Through gift, theft and license, our technology is leaking abroad almost as fast as we develop it. So scratch the long-term dream of a U.S. living off exports of high-technology goods and services.

Does anyone really believe in free trade?

By Norman Gall

NEVER MIND if the U.S. loses its manufacturing skills; we'll just import manufactured goods and pay for them by exporting high technology and knowledge-oriented products. Steel in, software out. Autos in, microchips out.

That's a comforting theory held by a lot of people. Is it workable? Increasingly it looks as if it is not workable. The whole concept is being seriously undermined as U.S. innovations in technology are adopted not only by Japan but also by such fast-developing countries as South Korea, Brazil, Taiwan, even India.

While these countries are more than happy to sell us manufactured goods, they closely control their own imports of technology goods they buy from us. Exports of computers and other high-technology products from the U.S. are still huge, but the long-term prospects are in question. In areas of medium technology, minicomputers in particular, developing countries are adapting or stealing U.S. technology or licensing it cheaply to manufacture on their own. Many of the resulting products are flooding right back into the U.S.

The Japanese developed this policy to a fine art: Protect your home market and then, as costs decline with volume, manufacture for export at small marginal cost. A good many developing countries have adopted the Japanese technique.

Against such deliberate manipulation of markets, what avails such a puny weapon as currency devaluation? Whether the dollar is cheap or dear is almost irrelevant. Free trade is something we all believe in until it clashes with what we regard as vital national economic interests.

These are the broad trends. Now meet Touma Makdassi Elias, 41, an engineer born in Aleppo, Syria. Elias has a master's degree in computer science from San Jose State, in Silicon Valley, and a doctorate from the Cranfield Institute of Technology in England. Grounded in European and U.S. technology, Elias is now a Brazilian.

His company, Microtec, is Brazil's first and biggest producer of personal computers. Elias came to São Paulo eight years ago to teach night classes in engineering. In 1982 the Brazilian government banned imports of small computers. Seizing the opportunity, Elias started making the machines in the basement of a supermarket in the industrial suburb of Diadema.

Technology? "We worked from IBM technical manuals," Elias told FORBES. "We had a product on the market by 1983. We started making 20 machines a month. Soon we'll be making 2,400. Now my brother may be joining our firm. He's a graduate of the Sloan School of Management at MIT. He's been managing an investment company in Dubai, in the Persian Gulf, but we need him here. Brazil is one of the world's fastest-growing computer markets."

There you have it in a nutshell: foreigners, some of them U.S.-educated, copying—stealing, to be blunt—U.S. technology and reproducing it with protection from their own governments. An isolated development? No, this is the rule, not the exception, in much of the world. How, under such circumstances, can the U.S. expect to reap the fruits of its own science and technology?

Time was when technology spread slowly. Communications were sluggish and nations went to great lengths to keep technological innovations secret. In northern Italy 300 years ago, stealing or disclosing the secrets of silk-spinning machinery was a crime punishable by death. The machines were reproduced in England by John Lombe only after he spent two years at risky industrial espionage in Italy. At the height of the Industrial Revolution, Britain protected its own supremacy in

textile manufacture through laws banning both exports of machines and emigration of men who knew how to build and run them.

These embargoes on the export of technology were eventually breached. France sent industrial spies to England and paid huge sums to get British mechanics to emigrate. By 1825 there were some 2,000 British technicians on the European continent, building machines and training a new generation of technicians. A young British apprentice, Samuel Slater, memorized the design of the spinning frame and migrated to the U.S. in 1789, later establishing a textile factory in Pawtucket, R.I. So, in the end, the technology became commonplace, but it took decades, and, in the meantime, England was profiting handsomely from its pioneering.

Not so today, when 30% of the students at MIT are foreigners, many destined to return to their native lands and apply what they learn of U.S. technology. What once was forbidden, today is encouraged. Come share our knowledge.

Consider the case of Lisiong Shu Lee, born in Canton, China in 1949, raised in Rio de Janeiro, now product planning manager for SID Informatica, one of Brazil's big three computer companies. Like many leading Brazilian computer technicians, Lee is an engineering graduate of the Brazilian air force's prestigious Aerospace Technical Institute near São Paulo. Born in China, raised in Brazil, educated in the U.S. "When I was only 24," Lee says, "I was sent to the U.S. to debug and officially approve the software for the Landsat satellite surveys devised by Bendix Aerospace." Lee later worked eight years with Digital Equipment's Brazilian subsidiary.

