Keynote Speech

Towards an Advanced Information Society

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Computerization and its Impact in Japan

My name is Kinoshita, and I head the Machinery and Information Industries Bureau of the Ministry of International Trade and Industry.

The world is presently hailing the inception of the advanced information-based society, and we are witnessing an historical turning point. At such a time, I believe it highly significant that over 1,100 participants from nations around the world have attended this international conference, and will exchange research results in high-level technical fields, relating to research and development of Fifth Generation Computer Systems, one of the most important subjects for study in the realization of the advanced information society.

At the opening of this international conference, I, as a policymaker involved with the promotion of the information industry in Japan, would like to report on the present state and future themes of research related to the new alignment of society toward emphasis on information; and at the same time, I would like to con-

sider a number of subjects to be studied in the drive to realize the advanced information-based society.

As I am sure everyone is aware, the utilization of computers in countries throughout the world is spreading each year at an extremely rapid pace. Japan is no exception, as computer system applications continue to grow with remarkable vigor. Whereas in March of 1977 there were 41,000 general-purpose computers installed, by the end of 1983 that figure had grown to 143,000, or an increase of 3.5 times in the space of six years and nine months. These are figures for systems in stock; as you know, many units shipped are destined to replace old systems, so that there are more computer systems in use than even these numbers suggest.

Recent years have also seen sharp increases in the numbers of personal computers shipped; the 283,000 units delivered in 1981 had only two years later, in 1983, jumped up to 1,141,000 systems, as shipments continue to double and triple yearly. It is said that the number of personal computers produced this year will reach 1.6 or 1.7 million units.

While the spread of computers has in the past been centered around the industrial sector, computer use is expanding rapidly to other spheres in society. Hereafter, it is expected that the resulting emphasis on information resources will not stop with urban areas, but will permeate ever outward, ever more deeply, to include rural areas, and to encompass all spheres, all segments of society.

The reasons for this are relatively simple. They lie mainly in the fast pace of technological advances, together with great cost reductions based on these advances.

The world economy has undergone sweeping changes since 1970; in looking back on these years of economic upheaval, one becomes aware of two types of "crude oil", so to speak, for which the market mechanism has worked surprisingly well. The first type actually is crude oil. As a result of the two oil shocks, the benchmark price of crude oil is currently almost twenty times the price which prevailed in the early 1970's. And owing to this, although it is the world's most basic resource, consumption of crude oil fell off. In these dozen years, despite growth in both population and the world economy, crude oil consumption has dropped by over 10% compared with levels before the first oil shock. Production by the OPEC nations in particular has slumped to about half of the previous maximum volume of production.

The other type of "crude oil" for which the market mechanism acted so effectively was, as you might suppose, the semiconductors which represent the "crude oil" of industry. Thanks to rapid advances in design and processing technology, both integration levels and also yields have been raised to new heights. As all of us know, since the development of 1K bit LSI memories in the early 1970's, integration levels have risen swiftly, with production of 64-K bit and 256-K bit chips in progress, and, at a few commpanies in Japan, production of 1-M bit memories soon to begin. As integration levels have soared, costs have dropped by large margins. In comparing costs in 1975 and today, we see that whereas in 1975 memory chips sold for one yen per bit, today's prices have fallen to about 1/100 of this.

As a consequence, the range of applications of semiconductor devices spread rapidly. The semiconductor chips which previously were used only in computers

and desktop calculators are now being adopted in video tape recorders, automobiles, electric washing machines, watches, toys, even in machines for the pinball game which the Japanese so love. The use of semiconductors is expected to spread even further in the future, and will doubtless be employed in one way or another in nearly all machines and tools.

The staple of the Japanese diet is rice; and whereas in the United States and other countries semiconductors have been referred to as the crude oil of industry, we in Japan sometimes talk of them as the sustaining rice of industry.

At any rate, with this great expansion of applications, the net worth of semiconductor production in Japan has risen mightily. Whereas total production in 1975 amounted to ¥110 billion, in 1984 it is expected to top ¥1.6 trillion.

