1985 has run full course, and has had a highly favorable impact on the economy after an initial period of shock and adjustment. But it is also true that Japan today is beset with problems of great magnitude, and one is the growing shortage of young workers as the population ages.

Improved productivity in the manufacturing sector has brought down the prices of many products, but increasing costs in the labor-intensive services sector is creating distortions in the price system. Medical costs continue to rise. A new generation—the so-called *shin-jinrui*, or new breed—is seeking out new values, creating a generation gap vis-à-vis its elders. In time, these and other developments could sap Japan's economic vitality. A heavy burden lies on information technology as one of the tools for keeping open potential bottlenecks in the economy.

In education, computers with artificial intelligence will have a revolutionary impact. In medicine, AI-based computerized testing and examination systems can greatly increase diagnostic efficiency, and substantially reduce costs. Information technology can aid in childcare and other essential household work, making it easier for more and more housewives to enter the job market as the shortage of young male workers grows.

It has often been pointed out that Japanese society is remarkably open to technological innovation. Take industrial robots, for example. Although these robots were developed in the United States, Japan now accounts for 70% of the world robot population. Japanese production line workers regard robots not as enemies but as friends, faithful and untiring assistants who perform hard, dangerous and complicted tasks on their behalf.

Indeed, new forms of information technology infused with artificial intelligence will be used increasingly, not only in our place of work but in our homes as well. Artificial intelligence will play an essential role in building a more affluent Japanese society for tomorrow.

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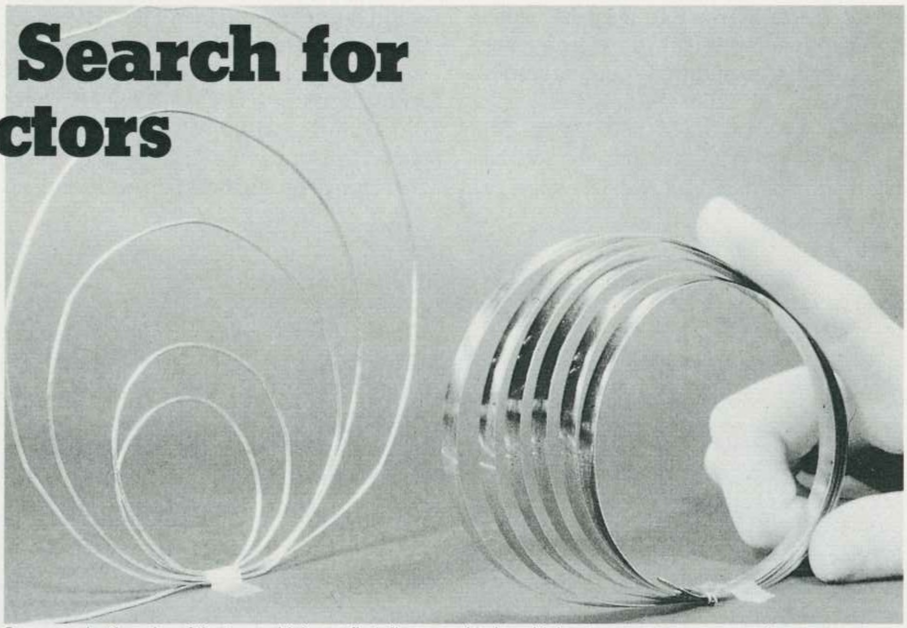
Leading the Search for Superconductors

By Shoji Tanaka



Superconductive wire of the type which was first discovered to be a higher-temperature superconductor.

A remarkable change has come over technology. Once a tool for human endeavors, technology has now become a powerful force shaping society itself. The remarkable technological advances of recent years have triggered the reform of industrial structure, and are even tipping the international balance of power.

Today the whole world recognizes that the true strength of a nation lies in its economic power rather than in its military power. And increasingly, the decisive determiner of economic strength is a country's ability to develop new technologies, and to cultivate the new markets they generate. At a time when the developing countries are entering markets heretofore dominated by the advanced industrial nations, and "deindustrialization" has become an issue of real concern for many of the world's economic leaders, it is no exaggeration to say that the future of the world will be shaped by the success or failure of the R&D in progress now and in the near future, and by the markets resulting from these efforts.