Like Microtec's Elias, Lee had learned most of what he knew from the Americans. In teaching this pair—and tens of thousands like them—U.S. industry and the U.S. academies created potential competitors who knew most of what the Americans had painfully and expensively learned. Theft? No. Technology transfer? Yes.

In Brazil over the past few years, the Syrian-born, U.S.-educated Elias played cat-and-mouse with lawyers representing IBM and Microsoft over complaints that Microtec and other Brazilian personal computer makers have been plagiarizing IBM's BIOS microcode and Microsoft's MS-DOS operational software used in the IBM PC. The case was settled out of court. Brazilian manufacturers claimed their products are different enough from the original to withstand accusations of copyright theft.

Where theft and copying are not directly involved in the process of technology transfer, developing countries find ways to get U.S. technology on terms that suit them. They get it cheaply. Before President José Sarney departed for his September visit to Washington, the Brazilian government tried to ease diplomatic tensions by announcing approval of IBM's plans to expand the product line of its assembly/test plant near São Paulo. IBM will invest $70 million to develop Brazilian capacity for producing the 5-gigabyte 3380 head disk assembly (HDA).

Ah, but there is a tradeoff involved in the seeming concession by the Brazilians. The tradeoff is that IBM's expansion will greatly improve the technical capabilities of local parts suppliers to make a wider range of more sophisticated products. About a third of the key components in IBM's HDA catalog will be imported, but Brazilian suppliers will get help in providing the rest, some involving fairly advanced technologies.

But does what happens in Brazil matter all that much? Brazil, after all, is a relatively poor country and accounts for a mere $3 billion in the U.S.' $160 billion negative trade balance. Brazil matters very much. For one thing,

Photos by Paulo Fridman/Sygma

Microtec's personal computer factory in São Paulo
Designs cribbed from IBM technical manuals, but different enough to withstand accusations of copyright theft.

Mictrotec founder Touma Makdassi Elias
From Syria to São Paulo via Silicon Valley.

Newsstand in São Paulo
Plenty of reading choices for computer hackers, too.

what happens there happens in similar ways in other developing countries—and some developed ones as well. Brazil, moreover, is fast adapting to the computer age. The Brazilian computer industry employs over 100,000 people. It includes everything from the gray market of São Paulo's Boca de Lixo district to the highly profitable overseas subsidiaries of IBM and Unisys. Both subsidiaries have been operating in Brazil for more than six decades and, for the time being, have been profiting from Brazil's closed-market policies. It includes many manufacturer/assemblers of micro- and minicomputers and of peripherals. Companies also are appearing that supply such parts as step motors for printers and disk drives, encoders, multilayer circuit boards, high-resolution monitors, plotters and digitizers. The Brazilian market is bristling with new computer publications: two weekly newspapers, ten magazines and special sections of daily newspapers.

Brazil is only a few years into the computer age. Its per capita consumption of microchips works out to only about $1.40 per capita among its 140 million inhabitants, vs. $100 in Japan, $43 in the U.S. and about $6 in South Korea. But given the potential size of the market and Brazil's rapid industrialization, it could one day absorb more personal computers than France or West Germany.

The point is simply this: In their natural zeal to make Brazil a modern nation rather than a drawer of water and hewer of wood, its leaders are determined to develop high-technology industry, whether they must beg, borrow or steal the means. Failing to develop high-technology industry would be to court disaster in a country where millions go hungry. But in doing what they must, the leaders of Brazil and other developing countries run strongly counter to the economic interests of the U.S.