Further, by virtue of the rapid progress in semiconductor production technology, activities for investments in equipment have also been exceedingly energetic, with the total of all equipment investments by Japanese firms said to reach ¥800 billion this year, a figure even greater than the total for equipment investments for steelmaking in Japan.

As I just mentioned, the price per bit of memory chips has fallen to 1/100 its previous price. Thus if we suppose that all semiconductor manufacturing was for memory chips, then in ten years, semiconductor production, in number of bits, has grown by an amazing 1500 times. This great drop in prices, together with the resulting tremendous increase in production volume, have had an enormous impact on the computer industry as well, as advances in semiconductors bring about great changes in computers.

In the 1960's, it was thought that computers were something which eventually would be installed, possibly one or two in each major city, for everyone to use in common. As it has turned out, however, computers have been made extremely compact even as their capabilities have been expanded, leading to sharp drops in price.

It is extremely difficult to judge the extent to which prices have dropped, but according to some rough calculations we have made, in ten years it seems apparent that prices have fallen to less than 1/10 their original level. As a result, utilization of the computer has spread widely, as already mentioned. As yet another result, Japanese computer manufacturers, including foreign-affiliated companies, have increased production at the extremely brisk pace of 20% to 30% annually.

Already personal computers and word processors have become commodities which are easily within the financial reach of the individual.

As we all know, such advances in the fields of semiconductors and computers have in turn had a great impact on telecommunications, enabling giant leaps in the technology for optical fiber and satellite communicatins, for telephone exchanges and other communications equipment. And this, together with the compactness of modern computer systems, has led to changes from centralized to distributed computer configurations, with information processing and exchange conducted more efficiently via communications networks.

In addition, the information processing is itself qualitatively more advanced than before.

In the past, computers have been used primarily for simple office work and cal-

culations such as computing salaries; today, however, the computer may be used to support decision-making processes in business strategy. In this way, the computer has evolved from a machine used merely for calculations to a tool for high-level processing of information.

If that period from the end of the 1960's through to the 1970's, when computers were introduced into government offices in major cities and into the larger corporations, may be called Japan's first Information Revolution, then we feel that today's great movement to spread the computer into rural society and the home might rightly be called the second Information Revolution. This second Information Revolution is exerting impacts in a variety of ways on different spheres of Japan's economy and society.

First, let us consider the impact on the manufacturing industries. One important change is the alteration of patterns of demand. In the machine industry, for instance, demand has shifted to products with built-in microcomputers, or to products which are components of systems controlled or otherwise operated by computer. In the town where I was brought up, there is a small company which builds equipment for machinery assembly lines. When this company adds robots to their assembly lines, they purchase the necessary semiconductor components and build computers into the robots themselves. Thus there already exist samll-size firms which build, in part, their own robot equipment, without asking for assistance from computer companies.

One consequence of all this, at least in the area of plant production facilities, is the problem of employment of blue-collar laborers, and the fear that in the future positions for such workers will grow more and more scarce. Accompanying the appearance of computers is a change in the conditions of competition among companies. Differences in information handling in company production and sales divisions, or differences in networks for the collection of information, may give rise to differences in corporate performance.

And, as the emphasis on information develops further, it becomes easier to promote business operations which cross the traditional divisions between types of business. Thus while companies in different lines of business which hitherto had not been in contention suddenly find themselves competing with each other, so also companies in different industrial categories may find the opportunity to form alliances and augment each other's strengths. Such effects on individual companies are anticipated to have in the future a great impact on industrial structures and organizations, indeed to the organization of work itself.

A second area into which the "Information Revolution" might spread would be new services for the consumer, such as home banking and shopping, made possible by two-way CATV, videotext and other systems. And in yet other areas, such as medical care, education and rural administration, as new information systems are implemented, social structures and patterns of living are likely to be changed considerably.

Third is the area of international exchange of information; it is expected that such exchange will not only be expanded in great measure, but will attain a higher level as well.

Not only in politics and economics, but culturally as well, international exchange

will grow more binding, and there is reason to hope that mutual understanding and trust between the peoples of the world will be strengthened.

