on these things through exchange of documents and mutual discussion by researchers. Previously, certain things were put on the table for joint research, and everything beyond that was considered impossible. Now these things must be shown openly.

At any rate, VLSI research has been carried out with three companies. Are three companies enough? We plan to extend this as much as possible as a sample.

Hiramatsu: What about joint development with foreign companies other than IBM and WE?

Kitahara: I do not know yet. MITI is proposing joint development on an international scale. In September, the British minister of industry came to Japan and set some joint research objectives. I understand that computers are included. We would like to watch such movements and consider the proper form of "liberalization," or if that term is not appropriate, the form of "cooperation."

Expectations of Facsimile

Hiramatsu: During this discussion, several development issues have come up. Looking ahead to the year 2000, we can imagine a great diversification of data communications technology. When we think about setting objectives, it is impossible to go in only one direction. What is your view of the future development objectives for NTT?

Kitahara: By way of a preface, it is a fact that NTT has spent the 30 years since it was established in 1952 totally absorbed in installing telephones. With 45 million subscribers, it formed the second largest telephone company in the world.

However, in the information society that will follow the telephone society, we will have a deep relationship with the national life and economy. We have not made a sufficient appeal or attempt to gain the understanding of the people with regard to the "NTT of the future." I believe this was a failure in management.

I actually wrote a paper entitled "NTT of the Future" and published it in the laboratory report of May 1968. In that article I stated that the delay in telephone service would be eliminated in 10 years. I asked the question, "What will be waiting for us after that?", and answered it in my own way. One part of the answer is facsimile. The Japanese are a nation of writers. However, they do not take easily to the typewriter or other machines using the alphabet such as the TELEX. They also dislike using the kana syllabary alone. It is desirable to have something that accepts writing with a mixture of the kana syllabary and Chinese characters. Therefore, facsimile is bound to succeed, and it is an objective that Japan should work toward in its role as the most technologically developed country of Asia. With this in mind, we began to work on facsimile in 1970.

A fundamental part of success with facsimile is the problem of paper. How can copies be made in the most compact and economical way? Ultimately, a thoroughgoing application of electronics is necessary. In the process of radically reducing costs, IC research emerged as a "secondary" research objective and we saw that this would be a basic element in future technology.

Mr Yonezawa, the president of NTT at the time, went to the United States in 1973 and asked to see Bell Laboratories with this in mind. However, Bell was very cool toward facsimile, and we found that it had been left to the private sector. Therefore, as we found out, the standards were different for each company. But overall, facsimile technology was very advanced.

In the course of this process, we seriously began working on facsimile with the idea of making it our own in 1975. The cost of IC had been greatly reduced. So we decided to go ahead. We were able to use size A5 paper and we produced the facsimile service which will go into practical application soon. And we are making a proposal to CCITT (Comite Consultatif International Telegraphique et Telephonique) for drawing up international standards and making common international connections possible.

This will be most inconvenient for America because of its variety of standards for existing equipment. But the United States is a country of rapid regeneration, so another new star will probably emerge soon.

The Pros and Cons of Family-Style Development

Hiramatsu: I knew that you had been enthusiastic about facsimile for some time. An example of one of the characteristics of U.S.-Japan technological development came up in what you just said. That is, NTT has always followed the international standards of CCITT. However, Bell Laboratories has a kind of pride and does not use anything not developed in its own laboratories. America has taken its own independent path with respect to standardization.

Kitahara: When I attended the CCITT conferences as a younger man, AT&T had an air of superiority. It was generally accpeted that the things they had developed were the best. One reason for this was that, because of the antitrust act, AT&T was shut up inside the United States and did not need to go overseas.

However, Japan has to earn its bread by exports. For this reason, it always had to meet international standards and work hard inside that framework.

Hiramatsu: I understand that. However, this was done within the closed system of the NTT family. And did this not actually delay NTT's product development?

For example, there is the facsimile which you just discussed. In spite of your enthusiasm, the product directly under control of NTT was late in achieving high-speed facsimile service. Ricoh has obtained a very large share of the market. And Ricoh is an outsider, not a part of the NTT family. I believe that this demonstrates a weakness of the closed joint development, production, and sales system known as the NTT family.

Kitahara: One reason that the facsimile was delayed, as I mentioned before, was that NTT was intent on building a telephone company and missed its timing for starting development of the facsimile. Another problem was that facsimile research was not very advanced at Bell Laboratories, and so it

failed to stimulate us. Also, there is the problem of division of labor between us and the private sector.