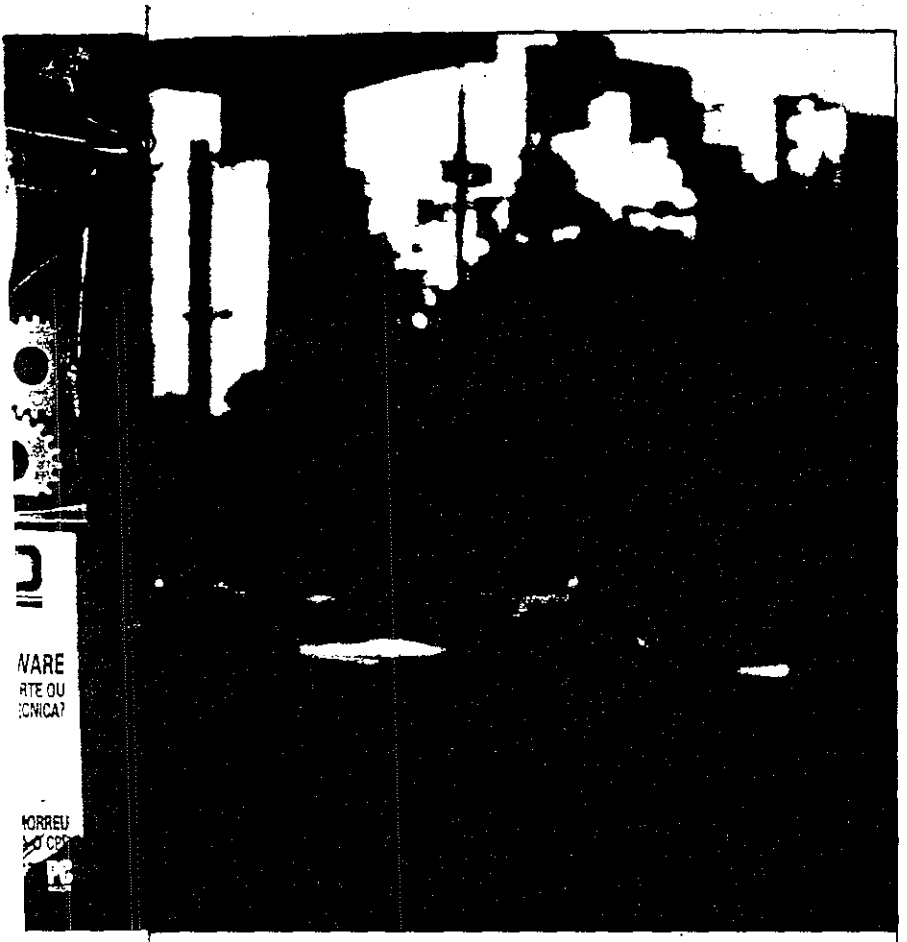
Because of these nationalistic policies, foreign-owned firms are banned from competing in Brazil's personal computer and minicomputer market. Brazil's computer industry is not high tech, if that means being near the cutting edge of worldwide technological advance. But it does show the ability of Brazilian businessmen and technicians to shop for and absorb standard technology, without paying development costs. In computers, where knowledge is the most expensive component, it becomes cheap to manufacture if you get the knowledge free or almost free. The U.S. develops, Brazil copies and applies. There are perhaps a dozen Brazils today.

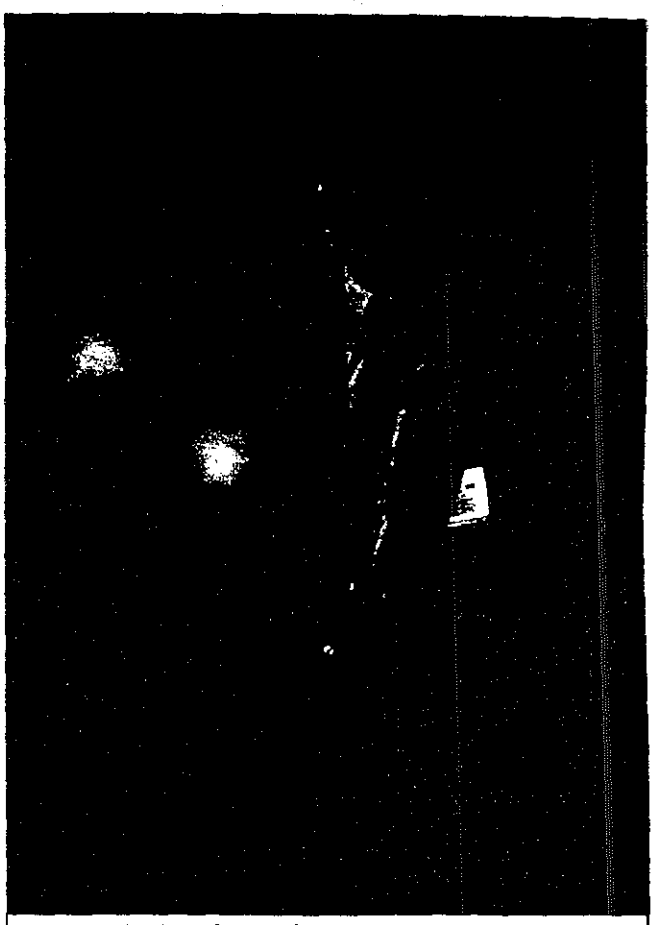
"We're a late entry and can pick the best technology," says Ronald Leal, 36, co-owner of Comicro, a CAD/CAM equipment and consulting firm. "We don't waste money on things that don't work. In 1983 we saw a market here for CAD/CAM done with microcomputers. We shopped around the States and made a deal with T&W Systems, a $10 million California company that has 18% of the U.S. micro CAD/CAM market. T&W helped us a lot. We sent people to train and they came to teach us."

