The Real World Computing Program: MITI's Next Computer Research Initiative

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The Fifth Generation Computer Project, which attracted so much attention in the United States, has now ended. Its successor is the Real World Computing Program (RWC), a new national research program funded by Japan's Ministry of International Trade and Industry (MITI) at a level of $500 million for the next 10 years. RWC has as its overall technical objective the development of flexible and advanced information technologies that are capable of processing a variety of diversified information (such as images, sounds, texts, patterns, and so forth). RWC emphasizes technologies that match the flexibility of human information processing capabilities such as pattern recognition, handling incomplete information, and learning, all of which are manifested in the way people solve problems in the real world.

The Fifth Generation Computer Project, which had been executed with a similar budget, officially ended in June after a 10-year period. In particular, the emphasis in RWC of flexibility has emerged from the need to overcoming the brittleness (that is, the inability to respond to new situations) of current artificial intelligence systems based on symbol manipulation and logic-oriented reasoning mechanisms on which its predecessor focused. Unlike the Fifth Generation Computer Project, RWC officially seeks international and interdisciplinary cooperation in actual research and considers it imperative that collaboration be established among industries, national research institutes, and universities. Furthermore, by not taking a monolithic approach such as was the "logic" approach in the Fifth Generation Computer Project, the new program will allow competition during the first 5 years among many ideas and proposals. RWC will take various approaches, and will select the research themes to be investigated in the second 5-year period following review by the RWC Evaluation and Promotion Committee.

Under the broad technical objective, the program is divided into five major research themes:

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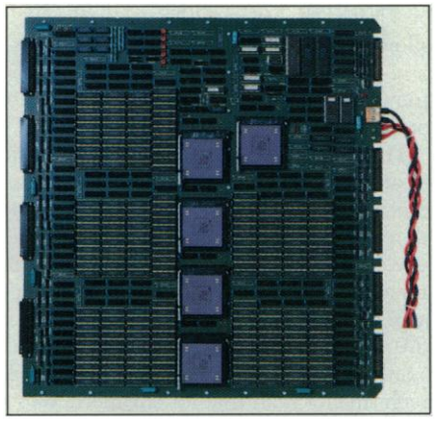
Theoretical foundations: This component will lay the theoretical foundations for flexible information processing, which has come to be known as Soft Logic. It will be a general framework for flexible statistical inference. The emphasis here is on problem solving by statistical and probabilistic approaches in conjunction with learning and self-organizational ones. Theories for pattern recognition, multivariate data analysis, probabilistic and statistical inference, neural computing, and machine learning will be deepened and unified.



Computing in the real world. This massively parallel processor, developed at the Electrotechnical Laboratory in Tsukuba, is the prototype for a new generation of computers to be developed by the Real World Computing Program.

Novel functions for applications: The goal here is to develop the technologies for the flexible information processing that conventional technology lacks in terms of robustness, openness, and real-time capability. Specific research goals include (i) establishing the schemes for flexible recognition and understanding of multi-modal information, including moving images, voices, texts, and gestures, and developing interactive information systems by which humans can communicate with such multi-modal information media, and (ii) developing flexible systems that are able to autonomously sense and understand and also control the environment through interactions with the real world.

Massively parallel computing: The purpose of this subproject is the development of prototype general-purpose massively parallel computer systems with 10,000 processing elements in the first phase, and if possible, systems with 100,000 to 1 million processing elements in the second phase. Operating systems, programming models and languages, and also programming environments for such systems will be developed. These systems are intended to provide the computing power needed for realizing the flexible information processing technologies.

Neural network systems: Here we wish to establish the technologies for large-scale neural systems, which include the development of new neural models, the development of hardware and software systems, and integration of these systems with the massively parallel systems discussed above.

Optical computing systems: This part of RWC aims at establishing basic technologies for (i) optical interconnection devices and networks, (ii) optical neural models, devices, and systems, (iii) optical logic devices, circuits, and digital systems, and (iv) advanced opto-electronic integrated circuits (ORIC) development environments.

Although the distribution of research funds among the above five themes has not yet been decided, it is expected that the following three theme groups will be equally funded: (g1) theoretical foundations and novel functions for applications, (g2) massively parallel systems and neural systems, and (g3) optical computing devices.

It is a fundamental policy that this program will promote international participation and collaboration. Although specific funding levels depend on the popularity of overseas participation, the prospective funding for overseas research activities is estimated to be at least 15% of the total budget [excluding optical computing research (*1*)]. Aside from the international joint research activities where no direct funding is involved, there are two modes of international participation.

One is through membership in the RWC partnership. The RWC partnership is the principal organization created for conducting the research program and it makes organizational decisions as well as technological ones. Its founding members are major Japanese computer and electronics industries. The members of the RWC partnership are the sole recipients of the research funding from MITI (except domestic national research institutes). Thus, overseas research bodies that become members of the RWC partnership can receive large amounts of funding and exercise considerable influence on the direction of the program. A large European research insti-

tution and other overseas research bodies have already expressed their intention to join the RWC partnership.