In Japan, we have begun to refer to a society in which information takes on a new importance as an "advanced information society"; in it, different information systems will be linked into networks, and a variety of services will be offered. In addition, rather than individuals playing the passive role of merely receiving information, they will be able to obtain that information which they require, use it and transmit it among themselves, in what is expected to be a society more closely reflecting human nature.

Upon observing the truly remarkable advances of technology in the fields of semiconductors, computers and communications equipment in recent years, we tend to succumb to the illusion that, even without any further great effort, the advanced information society will be just around the corner. I, however, tend to believe that things will not be all that easy. Rather, with the present outlook so favorable and such steady progress being made, it becomes all too easy to overlook a number of obstacles lying in our way. Just as unforeseen difficulties may cause an airplane to stray off course or lose speed, so do we, in striving toward this advanced information society, face similar dangers.

Software Crisis

The first such difficulty I would like to point out is that of software. While computer hardware is itself capable of extremely high-speed calculation, it is on the other hand a mass of relatively simple and inflexible machinery. In order for these machines, the numbers of which are increasing at an extraordinary rate, to function effectively, it goes without saying that a huge amont of high-quality software is necessary. Because the development and maintenance of software depends on an extremely labor-intensive process, if the need for such software resources is ignored, it is possible that grave "software Crisis," such as a serious gap between demand and supply or a deterioration of reliability, may result.

The number of system engineers and programmers presently employed at computer manufacturers, software houses, and other firms using computer equipment in Japan is about 400,000 persons. But as already mentioned, the demand for computers is rising rapidly, and the number of general-purpose computers installed is increasing at an annual rate of 20% or more.

Accompanying this is the increase in the volume of software being utilized and produced; it is said that there are presently about 39 million software packages in Japan today, and the rate of software production is increasing by 25 to 26% yearly.

If we assume that such increases will continue, then calculations indicate that the 400,000 software personnel required today will grow to about 1.6 million by 1990. Our own calculations indicate, however, that even if new software engineers are added at a fast pace, even if productivity is raised greatly in efforts to meet demand, there will still be a shortage of some 500,000 to 600,000 persons.

The number of students at Japanese universities studying data processing and related fields is between 20,000 and 30,000; the number of high school and technical school students studying in these areas is around 50,000 to 60,000. It is clearly im-

possible to satisfy the expanding demand for system engineers and programmers with these human resources alone.

Thus at present, many persons who in college majored in such diverse areas as history or foreign languages are now working as computer programmers.

If the demand for software does grow as is expected, then, there is no practical way to secure an adequate supply structure. At this juncture, then, we are forced to consider a number of countermeasures.

The first possible measure, presently being studied at MITI, involves the mechanization and automation of processes for the development and maintenance of software in Japan, which currently requires human effort, by the introduction of computers. By such a measure, it is hoped that software productivity may be raised to four times the present level, and the rate of automation be increased from the current 10% to 80%. The Japanese Government and concerned Japanese firms, with the cooperation of foreign corporations, are now making efforts to affect such an atuomation of software engineering.

The second and more obvious measure would be to raise the frequency of software use, enhancing the efficiency of software investments. In particular, it is desirable to raise the relative proportion of general-purpose software. General-purpose software currently accounts for no more than 5% of all software products in Japan—in striking contrast with the situation in the U.S., where it makes up 40% to 50% of all software in use.

In Japan, for instance, when a certain bank introduces a large computer system, even if it is similar to systems in use at other banks, different software is demanded. Such customers tend to order custom-made software developed specifically for their own system and needs. In this way, software with different characteristics is in use at different firms, so that the proportion of general-purpose software is quite low. The upshot is that software requiring considerable monetary inverstment is used only infrequently.

Thus a second necessary policy would be to correct this situation, by promoting the adoption of general-purpose software.

The third measure which we regard as necessary is the incorporation, whenever possible, of software in hardware. The goals of the Fifth Generation Computer Project are oriented along these lines. In addition to this, the automation of software production mentioned above is another important goal of the Fifth Generation Project.