With respect to the general facsimile service in use today, only the products purchased by NTT were used during the first year. After 1 year, the standards were made public, and there was nothing to prevent anyone who could meet the standards from operating freely. Therefore, I want you to realize that we plan to have the public sector participate actively.

Hiramatsu: Another similar problem is the electronic switching system. For a long time, NTT mainly used the space-sharing system. Because this differed from the system used in other parts of the world, private manufacturers had a difficult time. They were forced to make double research investments.

The same thing was true for AT&T, wasn't it?

Kitahara: Yes.

Hiramatsu: AT&T overcame this with the No 4 ESS, but NTT was unable to change its policy for a long time.

Kitahara: I believe there was some poor judgement on our part. We were weak in giving directions to the people in charge of switching. In retrospect, it was mistaken for NTT to change the electronic switching system twice using the space-sharing system known as the D10. Rather than doing that over again, it would have been better to switch to a time-sharing system.

And, as you say, WE also continued to stick to the space-sharing system. Telecommunications technology is truly a difficult field. One mistaken decision on the system and you can get caught in a deep valley in some areas.

Development in an Age Without Precedents

Hiramatsu: I see. Data communications technology can be partially understood for the 1980's. Most observers see Japan as strong in this area. But there are many things which are not yet understood.

Kitahara: Very many.

Hiramatsu: Among these, what do you think the development objectives of NTT will be?

Kitahara: What I am thinking about with respect to the network are the fields related to distribution of optical fiber communications to the home. This involves large numbers. There will be a large number of elements such as connections. However, we will find solutions in these fields. I believe that the technology for the INS (information network system) is fairly complete. The next problem is to prepare the functions of communications processing and data processing related to this system.

By preparing the functions of communications processing and data processing, we can produce a system that is very economical and efficient to use, that can be used easily by everyone from young children to the elderly. Communications processing includes four kinds of systems. These are the telephone system, the facsimile system, systems which produce printouts such as those used in data communications, and systems which produce video images such as the CAPTAIN system. The network will be made up of these four types of systems in spite of differences in size, speed, newness, or oldness of the systems.

For the other element, data processing, the only approach is to expand the computer to a very large size. In order to build a machine that can "talk to human beings," a super computer is necessary, a computer which can learn and combine information as complex as the billions of human brain cells. The basic research directed toward this new age will be very important.

Hiramatsu: Finally, with an emphasis on Tsuken, I would like to ask about problems related to the motivation of NTT's researchers, personnel management, and management of research and development. With respect to the ideal state of future research and development where originality must be brought out.

Kitahara: Just recently, I discussed this with some managers from the [redacted] laboratory. Essentially, we have entered an era in telecommunications research and development in which we have no models in the rest of the world. However, it is not a situation where we do not have even a whiff or a glimpse of something. Everyone goes to international scientific conferences at least once a year. There is always something startling among the things talked about there. Everyone says that there are. The problem is how to develop these things into something original.

Putting it another way, from now on we may need people who stand out. If "stand out" is the wrong word, perhaps "stick out"...maybe that's a worse expression (laughter).

Hiramatsu: Basically, people who are unusual, have unusual talents.

Kitahara: The view was expressed that perhaps we should encourage this type of person more, and I listened carefully. The era of control, of creating model students, is past. We were able to follow after certain things with model students. Model students will probably be necessary from now on too, but now the important issue is how to nurture and encourage outstanding individuals. I received the impression that this is what the new era will require of us.

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SCIENCE AND TECHNOLOGY

FMS USING SUPER HIGH PERFORMANCE LASER PROJECT DISCUSSED

Tokyo NIKKAN KOGYO SHIMBUN in Japanese 24 Feb 82 pp 43

[Text] In the industrial field of small-quantity production of diverse products, much attention is being given to FMA--the "flexible manufacturing system"--which is called the manufacturing system of the future. Small quantities of diverse products are efficiently produce by FMS, an assembly of "mechatronics" (electronically controlled machinery), represented by NC (numerically controlled) machine tools such as industrial robots and MC (machining centers), with a computer at the center. This is an unmanned system which requires almost no human intervention, and it holds the key to economical and rational production. One attempt at realizing the ideal of FMS is the "combined manufacturing system using a super high performance laser" which has gone forward under a national project; it is hoped that a pilot plant will be built in 1983, with effects which will spread to other sites. Attention is therefore focused on the present situation at national laboratories attempting to advance and systematize mechanical technology, primarily for this project.