Comicro learned fast. Says Leal: "We developed new software applications that we're now exporting to T&W."

Brazil exporting computer designs to the U.S.? Only five years after IBM began creating a mass market for the personal computer, the U.S. home market is being invaded by foreign products—of which Comicro's are only a tiny part. Technological secrets scarcely exist today.

Aren't the Brazilians and the others simply doing what





Lisiong Shu Lee of SID Informatica
Theft? No. Technology transfer? Yes.

the U.S. did a century and a half ago—protecting its infant industries?

If that were all, the situation might not be so serious for the U.S. But pick up any U.S. newspaper these days and count the advertisements for Asian-made personal computers claiming to be the equivalent of the IBM PC but selling at maybe two-thirds of IBM's price.

According to Dataquest, a market research firm, Asian suppliers will produce nearly 4.5 million personal computers this year. At that rate, they should capture one-third of the world market by next year. Taiwan now is exporting 60,000 personal computer motherboards and systems monthly, 90% of which are IBM-compatible. Of these, 70% go to the U.S. and most of the rest to Europe. Korea, Hong Kong and Singapore together ship another 20,000 each month.

Dataquest says it takes only three weeks after a new U.S.-made product is introduced before it is copied, manufactured and shipped back to the U.S. from Asia.

Thus the U.S. bears the development costs while foreigners try to cream off the market before the development costs can be recouped. That is the big danger. The days when a person could be executed for industrial espionage are gone.

President Reagan recently warned that the U.S. is being victimized by the international theft of American creativity. Too many countries turn a blind eye when their citizens violate patent and copyright laws. In 1985-86 U.S. diplomats successfully pressured Korea, Singapore, Malaysia, Taiwan, Hong Kong and Thailand to pass or at least to draft legislation enforcing patents and copyrights more strictly. Brazil is a major holdout.

The difficulties between Brazil and the U.S. over computers crystallized in the 1984 Informatica law, which Brazil's Congress passed overwhelmingly near the end of two decades of military rule. The law, in effect, legalizes stealing—so long as the victims are U.S. technology exporters. Complains the head of a leading multinational whose business has been curtailed under the new law: "They want our technology but want to kill our operations. This whole show is sponsored by a handful of sharp businessmen with connections in Brasília who are making piles of money from their nationalism."

The new law formally reserved the Brazilian micro- and minicomputer market for wholly owned Brazilian firms. It allowed wholly owned subsidiaries of foreign companies—IBM and Unisys—to continue importing, assembling and selling mainframes, but not out of any sense of fairness. It was simply that Brazilian companies were unable to take over that end of the business.

Under the law, joint ventures with foreign firms were allowed only if Brazilians owned 70% of the stock and had "technological control" and "decision control."

The main instruments for implementing this policy were tax incentives and licensing of imports of foreign hardware and knowhow, all to be approved by the secretariat of information science (SEI).

In 1981 Brazil's then-military government decreed that SEI would control the computer and semiconductor industries and imports of any and all equipment containing chips. The implications are especially ominous for U.S. interests: Brazil's SEI is modeled, quite openly, on Japan's

notorious Ministry of International Trade & Industry (MITI). Brazil's computer policy today follows the line of a mid-Fifties report by MITI's Research Committee on the Computer.

In the 1950s and 1960s MITI used Japan's tight foreign exchange controls to ward off what its nationalist superbureaucrat of the day, Shigeru Sahashi, called "the invasion of American capital." In long and bitter negotiations in the late Fifties, Sahashi told IBM executives: "We will take every measure to obstruct the success of your business unless you license IBM patents to Japanese firms and charge them no more than 5% royalty." In the end, IBM agreed to sell its patents and accept MITI's administrative guidance on how many computers it could market in Japan. How many Japanese products would be sold in the U.S. today if this country had imposed similar demands on the Japanese?

Some U.S. economists are describing the result of the Japanese policy as the "home market effect." They mean that protectionism in the home market tends to create an export capability at low marginal cost.