The fourth possibility, also rather obvious, is the improvement of hte process for education and training of data processing engineers, and the introduction of computer education into elementary and high schools, thereby allowing the whole of the citizenry to gain familiarity with computer systems. It is thought that such a policy to increase the number of people capable of utilizing computers will also be requisite.

A number of policies, then, must be implemented in parallel, or it will become impracticable to cope with the "software crises" already described.

With regard to software, I would like to bring up one more relevant point. This concerns the forming of rules and regulations for suitable protection of the rights of the software developer. The drafting of such rules is of crucial importance, as it constitutes a precondition for investments in software development.

MITI is of the position that the rights of

software programmers must be protected, and is presently conducting studies in preparation for the establishment of laws, in accordance with the character of the rights involved and the present state of computer systems.

It is a source of extreme dismay that there are individuals in the U.S. and Western Europe who are under the totally mistaken impression that the Japanese Government is considering or in the past has considered the abolition of laws for computer software protection in Japan.

One cannot help but regret that, while talking of this as the age of information and communication, there are persons whose understanding of the thoughts of the Japanese Government on this matter are entirely at odds with the facts.

Throughout, MITI's purpose has been, and continues to be, none other than the protection of the rights of software developers.

There is a need, however, to bear in mind international developments and the dialogue between nations concerning this problem. MITI for its part does not intend to submit any bills until international understanding has been reached on the matter. Further, we believe that Japan must participate actively in international discussion to make such understanding possible.

Computer Security

The second point I would like to make concerns the establishment of measures for computer security. As information processing and communication becomes more advanced, many economic activities will come to depend on computer systems. Also, many situations will evolve in which large amounts of data on individuals are stored in computers.

Under such circumstances, should some malfunction occur to bring the system down, widespread social consequences may ensue; leaks of data, on the other hand, could bring about disastrous results, both economically and as concerns the welfare of citizens.

Several months ago, there occurred a stoppage in part of the phone service to the Kasumigaseki area in central Tokyo, in which many government offices are concentrated. The reason for the stoppage was announced recently; it seems that dust had entered the package of a single semiconductor chip, in some way causing a short-circuit, which in turn affected the whole telephone exchange program, so that the entire exchange system ceased to operate. This serves to indicate how, the more completely computer systems are woven into the fabric of society, the greater the social consequences when such systems fail to function properly. Measures to preclude such events should, as a matter of principle, be undertaken by private firms on the understanding that it is their responsibility. However, the government, in fulfilling its role of assisting private industry where the efforts of the latter alone are deemed insufficient, should work to secure safety and reliability, by providing necessary guidelines, promoting technical development to raise software reliability, and so on. Further, with the rapid approach of the age of the credit card and cash withdrawal card in Japan, semiconductors are beginning to be used in such cards. When practically all transactions at banks and stores are effected by such cards, it is possible that information concerning individuals could be transferred automatically to the enterprise involved. With this, grave problems con-

cerning the protection of privacy may arise.

Interoperability

The third point concerns the problems in coping with differences between regions and between companies. As computers are introduced and the importance of information in industry is enhanced further, favorable effects on corporate management, in terms of automation and effective use of data, begin to appear.

And a revival and invigoration of the competition among companies is conceivable. In these and other ways, progress in information-based reforms is fundamentally a favorable development for the nation's economy. On the other hand, however, because of differences in coping with these trends toward emphasis on information, it is feared that great discrepancies will arise among companies, and especially between mammoth corporations on the one hand and medium- to small-size businesses on the other. Another possibility is that firms might become bound more tightly into industrial groupings and affiliations.

Up until now, such problems as these have not become apparent in Japan. But, there remains the fear that those firms which form the nucleus of the information industry might act, through information processing and communication systems, to place restraints on the activities of those companies with which they do business. What is more, as transactions become more complex and the reciprocal utilizaiton which I will discuss in a moment becomes lacking, situations will inevitably occur in which single corporations find themselves installing a large number of computer terminals, leading to unbearable financial burdens, while at the same time economic efficiency falls off. The need thus arises for a variety of policies to counteract such problems, and it is also thought that a clear vision must be evolved and countermeasures in terms of industrial and organizational policy be formulated.