Efficient production methods using automation, primarily of machinery, are firmly established in the fields of mass production represented by automobiles and electrical appliances. But in the fields of small-quantity production of diverse products, which make up about 70 percent of total machine production, labor reduction and rationalization of processes are difficult and diversification of demand is expected to increase, so improvement of productivity has become a major topic in these fields.

Accordingly, the project for a combined production system using uper high performance laser is intended to solve the many and varied problems in the field of small-quantity production of diverse products, and to develop innovative new technology which is in no way inferior to the automation technology of mass-production industries. That is, the goal is "to establish a combined production system capable of quick and flexible production of amall qunatities of diverse machine parts using a system which is integrated from metal raw materials through the completed parts."

This project was planned for 7 years, from 1977 to 1983, with a total investment of about 13 billion yen. Research and development is being carried out as a national project, with close coordination of three national research organs, including the Mechanical Engineering Laboratory of the Agency of Industrial Science and Technology, and universities and 20 private companies under the umbrella of the Technical Research and Development Association.

The research and development is organized into four subgroups: cutting and assembly, raw material processing, laser use, and diagnosis and control. Research and development of the total system has been carried out through the cooperation of the various subgroups. Five or six companies participate in each subgroup.

In order to bring about rapid advances in production technology in the fields of small-quantity production of diverse products, the concepts of combined and modular processes have been taken up as new production technology, resulting in development of a new production system which is capable of carrying out a variety of processes at one time in one location. This has meant the development of new processing components, including raw materials processing machinery, combination cutting machinery, combination assembly machinery, product inspection machinery and laser machinery, as well as the development of related new basic techniques.

The plan also includes development of design and control technology and automatic diagnostic technology, the development of system design technology for the total system, and also integrated technical development of the combined production system. The various subgroups have already completed research and development on their elements, and the final design of the combined production system will be completed around March. The machinery will begin to be manufactured in April, and construction of a pilot plant in the Mechanical Engineering Laboratory is to begin in May.

Although the design of the pilot plant has not yet been decided, the intention, according to industrial Technology Director Shotaro Ozaki of the Mechanical Engineering Laboratory, is "to design a practical system through experimentation in the pilot plant." This is risky, advanced industrial technology including processing technology, assembly technology, inspection technology and laser technology, and the ripple effect will be immeasurable.

The fusion of electronic and mechanical technology, for example, will facilitate automation of small-quantity production of diverse products and 24-hour operation with few operators (none at night), and the combining of processing and assembly and application of lasers will cut machine production time in half. It is also hoped that this technology will serve to reduce the shortage of skilled workers for machinery production and improve the work environment by handling dirty and hazardous operations.

The goal of total system research and development is to facilitate efficient production of the products in question by establishing system operation technology centering on planning and control, and system design technology

which combines and concentrates such processes as processing of raw materials, cutting, assembly, laser processing, and product inspection. It is thought that the products which can be produced using this system will include a broad range of mechanical components produced in small quantities, such as construction machinery and machine tools. It will use a carbon monoxide gas laser with a 20 kw output for production of transmission devices and hydraulic devices weighing 500 kg, measuring 1 meter and having up to 300 parts.

The companies particpating in the project are Toshiba Machine Co, Toyoda Machine Works, Makino Milling Machine Co, Hitachi Seiki Co, Yamazaki Machinery Works and Yasukawa Electric Mfg Co in the cutting and assembly group; Ishikawajima-Harima Heavy Industries Co, Kobe Steel Ltd, Mitsubishi Heavy Industries Ltd and Aida Engineering Ltd in the raw materials group; Mitsubishi Electric Corp, Toshiba Corp, Nippon Electric Corp, Matsushita Laboratories, Horiba Ltd and Sumitomo Electric Industries Ltd in the laser group; and Fujitsu Fanuc, Okuma Machinery Works, Nippon Steel Corp and Oki Electric Industries in the diagnosis and control group.

The details of research and development are as follows:

First, the raw meterials processing technology will require development of super-free forges to form the larger shafts, hot hydrostatic particle presses to form particles into parts with irregular shapes, disk and ring shapers to form circular parts, and precision multi-axis forges to form small, graduated spindles. Each of these machines will require shaping technology such that they can respond with a certain degree of flexibility to changes in the shapes of parts, using only a small number of tools.

