Creating Tomorrow's Information Technology

By Seiji Hagiwara

The greatest problem facing Japan's high technology, and particularly its information technology, today is a fundamental weakness in basic research. Although it is frequently said that Japan has caught up with the technological level of other advanced countries, the fact remains that Japan to this day continues to devote more R&D money to developing applied technology keyed to product manufacturing than it does to basic research. Not surprising, then, that some countries criticize Japan for taking a technological free ride. Some Japanese themselves have observed that the present situation could be detrimental to the long-term development of the nation's economy.

This was the case with the information field up to the 1970s. However, as information technology has come to attract the keenest attention of all the various fields of technology, innovativeness and strengthened basic research in this area will have the greatest impact on Japan's technological development as a whole.

Two points require particular attention if Japan is to strengthen its capabilities effectively in this field. The first is to concentrate on the most important areas. The underlying trends in recent technology development are a shift from hardware to software and from applied to basic research. Japan's development efforts, too, should be weighted toward software-oriented information technology rather than hardware.

Second, technology development should possess a global perspective. There are high hopes riding on information technology. The opening of this new industrial frontier could prove a major stimulus to the world economy as it struggles with structural recession. Exactly because information technology does have the potential to open up new fields, it is important that it be developed through international cooperation.

The Ministry of International Trade and Industry (MITI) is well aware of these two points as it promotes a host of information technology development projects (Table 1). These projects aim to overcome Japan's present weakness in basic technology, to expand the industrial frontiers of economic society in the 21st century and to make a major contribution to the future of international society.

The number of information-related technology development projects under MITI's wings totals 25 in all. The fact that these 25 projects alone consume 15% of MITI's technological development budget is clear indication of the high priority assigned them. Especially noteworthy is the fact that 21 of the projects concern basic research or, if they are related to actual application systems, concentrate on fundamental concerns. Three classic examples are the fifth-generation computer project, the project for the development of OSI (open systems interconnection) technology—an absolute necessity in a network society—and the computer-assisted translation system project to help Japan's neighboring countries.

The fifth-generation computer project

Modern computer technology has entered its fourth generation with the advent of the VLSI. The first-generation computer was a primitive machine packed with vacuum tubes. Each revolutionary advance in the integration of electronic circuits has given birth to a new generation of computers.

The growing importance of information in industry, society and our individual lives has brought with it urgent needs that are beyond the ability of even high-speed computers with highly integrated circuits to fulfill. Machine translation is one, corporate management analysis another. New man-machine interfaces, from voice recognition to natural language processing, are also essential. It was to develop a computer that could meet such "human" needs that MITI initiated full-fledged R&D efforts on a fifth generation of computers in 1982 following the completion of preliminary studies under way since 1979.

The project involves a 10-year, step-by-step program divided up into a three-year first stage, a four-year middle stage and a three-year final stage. The aim is to develop by 1991 a revolutionary computer that will be nothing less than a high-order artificial intelligence (AI) system.

The project overturns all the conventional assumptions of computer development. Instead of seeking ever "faster, more accurate" machines, researchers hope to develop a machine that can handle ambiguous expressions close to human thought. It might be more appropriate to call it an entirely new species of computer rather than merely the fifth generation of the computers we know today. As a sign of just how innovative this project is, when MITI first proposed it to Japanese computer makers, they were reluctant to join. They doubted it would ever ring on the cash register.

Fifth-generation computer R&D was commissioned to the Institute for New Generation Computer Technology (ICOT), a development organization spe-

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Table 1 MITI Information Technology Development Projects