The fourth problem which demands careful study concerns the establishement of reciprocal or two-way utilization of information equipment systems. With the advent of the Information Age, various information-related equipment, first and foremost the computer, will be joined into integrated networks. In the future, it is expected that such information systems will be formed not only within Japan, but between nations as well. At present, however, it is often extraordinaily difficult to link different computer systems into information networks, and often the transfer of software between systems is not practicable. MITI believes that to resolve such problems, the securing of what is originally a military concept, known as interoperability, will be necessary.

I have served for two years, up to this past June, as Director of the Equipment Bureau of the Defense Agency of Japan; in this period, especially during conferences with representatives of the United States Department of Defense, the needs for "interoperability" and "standardization" were stressed time and time again. Returning to MITI for conferences to formulate policy regarding computer systems, I took great interest upon hearing such a military term as "interoperability" used in this new context.

One may well ask why the concept of interoperability was stressed over that of standardization. The reason for this is

that, in order to achieve effective links between computer systems, we reasoned that mere standardization is not sufficient; capability for conversion must also be incorporated into any such network. Fortunately, through the process of information conversion, it becomes possible to connect different types of computers. We thus came to the conclusion that interoperability should be pursued as the optimum combination of standardization and conversion.

There is one related point which I would like to make clear, however. In modern society, an extremely important factor in the marketing of products is differentiation of one's own product from those of the competitors. In the area of computers as well, whether so intended or not, individual manufacturers in marketing their equipment must also endow their products with characteristics to distinguish them from competing products, when announcing new systems and supplying them to customers.

Still, it is mainly areas such as fashion in which product differentiation is widely accepted as desirable; whether this differentiation must be pursued in areas closer to the root of national life is another question for deliberation. I believe that the stage in which computers could themselves be regrarded as "fashion" items has passed; by now they represent as important a component of the infrastructure as do roads and electric power. Thus it may be that such product differentiation is no longer necessary.

At present it appears that, with the revision of laws in Japan regulating electrical Communications, activities by the private sector to establish and operate VANs will soon gain momentum.

VAN services represent one means of resolving the problem of linking computers. But VAN services alone cannot resolve all problems related to such data links; there is a limit to what they can achieve. As VAN-related computer hardware and software comes into more and more frequent use, the spread of VAN systems will be linked directly to the success of such computer systems; whether all this is desirable in terms of the efficiency of society as a whole, however, remains to be seen.

With regard to these points, my colleagues and I believe it necessary to push forward with policies for standardization based on a common understanding, or where standardization is not feasible, to effectively combine the latter with data conversion. This will require sufficient planning not only on the part of manufacturers, but by users as well.

Further, technical development to this end must be carried forward. Without these kinds of policies, not only will the progress of the second Information Revolution be checked, but the road leading to the advanced information society will become difficult indeed.

Man-machine Interface

Up to now, I have spoken of the issue of "reciprocal utilization" as a matter of linking machine to machine; I would like to bring up one more subject in this context, which is the linking of man to machine, the problem of the so-called man-machine interface.

The new 18-story MITI building has been completed, and computer terminals have been installed in the offices of directors such as myself.

The other day a man from a TV broadcasting company visited me and filmed me as I was awkwardly punching the keyboard. There can be no doubt, though, that the computer is fantastically convenient once one puts it to use. By punching a few keys each morning in a prescribed manner, one can read a summary of that day's news in the Wall Street Journal—the news is at one's fingertips must faster than an airmail subscription would allow.

For instance, restrictions on auto exports to the U.S., which is related to the current trade friction, is an important problem; by hitting a few keys, I can find out in a moment the numbers of vehicles shipped to the States.

Through daily use, then, I experience the great convenience of the computer. Still, although I have worked in both Europe and the U.S. and have gained a familiarity with foreign languages, I have often wondered why the alphabet or the English language must be used in the keyboards and the display outputs of computers in use in Japan.

