Keynote Speech

Yuji Tanahashi
Director General
Machinery and Information
Industries Bureau
Ministry of Internaltonal
Trade and Industry

Thank you for your kind introduction, Mr. Hiroshige. I am pleased to have been asked to speak at the very beginning of the FGCS '88 International Conference about what we at the Ministry of International Trade and Industry consider to be problems and what steps need to be taken to solve them.

The world is now in the midst of an information revolution, and our hand is on the door knob of the 21st century.

Electronic technology is making remarkably rapid progress, not year by year or month by month (Nisshin Geppo), but minute by minute and even second by second (Byoshin Bunho). Hardware innovations particularly stand out. For example, when Japan launched the Fifth Generation Computer Systems project in 1982, 64 kilobit semiconductor memories were commonly utilized, and the curtain was just beginning to rise on Very Large Scale Integrated Circuit. Later in 1984, mass production of 256 kilobit memories began, followed by 1 megabit (1 Mb) memories in 1987. The rapid turnover of generations has made the rule-of-thumb "one geneation in three years" a literal reality. Around 1992, when this project is scheduled to come to an end, a couple of more generations will have passed, and we will be into the age of 4 or even 16 megabit memory chips.

Behind this rapid advance of memory technology is the fine manufacturing technology of silicon. The practical application of memory technology moved on to logic devices such as microprocessors in just a few years.

If this rate of progress continues, a microprocessor using the fine manufacturing technology known as "half micron" for 16 megabit memories, of which some prototypes are already in existence, will appear in the middle of the next decade. This technique is expected to allow the integration of five million transistors on a single chip. This scale of integration would be comparable to all the transistors currently used in the CPU of a large mainframe computer.

Such progress and diffusion of hardware necessarily bring about a leap in the need for software. The Human Resources Subcommittee of the Information Industry Committee under the Industrial Structure Council of MITI predicts that Japan will be about 970,000 software engineers short in the year 2000. This is nearly twice the current total of 470,000 to 480,000.

This means that during the so-called "software crisis", the steps that Japan takes to train personnel for the information

industry will be of the utmost importance. It is not going to be easy to fill this very large gap. Conceivable measures to do so include education and training and achievement of higher software productivity.

For the former, it is important to enhance an educational environment in which children become familiar with computers at an early age. This is why we are presently developing a computer for education in cooperation with the Ministry of Education. In the United States and Europe, 80 to 90 percent of all primary and junior high schools are said to have already introduced personal computers in the classroom. In contrast, this figure in Japan is still only about 20 percent. We are therefore going to accelerate installation of personal computers in our schools. Regarding the education of information processing engineers, we have been working on the development of a computer aided instruction system (CAI) for data processing engineers called CAROL (Computer Aided Revolution on Learning system) which is progressing on schedule, and promoting the concept of an "information technology college." In Japan, there are already 125 information technology colleges which are equipped to train and give licenses to students in all relevant areas and at various levels.

We will, in addition, implement a new policy measure to stimulate the educational efforts of high-level information processing engineers in various localities, beginning in the next fiscal year. We are working on this project in close cooperation with the Ministry of Labor.

In an attempt to achieve higher software productivity, the "SIGMA Project" (Software Industrialized Generation and Maintenance Aids) is underway. The Project is now in its final phase of preparation and is expected to be ready for full operation in the year 1990.

In addition to these various measures, another important thing is, I believe, the effort to make computers much more human-friendly machines. One of the interfaces between human and machine is programming language. Since the first high-level language, FORTRAN, appeared in the latter half of the 1950s, programming languages have gradually evolved to the point where a user-oriented language called a "fourth-generation language" has recently emerged.

In the meantime, programming productivity has increaed markedly. From another point of view, this means that the computer is expanding its capabilities and gradually taking over jobs previously done by human beings. In other words, the progress of hardware technology now enables us to spare no small part of the ever-increasing computing power for processing a user language.

Diverting more of this mighty computing power to the human interface will surely make it possible to realize a human-friendly computer. I mean a human-oriented compuer having a communication function that accepts instructions in chart, graphics or even natural language. The Ministry of International Trade and Industry is now carrying forward a six-year project called "Friend 21" (Future Personal Information Environment Development), which aims at developing such computer technology.

Human beings continue to make more and more sophisticated demands on computers. Conventional numerical and business calculations are no longer enough for us. We now want computers to understand spoken words and to execute or support our intellectual activities,

including decision-making, design, and planning. We are now in the age of knowledge information processing. This may be the natural course of evolution in computer science over the past half century.