	Project name	Description, elements, working name, etc.	Budget (duration) Unit: ¥ billion
Material and Device Technology	New functional devices	Three-dimensional integrated circuits, super lattice devices, biodevices	**7.8** (FY 1981–1986)
	High-speed science and technology computation system	Very high-speed devices	**23.0** (FY 1981–1989)
	Optoelectronic integrated circuits	OEIC	**10.0** (FY 1985–1995)
	Applied synchrotron radiation technology	SOR (X-ray lithography)	**14.3** (FY 1985–1995)
Information Processing Technology	Fifth-generation computer project	Artificial intelligence, natural language processing, machine translation and man-machine interface	**About 20.0 until FY 1986** (FY 1982–1991)
	Software technology development	Technology to integrate software environment, other	(1982–)
	High-speed science and technology computing system*	High-speed processing, large-capacity high-speed memory, decentralized processing machines, other	**23.0** (FY 1981–1989)
	Database system for mutual computer operation	Multimedia, decentralized database, other	**15.0** (FY 1985–1991)
	Machine translation system with neighboring countries	Machine translation	**6.25** (FY 1986–1992)
	Electronic dictionary for processing natural languages	Fifth-generation computer language concept and knowledge base	**Minimum 14.3** (FY 1985–1994)
	Industrial software production system	Sigma project	**25.0** (FY 1985–1989)
Telecommunications Technology	Database system for computer interoperability*	Data transmission software, promotion of OSI, establishment of interoperability conformity	**15.0** (FY 1985–1991)
	Basic measuring technology for coherent optical communications	Laser technology, high-efficiency, high-density, high-modulation system	**4.3** (FY 1985–1991)
Space Technology	Resources exploration observation system	Composite open radar, engineering sensor, high-speed, large-capacity transfer technology	**23.0** (FY 1984–1990)
	Utilization of space observation	Development of space environment testing device	**5.7** (FY 1985–1992)
Application Systems	Medical treatment support system	MEDIS	**Undecided** (FY 1982–1988)
	Robots for hazardous tasks	Image recognition, other	**20.0** (FY 1983–1990)
	Advanced information processing-type image information system	Advanced HI-OVIS	**4.8** (FY 1985–1990)
	Commissioned R&D on medical and welfare equipment	CT scanner, nervous disorder diagnosis and medical treatment support system	(FY 1976–)
Electrotechnical Laboratory Projects	Materials	Electronic material, magnetic and amorphous material, other	
	Electronic devices	High-speed devices, new functional devices, other	
	Pattern information	Voice, image recognition, bionics, other	
	Computers	Information processing, storage, input-output technology, other	
	Software	Program language, network architecture, other	
	Control	Information system control technology, other	
	Microwave and electronics	Laser, optoelectronics technology, other	
	Information technology in extreme environments	Space environment technology, other	

Note: * Items straddle technological fields.

Table 2 Enterprises Established with Investment from the Basic Technology Research Promotion Center

Name of project	R&D enterprises established	Amount invested by the center (¥ million) (FY 1985–1986)	Private investors
Electronic dictionary for natural language processing	Japan Electronic Dictionary Research Institute	200	Fujitsu, Toshiba Corp., Hitachi, Oki Electric Industry Co. and four others
Second-generation optoelectronic integrated circuit	Optical Technology Research and Development Co.	100	NEC Corp., Oki Electric Industry Co., Sumitomo Electric Industries, Toshiba Corp. and nine others
Basic measuring technology for coherent optical communications	Optical Measuring Technology Research and Development Co.	90	Yokogawa Hokushin Electric Corp., Advantest Corp., Ando Electric Co., Iwatsu Electric Co., Anritsu Electric Co.
Applied synchrotron radiation technology	Soltech	150	Mitsubishi Electric Corp., Toshiba Corp., NEC Corp., Hitachi and nine others
Advanced information processing-type image information system	Base Information System Development Co.	80	Sumitomo Electric Industries, Fujitsu, Matsushita Electric Industrial Co.

cializing in technology for the new machine. As the reputation of the fifth-generation computer project has grown, attention not only in Japan but in other countries as well has focused increasingly on the activities of ICOT. When the project was launched in 1982, for example, other nations quickly followed suit, including Britain's Alvey Project in 1983, the EC's Esprit Project and the U.S. Defense Department's Strategy Computing Initiative in 1984.

In June last year, moreover, America's National Science Foundation (NSF) asked that it be allowed to send researchers to ICOT, a request that was quickly accepted. Japan, until now on the receiving end of technology development, is now able to conduct mutual exchange with other countries as an equal. This is a development to be welcomed. The fifth-generation project involves the development of ultrahigh technology that demands strong international cooperation. The fruits of this landmark project will contribute not only to Japan's economy and society, but to the expansion of the world's industrial frontiers and the realization of world peace.

OSI technology and international cooperation

With the rapid dissemination of mass communications media and the great strides in computerization, information has come to play an increasingly sophisticated role affecting the very structure of Japan's society. In the 1990s, man will need infinitely more voluminous and varied information for his life and daily activities than we are used to thinking about today.

Yet because of differences in communications protocols, computers made by different companies—and sometimes even the same company—are unable to interface and trade data between them. Already this is proving a bottleneck in the establishment of the network society.