"Home market protection by one country sharply raises its firms' market share abroad," says MIT's Paul Krugman, reporting the results of computer simulations of international competition in high technology. "Perhaps even more surprising, this export success is not purchased at the expense of domestic consumers. Home market protection lowers the price at home while raising it abroad."

Brazil surely has similar intentions. IBM and other U.S. computer companies are transferring technology to Brazil as never before.

The Brazilians may have grasped a reality that the U.S. has been unable politically to address: that while there is no way to check the fast dissemination of technology today, the real prize in the world economy is a large and viable national market—a market big enough to support economies of scale and economies of specialization. In short, while a country can no longer protect its technology effectively, it can still put a price on access to its market. As owner of the world's largest and most versatile market, the U.S. has unused power.

Taiwan, Korea, Hong Kong and Singapore, lacking large internal markets, could develop only because they had easy and cheap access to the rich U.S. market.

Why doesn't the U.S. reciprocate? The Reagan Administration has threatened to restrict imports of Brazilian exports to the U.S. by Dec. 31 if Brazil doesn't 1) protect software with new copyright legislation, 2) allow more joint ventures with foreign firms, and 3) publish explicit rules curtailing SEI's arbitrary behavior.

But the Brazilians are hardly trembling in their boots. Brazilian officials hint that if Brazilian exports to the U.S. are curbed, Brazil won't be able to earn enough dollars to service its crushing external debt. Diplomats of both countries want to avoid a showdown, so they keep talking. And while they talk, the Brazilians do what they please.

U.S. Customs has responded to manufacturers' complaints by stopping pirated products at the border. But the Taiwanese now have such cost advantages that they can easily afford to license technology that they have already copied. The Koreans are more scrupulous, but pirated technology not reexported to the U.S. is very hard to control.

More than three years ago Edson de Castro, president of Data General, told a Commerce Department panel that foreign nations' computer policies "threaten the structure and future of the U.S. computer industry." De Castro explained why: "U.S. computer companies are reliant on international business and derive a substantial portion of revenues from exports. Because of the rapid pace of technological development, the industry is capital intensive. Growth and development rely heavily on an expanding revenue base. This can only come from full participation in established and developing global markets. Reliance upon domestic markets is not enough."

Yet after resisting the Brazilian government's demands for a decade, de Castro's Data General is selling technology for its Eclipse supermini to Cobra, the ailing government computer company. Other U.S. computer manufacturers are following suit.

Hewlett-Packard, in Brazil since 1967 with a wholly owned subsidiary to import and service the company's products, has just shifted its business into partnership with Iochpe, a Brazilian industrial and finance group. A new firm, Tesis, 100% Brazilian-owned, will make HP calculators and minicomputers under its own brand name.

"Only a few years ago HP refused to enter joint ventures, but now we have ones going in Mexico, China, Brazil and Korea," says a company executive. "In the past we felt, since we owned the technology, why share the profits? Then we found we couldn't get into those foreign markets any other way."

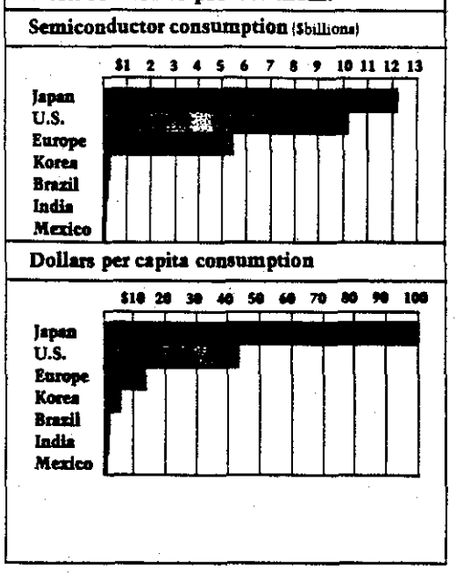
Harvard Professor Emeritus Raymond Vernon, a veteran analyst of international business, says of world technology markets: "Except for highly monopolistic situations, the buyer has a big advantage over the seller. Countries like Brazil and India can control the flow of technology across their borders and then systematically gain by buying technology cheaply."

Vernon draws an ominous parallel: "A century ago the multinationals were in plantation agriculture and electric power. Now they're all gone because their technology and management skills were absorbed by local peoples. The same thing is happening in other fields today, including computers."