The other mode of international participation is to become research subcontractors of the RWC partnership. Potential subcontractors submit specific (3-year or 5-year) research proposals to the RWC partnership and they are screened through the standard review process conducted by the RWC evaluation committee. The request for proposals is being made public in October 1992 and the deadline for submission is the end of December 1992.

A facility to promote the international participation and collaboration is also being formed: The RWC international network. This global computer network allows European partners and subcontractors to use the computing facilities and databases for research information available at the RWC Research Center located in Tsukuba City. Although the level of access to the research information depends on the mode of participation and collaboration, this network is expected to accelerate the mutual exchange among the RWC partnership members and subcontractors international as well as domestic.

The major concern in allowing international participation and collaboration was how Japanese intellectual property right (IPR) law might affect the collaborations. In essence, the Japanese government committed itself to particular agreements stating that the international joint research related to industrial technology will benefit the foreign corporations. According to this commitment, it has become possible to reduce to zero or to a small amount the royalty of the patent rights and utility model rights that needs to be paid for the international joint research. The extent of the reduction is determined for each patent with an approval obtained from MITI. Furthermore, noncommercialized research-phase software and patents can be transferred to third parties with no restrictions. In fact, MITI made it clear that even the software developed for the Fifth Generation Computer Project was to be made available at no cost.

The RWC project is Japan's effort to contribute to basic science and technology for information processing, not to advance the country's own technology alone. The program is generously long-termed, very oriented toward basic research, and reasonably well funded. The project structure is internationally open as much as MITI possibly allows. The research goals and public stance are rather low-key and not inflated in contrast to the Fifth Generation Computer Project, but the success or failure of RWC will surely draw the attention of the world.

REFERENCES AND NOTES

1. Based on an interpretation of a 1988 U.S.–Japan science agreement that requires that large-scale international projects be coordinated through government channels, U.S. researchers can at present only participate in the optical computing fields through the coordination of the two governments, and cannot participate in any other parts of RWC.

Public and Private Support of Basic Research in Japan

Yukihiro Hirano

Basic research in Japan is characterized by increased efforts on the part of Japanese private companies but a generally poor research environment in the public sector.

Private companies' share of basic research expenditures in Japan has increased from 18% in 1978 to 39% in 1990 (*1*) (see figure), whereas the corresponding value for the United States was 20% in 1989 (*2*). It follows that any examination of Japanese basic research activities should pay due attention to the contributions of private companies.

The trend toward an increase in basic research undertaken by Japanese companies reflects a more general expansion of the relative importance of the research and development (R&D) activities of Japan's private sector. In 1978, the government's share of Japan's total R&D funding stood at 28.0% but, by 1990, this figure had dropped to only 16.5% of the total (*1*). This share is much smaller than that for advanced Western nations. For example, the government shares of R&D funding are 46.1% in the United States (in 1990), 49.9% in France (in 1988), 36.7% in the United Kingdom (in 1988), and 32.5% in West Germany (in 1990) (*3*). Although a large part of the gap is explained by the difference in defense-related R&D expenditures, even after taking this into account, Japan remains conspicuous for its low level of government funding of R&D.

The science and technology policy circle in Japan has taken these facts to support the idea that Japan's government investment in R&D falls short of the standards that should be adopted by a leading industrial country. They argue that an expansion of public sector spending on R&D and, in particular, basic research would be in the interest of the public.

Japanese companies have increased their own in-house basic research activities since about 1980. Expenditure on basic research, as a proportion of total R&D expenditure, increased from 4.6% in 1979 to 6.4% in 1990 (*1*). The corresponding ratios for Japan's Western counterparts are 3.9% in the United States (in 1990), 4.9% in West Germany (in 1983), 4.5% in France (in 1988), and 2.5% in the United Kingdom (in 1981) (*3*). Therefore, Japanese companies are more eager to pursue basic research than their counterparts in the advanced Western countries. As evidence of this trend, many Japanese companies have established new institutes for basic research since the middle of the 1980's. Big firms such as Hitachi and NEC constructed new facilities for basic research.

Why are Japanese companies so eager to conduct basic research? Corporate executives believe that fundamental knowledge is of increasing importance to their business. They are now trying to shift their business strategies away from low-profit, large-sales commodities towards high value-added commodities supported by advanced technologies. Future advanced technologies cannot be fully developed without a basic understanding of fundamental phenomena and of the working mechanisms of natural laws in the related areas. An increased awareness of the necessity of such basic understanding for development of advanced technologies has forced Japanese companies to try to gain this understanding through in-house basic research.

Yet, however eager Japanese companies become to pursue basic research, Japan cannot rely totally on private companies to produce the nation's basic scientific knowledge. Research targets and the openness of research activities will be restricted by business operating requirements. Private sector research inevitably involves commercial restraints which can, on occasion, compromise creativity. By contrast, public sector research can provide for more open-ended projects that will support tomorrow's technologies.

According to a survey conducted by the Science and Technology Agency of Japan (STA), Japanese researchers themselves view Japan as being inferior to the United States but as nearly equal to Western Eu-

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