Next, the cutting process technology will require combination cutting equipment which will incorporate technology of six types: (1) technology to combine interchangeable units and put together combination cutting machines which cut, grind and measure; (2) technology for feeder mechanisms capable of separations or combination, having improved mainshaft performance, fewer varieties of mainshaft units, and more compact structure; (3) technology for improved cutting efficiency and methods of cutting away scrap pieces and preparatory cutting; (4) technology on supports adaptable to varied processing of parts having different shapes; (5) technology for control and drive systems suited to combination cutters with modular construction; and (6) technology to diagnose operating conditions, sense impending malfuntions, and make adjustments. Through use of these technologies, the processes now performed by separate machine tools can be handled in a single location, and the number of processes and workers can be reduced significantly.

In regard to automatic assembly technology, the goal is to develop varied technology for small quantities of diverse products for which standard automatic assembly is not possible. Standard assembly machinery uses separate stations for different processes such as screw-tightening, injection or insertion, and each station performs a single, specialized function. For that reason, such machinery can be used only for mass production. With combination assembly machinery, on the other hand, it will be necessary to

develop the capability to exchange assembly tools within an assembly machine, and to develop technology to perform a variety of functions, such as determining the location of a unit and picking up parts to be assembled, or inspecting and replacing parts. In this system, the work will continue automatically until the product is completely assembled.

The use of lasers--a carbon monoxide gas laser with an output of 20 kw in this case--is one method for reducing the time and the number of processes needed for small-quantity production of diverse products. Lasers can combine the cutting off of minor distortions (to save subsequent processing), welding, and case hardening with rough formation and cutting processes. The national research organization with responsibility for this aspect is the Electrotechnical Laboratory of the Agency of Industrial Science and Technology; it is pursuing the establishment of the basic technology.

Because laser beams can be used for a number of purposes like cutting, welding and hardening, there is no need for automatic exchange of tools. Moreover, robot or unmanned operation is possible; this is related to the individual process times. Lasers are expected to be a trump card in the era of new materials, since they can efficiently handle difficult materials like ceramics and composites. Director of Electronic Processing Research Masayuki Ikeda of the Electrotechnical Laboratory says: "Laser beams can be used together with other processing methods, in addition to uses combining such functions as processing and measuring." From this, it appears that the era of laser processing will arrive even sooner than had been anticipated.

Basic Technology To Be Established To Meet Demands of Industry

Mechatronics devices have been introduced to reduce manpower and costs to the minimum, and employees have begun to escape from simple tasks and dirty work. Completely unmanned factories which efficiently produce diverse products in small quantities will soon make their appearance. What kind of research and development have national research organizations embarked on? We visited the Industrial Technology Agency's Mechanical Engineering Laboratory in Ibaraki Prefecture's Tsukuba Research Park.

It appears to be true that "mechatronics is no more than improving the performance of machines" (Deputy Director Makoto Kimura), and that "there are many things the national research organizations should be doing, and they haven't done research on mechatronics" (machine tool section chief Kataro Yoshida).

The advancement and systemization of mechanical technology is the basic direction of research at the Mechanical Engineering Laboratory, but it has played a central role in research and development of the combined production system using a super high performance laser, a large-scale industrial technology research and development project. It has carried out research in some 10 basic areas, including cutting, molding, automatic assembly, automatic diagnosis, and design and control technology.

The demands on processing technology have increased from micron range tolerances to the submicron range. Superprecision processing technology

has not yet been firmly established in Japan, and the transfer of technology from the United States has become impossible. For this reason, special research on superprecision metal mirror processing technology began in 1981. This was intended to develop technology for processing metallic mirrors (aluminum alloy, deoxidized copper) up to 500 mm in diameter, involving turning and cutting technology including evaluation of processing characteristics, design of high-precision processing devices, and technology for precise control of movement in the X, Y and Z axes.