For Japan, these developments pose both threat and promise. Today Japan's ability to generate creative new technology is growing rapidly, and the importance of R&D is a moot point. But even more than that, the new tide of technology offers Japan a great opportunity to at long last make a significant contribution to the rest of the world. The time has arrived for technological cooperation.

From the 1960s through the first half of the 1970s, the greater part of Japan's efforts in technology development was devoted to catching up with the advanced countries. From the second half of the 1970s on, however, that orientation shifted toward the future with the start of the now-famous "Very Large-Scale Integration" project. Beginning in 1976 and ending in 1980, this project played a significant role in enhancing information technology throughout the world.

International phase

With the fifth-genertion computer project launched in 1980 and numerous other projects undertaken since then under MITI's next-generation substrate technology development system, Japan's technology development efforts have entered a new, international phase. From the very beginning, these projects anticipated internationl cooperation. Many foreign researchers are already participating in the next-generation computer project, and others have been invited to take part in the discussions about projects related to next-generation substrate technology at annual workshops. Research results, too, are made public once a year.

Clearly, the nature of the Japanese government's national research projects has changed dramatically over the past 30 years. They have gone from efforts to catch up with the advanced countries in conventional technologies to future-oriented projects designed to independently develop original technologies. Moreover, they have evolved into international cooperative undertakings oriented toward basic science and technology. The fact that the average length of these projects has been extended from some four years in the 1960s to 10 years today is further proof that Japanese research programs are increasingly oriented toward basic technologies. This metamorphosis might well be regarded as an expression of Japan's new sense of mission and its conviction that it must contribute to the future of the world through the development of new technologies.

Japanese companies normally take part in these technology development projects. Yet it is not as easy to enlist the cooperation of these companies as foreign countries imagine. This is because they are engaged in furious competition vate sector participation, project coordiamongst themselves—some of the most furious in the world. When enlisting prinators must pay close attention to the "harmony" of collaboration and competition. Contrary to what many think, Japanese companies' collaboration in these R&D projects is strictly limited to so-called pre-competitive areas.

The HSST, a magnetically levitated train now officially approved for passenger transportation

Sign of commitment

Japan's national research projects have continued to evolve as has the nation's own role in the world at large. Today they have become important expressions of Japan's commitment to contributing to the world in science and technology. A case in point is superconductivity.

In early 1986, scientists in Switzerland discovered the phenomenon of superconductivity taking place at temperatures higher than the normal transition temperature. At the time, the discovery did not attract worldwide attention. But when the presence of superconductivity in ceramics at higher than normal temperatures was confirmed in Japan in December of the same year, it ignited a superconductivity fever which swept the world. For two years there was a frantic race to discover new superconductive materials. Today the fever has subsided somewhat, but now a new race is in the offing to commercialize superconductivity technology using liquid nitrogen.

Three kinds of compounds are now attracting attention as superconducting materials: a compound using yttrium with a transition temperature of minus 181 degrees C, a compound using bismuth (minus 163 degrees C), and a compound using thallium (minus 148 degrees C). All these transition temperatures are higher than that at which superconductivity occurs in liquid nitrogen, minus 196 degrees C The yttrium compound's transition temperature is relatively low, while the bismuth and thallium compounds are somewhat hard to handle, and it is not yet known which if any will be the most suitable. It may be noted that the yttrium and thallium compounds were discovered in the United States, and the bismuth compound was discovered in Japan.

There are three broad trends in superconductivity R&D today:

(1) The search for new materials with higher transition temperatures;

(2) Precise physical experiments aimed

at structuring a theory of higher temperature superconductivity; and

(3) Commercializing already known superconductive materials.