In order to solve this problem, the International Organization for Standardization (ISO) is advocating the standardization of communications protocols, dubbed OSI. By its very nature, OSI requires the closest international cooperation, and Japan intends to do its part. In order to design a network system possessing the requisite interoperability, Japan is working on a multimedia database for characters, diagrams, images and sound, and is developing the interfacing technology needed for mutual operation.

The seven-year OSI project falls under the jurisdiction of the Agency for Industrial Science and Technology, a sub-organ of MITI with an R&D system for major projects. It is broken up into a number of research themes:

1) Network design technology enabling the linking and mutual operation of information-related devices and systems;
2) Technology for sophisticated processing integrating diagram, image and sound information with character information;
3) Technology enabling users to utilize different categories of dispersed data as if they were all the same; and
4) Technology to guarantee safety and forestall technical snags in pursuit of a highly reliable information system.

Clearly, the OSI project is different in intent from the drive to create a fifth-generation computer. It is not likely to trigger a wave of technological innovations. Nonetheless, the crucial technology involved will have a major impact on solving many of the fundamental problems of modern life. It is nothing short of the unifying infrastructure for an information-oriented society.

Machine translation and information handling in developing countries

In the advanced countries, information is already an indispensable resource for industry and society at large. In the developing world, however, this process of "informationalization" lags far behind. While developing countries recognize that information-related technology constitutes a basic resource essential to the full-scale take-off of their economies, they are plagued by shortages of trained human resources and know-how.

Many things can be done to remove these obstacles. But one of the approaches attracting the greatest attention in Japan today is the application of advanced information technology. In specific terms, this means the development of a

machine translation system to increase information flows to Japan's neighbors.

The aim of MITI's project in this area is to develop an automatic machine translation system for Japanese and the languages of China and the ASEAN countries. The program encompasses joint research with research institutes in the countries concerned, itself a stimulus to expanded technological and cultural exchange and mutual development.

Other aspects of the project are no less important. An indispensable prerequisite for this undertaking is the systematic study of each participating country's language. Thus, one feature of the program is the use of computer technology to approach the study of language, a theme with universal relevance and the potential to contribute immeasurably to international understanding.

The specific goals of MITI's research involve developing a machine-readable intermediate language into which all human languages can be rendered, and technology for automatically rendering different tongues into this intermediate language and out again. Personnel exchanges are already under way with universities and research institutes in China, Indonesia, Malaysia and Thailand. The project is already helping to promote office and factory automation in the partner countries, as well as contributing to the training of technicians and technology transfers. This new form of international cooperation through joint technology development with the developing world has only just begun. It may yet become the mainstream of technological cooperation in the future.

International cooperation and private-sector vitality

In the future it will become increasingly important to develop key technologies through the twin pillars of international cooperation and private-sector vitality. Indeed, success in this venture will sway the future fortunes of the world.

Today Japan and the U.S. are experiencing the unfortunate fruits of trade friction dating back many years. There were disputes over textiles and steel in the early 1970s and over home electric appliances in the late 1970s. Today tempers flare over high-tech products in communications, electronics and semiconductors. In the West, it is widely believed that Japan's competitive edge in manufactured products is the result of its quick commercialization of basic research results produced, and paid for, by the West. They feel growing frustration with what they perceive as Japan's free ride in technology, and emotions are rising, especially in the U.S.

One way for Japan to answer such criticism is to make clear its intention to contribute to the world in basic research, and to tell other countries clearly and positively what research projects are already under way. Japan should increase its exchanges of personnel and information regarding basic research with other advanced countries. Nor should it lag in its technological cooperation with developing nations. In these ways Japan can increase that crucial transparency in technological development, and especially information technology.

The ratio of government expenditures to total technological development funding in Japan is only about 25%, significantly lower than in most Western countries. It is urgently necessary to increase the government's share of R&D expenses. Realistically, however, austerity has been the keynote of the national budget in recent years, and is likely to remain so for some time to come. Conversely, however, Japan's private industry is exceptionally vigorous, and keenly interested in new technology. The future of technological innovation in Japan will depend greatly on the skill with which private-sector vitality can be applied to development efforts.

The Basic Technology Research Promotion Center, established in October 1985 with investment from a group of leading private corporations, seeks to channel private-sector vitality into basic research. The activities of the center deserve close attention and support. Already the center has helped capitalize promising new R&D companies in the field of information technology (Table 2). It should prove a potent force in promoting Japan's basic research in the years to come. ●