electronics industries. The first was the VLSI project from 1976 to 1980, a period that coincided with Japan's surge of influence in that branch of microelectronics. Another of these national projects—in optoelectronics and optical communications—concerned another field in which Japan is now a leader. Often in such programs the MITI money is matched by a company many times over.

Shoji Tanaka, who presided over the VLSI project, was asked in 1988 to help direct a new MITI project in response to the discovery of high-temperature superconductivity—the International Superconductivity Technology Center. (See the article by Shoji Tanaka in PHYSICS TODAY, December 1987, page 53.) ISTEC's main mission—to conduct its own studies of the field—is carried out at its Superconductivity Research Laboratory, which Tanaka directs.

ISTEC is supported largely by 46 industrial firms, which have each paid an initial fee of 100 million yen (about $700 000) and annual dues of 12 million yen (about $86 000) to be full supporting members. So far all supporting members are Japanese, despite invitations to foreign companies. These full members each send two of their scientists and engineers to the research facility for several years. The work done at ISTEC is limited to basic technologies, far from commercialization, so issues involving property rights are minimized. Any patents that do result will be shared by ISTEC and the company whose employee was involved. Of the technical staff of 87 now at the Superconductivity Research Laboratory, 12 hold PhDs and 41 have earned master's degrees. Because they are so young, Tanaka feels they are flexible and mix easily. One scientist told us he values his time at ISTEC, where he can do more fundamental work than at his home base.

In addition to the full-support members ISTEC has attracted 67 firms, including nine foreign companies, as ordinary-support members. They pay 2 million yen both initially and annually to gain access to both information and symposia sponsored by ISTEC.

Tanaka outlined for us the work done in each of the six divisions, one of which is located in Nagoya. The organic superconductor group consists of Tanaka and three colleagues he brought with him from the University of Tokyo.

ERATO: Exploratory research

While ISTEC and other MITI-sponsored programs pool the resources of industry to stimulate research with commercial potential, other government-sponsored research programs in Japan are taking steps down less traditional paths in an effort to foster more creative and interdisciplinary research. One such program, called Exploratory Research for Advanced Technology, assembles teams of about 15–20 researchers to pursue five-year projects that are open ended, with no stated "deliverables." Some of the projects involve higher risks than industry would normally accept. Often the projects are interdisciplinary—an approach that counters the vertical structure of most Japanese companies. While most ERATO participants come from industry, some are from the universities so the projects enhance communications between two groups that in Japan traditionally have remained relatively isolated from each other. (Professors at national universities, for example, are government employees and not allowed to consult for industry.)

In Tokyo, PHYSICS TODAY chatted with Genya Chiba, who directed ERATO from its inception until recently and who is also a vice president of its sponsor, the Research and Development Corporation of Japan (JRDC). (Since our visit, Isao Usui has succeeded Chiba as ERATO's director.) JRDC is a statutory corporation of the Japanese government that was created in 1961 by the Science and Technology Agency to foster technology transfer from academia to industry and to establish stronger links between them. JRDC in turn founded ERATO in 1981. A similar effort—the Frontiers Research Project—was initiated in 1986 by RIKEN, an institute for physical and chemical research that also falls under STA. Although ERATO commands about half of JRDC's annual budget of roughly $70 million, its projects are not on the scale of MITI's.

About half of ERATO's projects have been directed toward physics and the other half toward biology. Several of the initial projects, such as ultrafine particles (see the article by Chikara Hayashi in PHYSICS TODAY, December 1987, page 44), perfect crystals, and amorphous and intercalation compounds, dealt largely with materials science. In reviewing the intercalation compounds project as part of a JTEC evaluation of ERATO in 1988, John Rowell (Conductus Inc) noted that it gave Japanese researchers valuable experience in materials synthesis techniques, a mastery of which is largely absent in the US.

The physics-related ERATO projects

Welcome mat for foreign scientists

Until recently, only a handful of American scientists and engineers had ever been to Japan for research stays longer than three months. Yet, on a recent trip to Japan, PHYSICS TODAY found that scientists at ETL, ISTEC and ERATO were all eager to involve US researchers in their programs. They pointed to a number of programs that support visiting scientists from abroad. Kazunobu Tanaka at ETL believes that young US postdocs, with their energy and initiative, set a very positive example for their Japanese counterparts. ERATO's overseas representative Alan Engel told us that ERATO aims to have the strong mix of cultures that seems to characterize the best and most creative labs worldwide. ERATO's goal is to have about 30% participation by foreign scientists, and by August the program will have nearly 30 foreign participants among its approximately 180 researchers, with 7 coming from the US. So far US researchers have not exactly flocked to these exchange programs, apparently because they are deterred to some extent by language and cultural barriers and by the professional risk of spending a year or more in Japan before finding permanent employment.

Beginning in 1988, the National Science Foundation, in cooperation with Japan's STA, Monbusho and the Ministry of Foreign Affairs, began offering 60 postdoctoral research positions each year in Japan, and additional support for more senior researchers. In the last two years, NSF has nominated more than 100 US researchers for those programs. Recently the number of US scientists going to Japan each year has sharply increased, but many more could be supported, according to Douglas McNeal, an international analyst at NSF. To enable physicists and other scientists from the US to interact more easily with Japanese researchers, NSF also offers support for study of the Japanese language. In addition, this year for the first time NSF and its Japanese counterparts are sending 25 US graduate students to Tsukuba for a summer program that combines language study with research in one of the national labs there. Both NSF and the hosting Japanese agencies hope thereby to foster long-term cooperation between the summer interns and their Japanese colleagues.

—BARBARA GOSS LEVI