Estimates put the present proportion of persons capable of using computers in Japan at about 2% of the total population. But for computers to really find their place in society, many more people must learn to use them. Even if not to the extent of the automobile, still not only businessmen, but also a sizable proportion of all housewives would do well to learn to use computers. The age in which only specialists use computers is ended, and I believe we must make efforts to conceive systems which may be used readily by the layman. And in such cases, it becomes essential to strengthen the bond between the computer and its human operator.

In the early 1970's, the English author Schumacher published what became a famous book, Small Is Beautiful; probably many of you in the audience have read it. In the book, Schumacher gives strong warning of the dangers inherent in the economic trends of the 60's, that is, the development of technology for large-scale production which leads to excessive use of resources, and ultimately an economic system based on central control. As the alternative, he proposes that we instead build for ourselves an economic system which employs intermediate technology, albeit of a lower level, and which conserves resources and distributes control. In this way, he adds, we should recover the humaneness our society once had.

As it so happened, just at the time that Schumacher made his appeal, rapid progress was being made in the semiconductor field, with semiconductor devices being made more compact and densely integrated. With the oil shocks of the 1970's as a turning point, the tide of the world's technology was turning from large-scale systems to compactness.

This is true not only for the semiconductors I have already discussed, but also for optical fibers, biotechnology and other fields. Advanced technology has eagerly embraced the principle of "small is beautiful."

As already explained, the trend toward compactness is also leading to shift away from central processing, toward distributed computer systems. In this sense as well, the system of distributed control espoused by Schumacher may well be achieved.

The problem is, however, whether Schumacher's desire for a return to humanity can be realized in a new information-oriented society. Machines are after

all tools to be used by humans; a computer system must not constitute an end in itself.

At present, however, it is the human who is being pressured by the machine, to perform tasks such as producing software and entering information into databases. In terms of databases, for instance the statistics on auto exports to the U.S. I mentioned a moment ago, what are shown at the touch of a button are figures for August of this year; none of the statistics are up to date. If one asks why figures for exports up to and including the day before cannot be had, the answer is simply that the system isn't built that way.

While it is not technically impossible to collect all the figures relating to exports up to the day before, input them into a computer and provide them to the persons requiring them, such a process would require vast amounts of manpower. Under such a system, there would be no point in using the computer. If, however, a system were developed by which the figures were automatically entered as goods passed through customs, to be output as statistics in our offices, then there would be no need to rely on humans for the input of these and other figures.

Database usage involves questions of whether data can be input by voice or by diagram; these are also problems which demand resolutions.

By now, I have covered a number of topics; in closing, I think it can be said that the real significance of the growing importance of information lies in the realizaiton of a varied and abundant human life-style. The electronics industry, centered on the computer, is currently enjoying booming prosperity. This may well be due not only to the steady expansion of production, but also to a rather vague anticipation of the possibilities lying ahead, induced by the very fact that the present technology is not yet mature.

This prosperity, however, is not an immutable fact. Rather, it harbors the danger that all may end as an illusion. To make this prosperity permanent and keep it from ending as nothing more than an illusion of what might have been, all those working to put information to man's use must go about their work without losing sight of the basic principle of humanness in the society to be built, relying on mutual cooperation.

Significance of Fifth Generation Project

The development of a fifth generation computer does not have as its goal the realization of an entity to replace man's intellect; rather, the purpose is to bind men more closely together, to create a computer system which people may use more readily, and to use this system to contribute to the creative intellectual activities of man.

The Fifth Generation Computer Systems Project cannot be advanced effectivethrough the efforts of Japan alone. From the beginning, MITI has caled for international cooperation as the precondition for real progress; and this International Conference is being opened today with this goal in mind.

sent today actively express their opinions, assisting us in our efforts so that a truly magnificent Fifth Generation Computer Systems might be realized.

I would like to close with a wish for the continuing health and happiness of all present today, and a sincere hope that this conference might prove fruitful for all its participants.