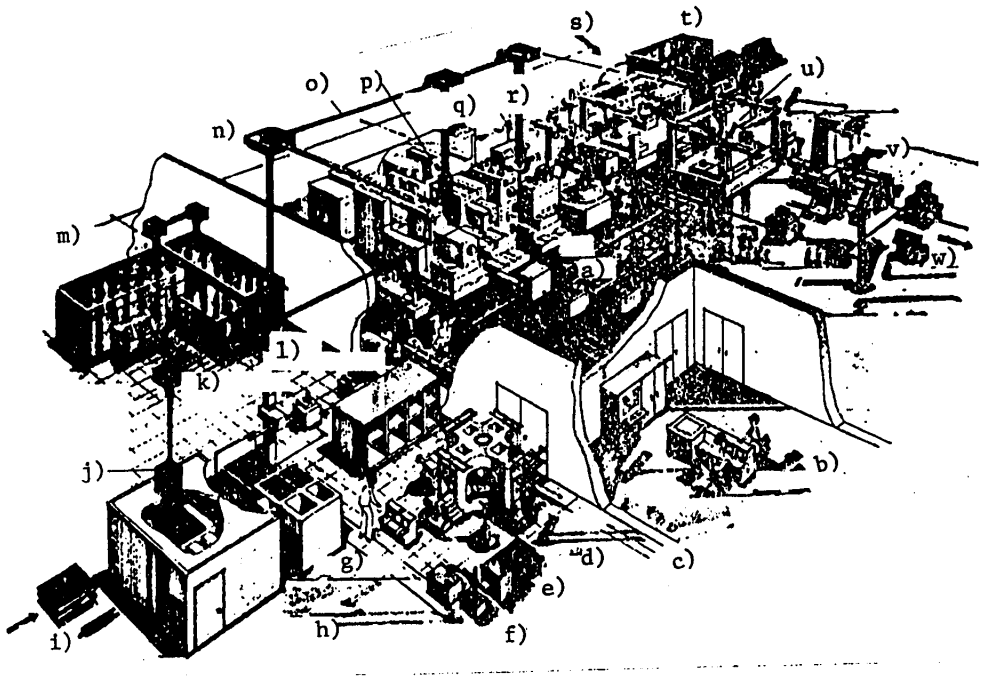
Robots can be called the "representative player" of the mechatronic team. The Mechanical Engineering Laboratory has developed seeing-eye dog robots (machines with the function of leading the blind) and systems, to aid those with serious physical impairments, which combine manipulators controlled through dialog with the operator and self-propelled vehicles which can move in any direction. These are all aimed at physical welfare, but "welfare equipment always involves risk; it is a problem with which the national research organizations and universities are experienced" (industrial technology director Ozaki).

Robot research has attempted, from a number of different angles, to give machines and computers the functions of the eyes and ears of men and animals (functions such as pattern recognition, visual information processing and voice recognition). This smart robot research "has the primary purpose of developing functions which can be used in future industrial robots" (robot engineering section chief Eiji Nakano).

In order to automate operations like manned assembly, the laboratory has developed adaptive manipulators with actuators resembling human muscle movement functions. It has become clear that simple control logic can make these manipulators execute basic assembly operations like pressing, handling, aligning, or inserting shafts. "As these basic techniques are established, one by one, assembly robots will become a reality" (chief researcher Hidetoshi Ito).

Computer-assisted design (CAD) has, with the miniaturization of microprocessors and advances in image processing, appeared in workplaces where energy conservation and automation were thought impossible, and has been called "the second industrial robot." The Mechanical Engineering Laboratory has developed automatic design systems capable of very efficiently designing press molds which require a high degree of dexterity. Research to achieve commercial utility has continued on the basis of this success.

In any case, the Mechanical Engineering Laboratory, which handles a broad range of mechanical research topics, will play an important role in "establishing basic techniques one by one" in response to industry's demands for "machines that can use the new tools that appear and new tools for high-performance and high-speed machines" (Deputy Director Kimura).



Flow of Combined Production System

(a) Conveyer mechanism
(b) Production control device
(c) Heat treatment area
(d) Ingot processing mechanism
(e) Induction oven
(f) Raw material conveyer mechanism
(g) Raw material records desk
(h) Materials preprocessing device
(i) Materials input
(j) Materials meltdown head
(k) Laser beam polarizer
(l) Ingot stockyard
(m) High-output laser oscillator
(n) Laser beam splitter
(o) Laser beam guide
(p) Welding head
(q) Combination cutting mechanism
(r) Case hardening head
(s) Purchased parts input
(t) Medium-output laser oscillator
(u) Combination assembly mechanism
(v) Product inspection mechanism
(w) Product output

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