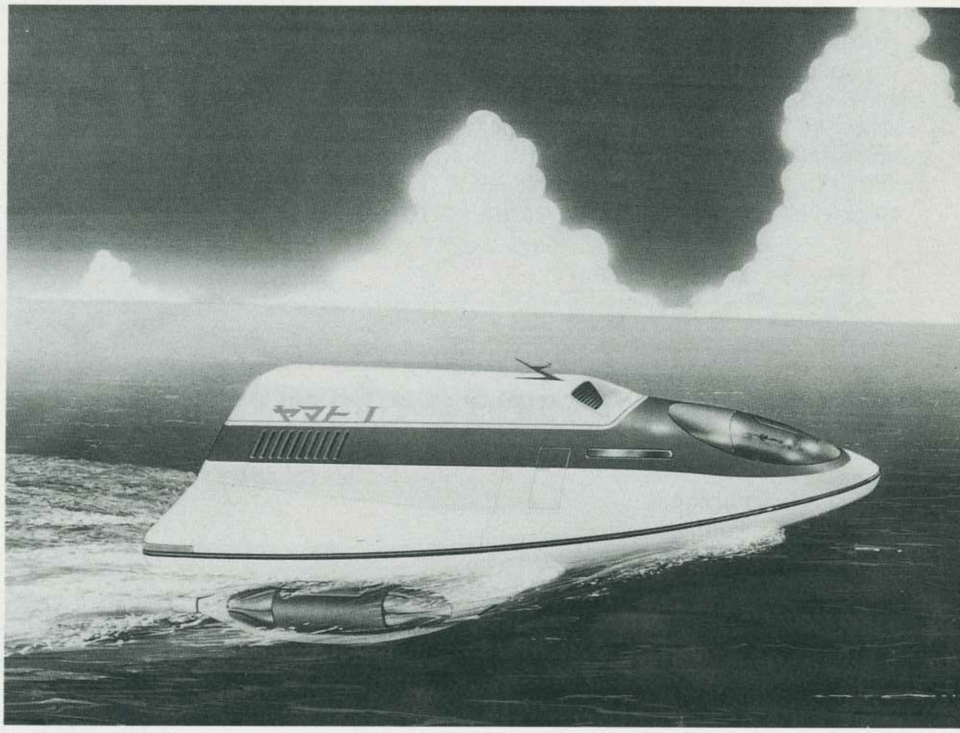
It is the third area of research which has excited the greatest interest. Higher-temperature superconductors have promising applications in electronics and electric power, and transportation. To be useful in electronics, the materials must be processed into a thin, high-quality film, while electric power and transportation applications require superconducting wire or tape with outstanding properties. The film must have critical current density of more than 10^6amp/cm^2, and the wire and tape about 10^6amp/cm^2.

Attaining targets

There have been many published reports of thin films meeting the target values. Therefore, development efforts will be evolved into the phases necessary to improve their compatibility with substrates. The barrier in superconducting wire and tape research is the difficulty of further increasing the critical current density. A tape sheathed in silver is reported to have attained 10^4amp/cm^2, but more development efforts are required. Nonetheless, the pace of progress has been much faster than originally anticipated, and some feel the critical target values can be obtained within the next several years.

There are also a broad range of applications for superconductivity in liquid nitrogen. It can be applied to magnetically levitated trains and to superconductive magnetic ships. More sophisticated and larger in scale are the potential applications in electric power storage systems. Liquid nitrogen superconductivity can also be used in electronics. Examples include SQUID devices, which are sensors using extremely sensitive magnetic fields, superconductive transistors, and substrate-mounted circuits for electronic devices.

When the superconductivity fever infected Japan, electronics, electric power, steel and auto companies all rushed to start researching the phenomenon. The concerned government agencies were quick to act as well. The Science and Technology Agency and MITI inaugurated a research group and a research committee in February and March 1987, respectively. The Education Ministry moved to extend the period for research on development of new superconducting materials under its own research framework. STA launched a so-called multicore project in fiscal 1988 to conduct research on higher-temperature superconducting materials, while MITI finally initiated its long-pending "superconductive power generator" project, together with a "superconducting element" development project. In the meantime, with MITI's approval, the International Superconductivity Technology Center (ISTEC) was established to serve as an international base for research and development of superconducting materials.