Needless to say, the Fifth Generation Computer Systems project started in 1982 with a ten-year plan having precisely the objective of developing an innovative computer best suited for knowledge information processing. Knowledge information processing requires highly sophisticated techniques such as inference. Just how sophisticated this is can be seen from the fact that to accomplish inference such as a syllogism, a conventional computer must execute about 100 instructions and procedures.

"Trial and error" is inherent in knowledge information processing. The conventional method of giving the processing procedures to the computer one by one as programs cannot cope with this type of information processing effectively. Even if the programs could be written, one would inevitably have to handle very redundant programs that would take too long to execute. However remarkable the technological progress is, it is still not enough to solve this problem.

In the Fifth Generation Computer Systems project, in which concerned industries are working closely with the academic realm, we are attempting to solve this problem by providing the computer with knowledge and inference functions that make it possible for the computer itself to conduct trial-and-error processing. In addition, parallel processing is indispensable for achieving the computing speed necessary for knowledge information processing, and, as stated by Conference Chairman Aiso, and by president Mita, so our project aims at achieving, parallel processing technology on a scale of one-thousand processors in the final stage.

Among the parallel processing research and development efforts being carried out throughout the world, this project, attempting to enable the parallel execution of very high-level information processing, such as knowledge information processing, is of the top rank, I believe, even when viewed as a parallel processing research project.

Growing numbers of researchers these days are seeking to analyze the functions of the human brain and their applications to information processing. I refer to research on neural networks. Neural networking, while an effective means of pattern recognition for handwriting, voice and so on, also makes it possible for the computer itself to find solutions through repetitive learning——a feature superior to those found in ordinary computers. Developing this computer, based as it is on totally new principles, will require interdisciplinary research by researchers in fields such as cognitive science, psychology and physiology as well as computer science. In 1989, the Ministry of International Trade and Industry will bring together researchers in various fields to start investigations into the future prospects of new informaiton processing technologies such as neurocomputers and the technical problems entailed in their development.

In three years time, when this Fifth Generation Computer Systems project has reached completion, the Neuro-computer will, in most likelihood, have entered the developmental stage.

Japan has tended to depend on efforts abroad for product innovation and to focus on process innovations. Now that

Japan's GNP accounts for more than ten percent of the world total, what Japan is asked to do is pursue product innovation in the truest sense, and this innovation could support the progress of tomorrow's global economy. I believe the Fifth Generation Computer Systems project is one of a limited number of projects capable of meeting this need.

Similar research efforts are being eagerly pursued in many countries. Government-sponsored projects alone include among others, the Strategic Computing Initiative (SCI) of the United States, the Program for Advanced Information Technology of the United Kingdom, and the ESPRIT (European Strategic Program for Research and Development in Information Technologies) Project of EC, each of which has its own, distinguishing features in the details of its research, but all have the common objective of advancing computer science.

In such basic and high-tech research and development efforts directed toward achievement of a goal common to all mankind, it is essential, I believe, to remove fences between nations and to marshall the knowledge and wisdom of all nations. In the Fifth Generation Computer Systems project, emphasis is placed on international cooperation. The third international conference is also part of such efforts. Other activities include the active presentation of research results and papers in and outside Japan and the holding of periodical "AI Symposia" with the National Science Foundation of the United States and INRIA of France. In addition exchange of researchers is ongoing. I am pleased to be informed that efforts to exchange researchers will be made very soon between the Information Engineering Directorate of the United Kingdom's Department of Trade and Industry and ICOT.

We are optimistic that this will also be a boon to Japan's goal for increased international exchange in general. Along the same line, I am pleased to hear that more than 300 participants from overseas were registered.

The results produced in basic research should be the common property of all mankind. We are determined to make further efforts to achieve what we at the Ministry of International Trade and Industry assert to be globalism in the area of technology. It is our desire that we achieve techno-globalism through promotion of the Fifth Generation Computer Systems project and other programs.

In this symposium held over the next five days, we will have lectures by Professor Simon of Carnegie-Mellon University and many other prominent researchers, as well as presentation of papers by 95 researchers from fifteen countries. ICOT researchers will give presentations on their research results, including demonstrations. The subjects cover a wide range: foundation, software, architecture, and applications. I sincerely hope that this exchange will give all participants the opportunity to broaden their horizons and help them move forward in their individual research.

The final three-year stage of the Fifth Generation Computer Systems project will begin next fiscal year, and I would hope that we will gain some insight here that will help us carry out this last stage of the project.

In conclusion, I sincerely hope this conference is a successful and meaningful event for each and every one of you.

Thank you.