A superconductive electromagnetic propulsion ship planned by a Japanese semigovernmental organization

The most distinctive feature of Japan's superconductivity projects is their unprecedented commitment to international cooperation. This is in line with the spirit of a report submitted to the Science and Technology Council in October 1987 at the request of then-prime minister Yasuhiro Nakasone, which asserted that higher-temperature superconductivity is a common asset of all mankind. Another striking feature of the current projects is the equal opportunity accorded all participating enterprises, whether Japanese or foreign.

Biggest in research

ISTEC is an important part of this effort. ISTEC holds an international symposium and/or workshop every year to exchange information. Moreover, it surveys future technology forecasts, and widely publicizes the survey results.

The biggest feature of ISTEC, however, is its affiliated Superconductivity Research Laboratory, in which foreign enterprises are allowed to participate on the same terms as Japanese companies. At present, 46 Japanese companies are using the lab. Established in October 1988, it is already the largest facility of its kind devoted to superconductivity research, with a staff of about 100. At present, no foreign company is taking part, but the laboratory has received numerous inquiries from foreign enterprises, and now that principles have been established for handling intellectual properties, foreign enterprises are expected to join in the near future. The research lab also accepts researchers from foreign universities and state research institutes, and has already decided to accept two American and one British researchers.

Japan's research and development work in basic technologies is becoming increasingly fundamental, long-term and international in nature. The day is fast approaching when Japan will be in a position to make a big contribution to world prosperity in the 21st century.

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Rise of Biotechnology

By Satoshi Kusakabe

The industrial utilization of bacteria and plants is nothing new, dating back in some cases for hundreds of years. But there has been an explosion in new applications since the development of recombinant DNA technology in 1973. Today a high-tech biotechnology industry produces a whole spectrum of products, from pharmaceuticals and food to cosmetics, reagents and amino acids.

Japan's Ministry of International Trade and Industry has closely followed the rise of Japan's biotechnology industry. Since 1981 biotechnology has been a priority item on MITI's agenda. Now the ministry has drawn up a new policy that will help govern Japan's biotechnology efforts far into the future.

Taking root

Aside from traditional applications of fermentation technology and other embryonic biotechnology techniques, industrial biotechnological research and development work really began in Japan in the early 1980s. Many organizations and corporate research laboratories hopped onto the biotechnology bandwagon in these early days, generating wide-ranging basic research and leading to the first commercial biotechnology products.

MITI was well aware of these developments, and established a number of policies to help the budding biotechnology industry take root in Japanese soil. Major MITI programs included the "Next-generation Industrial Infrastructure R&D" system, which launched projects into recombinant DNA and other areas of biotechnology in 1981. These early research projects proved a catalyst that stimulated independent R&D efforts throughout Japan.

As the technology itself took shape. MITI's policy focused on the more practical matter of establishing a viable Japanese bioindustry. In 1986, the ministry drew up industrialization guidelines for recombinant DNA technology that put in place the safety standards essential for building up industrial infrastructure in this new field. As a direct result of this ground-laying work, recombinant DNA technology began finding its way into people's daily lives in the form of detergents, cosmetics, amino acids, reagents, enzymes and other products.

By the autumn of 1986, Japan was ready for its first biotechnology fair. Held in Tokyo, the event provided an international forum for the exchange of information and ideas in this rapidly evolving field, and proved so successful that a number of Japanese industries established the Bioindustry Development Center (BIDEC) the following year. The nonprofit BIDEC promotes both international exchange in biotechnology and supports the new industry.

Yet all that has been done so far is only a beginning compared with the full potential of this new industry. Since the turn of the year MITI has adopted a new strategy for biotechnology designed to position this increasingly growing technology and industry as a valuable part of Japanese society, compatible with both human beings and the environment.

In specific terms, this policy calls for ensuring that the broad range of biotechnology products now under development will contribute in a meaningful way to bettering the lives of the people. At the same time, the ministry is committed to furthering the exploration of this field, one of the last great frontiers left to mankind, through increased basic research. The new policy was formulated, moreover, with an awareness of the need for Japan to contribute more to international society and to preserving the global environment.

Today environmental problems—be they pollution on a global scale or waste materials crossing national borders—are being seen from a new perspective that has cast new light on industrial activity and its impact on the global environment. Values are changing at the private sector level, not in the sense of abandoning such old values as efficiency and convenience,