This is why it makes little difference whether the dollar is cheap or dear. In this mighty clash between nationalism and free trade, nationalism seems to be winning. Where does this leave the U.S. dream of becoming high-technology supplier to the world? Rudely shattered. ■

Where the chips fall

No matter how you slice it, per capita or by dollar volume, most of the world's semiconductors go to the U.S., Japan and Europe. Don't be misled, though. The smaller markets matter, especially to the governments that work so hard to protect them.



America's New-Wave Chip Firms

By Michael S. Malone

An apparent rebound in the U.S. semiconductor industry, caused in part by a surge in personal-computer sales, and the recent announcement of a proposed merger between two established semiconductor companies, Advanced Micro Devices and Monolithic Memories, are two reminders that change is the only constant in the high-tech business. That is a good thing to remember in this time of Pacific Rim trade disputes and calls to protect our "beleaguered" domestic chip industry.

When one reads the numbers, the first reaction is to man the economic barricades, dredge the bottomless moat of subsidies and pour the walls for a Maginot line of tariffs. But if one looks closer at the apparent problems of the U.S. semiconductor industry, the suspicion grows that there are forces at work here that have nothing to do with Japanese competition. Worse, this growing urge toward protectionism may do greater damage than good among the semiconductor start-up companies.

The Japanese have been competing unfairly in the electronics industry for years. But we must make sure that in punishing them we don't punish ourselves even more. A quiz: What do RCA, Sylvania and General Electric have in common? They were among leading U.S. electronic component makers in 1956. They built vacuum tubes. Along came transistors, then integrated circuits, and these giants were knocked off their perches by little upstarts like Fairchild and Motorola. Most of these firms, in turn, were supplanted by newcomers like Intel and National Semiconductor.

Second question: What were the three leading U.S. auto makers in 1956? General Motors, Ford and Chrysler. In other words, there is a big difference between providing a bridge loan to an established firm in a mature industry, like Chrysler, and propping up a gaggle of companies in a volatile business like semiconductors in which they may not even be competitors tomorrow.

Wildcatting and Shoot-Outs

One reply might be that perhaps after 30 years of wildcatting and shoot-outs in the streets of Silicon Valley, the U.S. semiconductor industry is ready to settle down into a peaceful dotage. Protection then would be a sort of corporate Medicare, guarding our increasingly infirm, but still valuable, chip companies from those hooligans and young toughs across the sea.

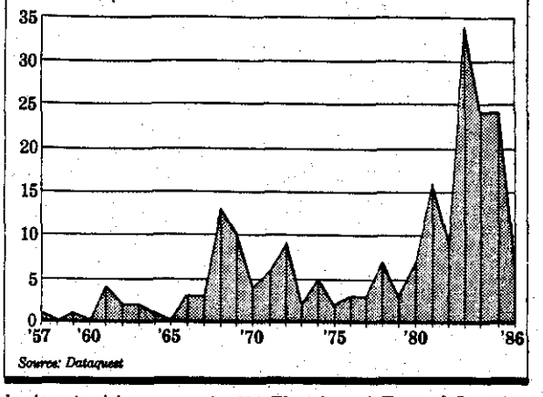
If you believe that, take a look at the accompanying chart of world-wide start-ups between 1957 and 1986, prepared by a Silicon Valley market research firm, Dataquest Inc., as part of a report on semiconductor companies founded since the late-1970s. Dataquest found 134 chip-company start-ups world-wide beginning in 1977, 113 of them in the U.S. There were more chip companies started in the U.S. in the past 10 years than in the 25 years before that.

Hardly fits the image of a surviving handful of U.S. chip makers huddled behind the last unbreached breastwork, does it? What's more, while the rest of the U.S. electronics industry is staggering out of an extended recession, these little start-ups are growing like jungle bamboo. Last year, for example, Cypress Semiconductor nearly tripled its sales to $51 million. LSI Logic, founded in 1981, expects revenue this year to top $300 million. While these growth rates certainly cannot be maintained for very long, it seems possible that by the mid-1990s these firms and others will be of comparable size to their famous predecessors.

Sheridan Tatsuno, who co-authored the report with Penny Sue, measured a recurring 12-year to 15-year interval between start-up crests, "suggesting a technology life-cycle that progresses from initial research to commercialization to gradual decline." Further, he added, these sudden increases in start-ups seemed to coincide with "a rapid loss of market share among older companies that are unable to compete with start-ups in emerging technologies."

Hence, the primarily low-density, military-oriented chip houses of the '60s were overrun by the medium-density, broad-product-line firms of the '70s; and they, in their turn, are being end-run by high-density, niche-market, custom chip makers of the '80s. Each time, the older chip firms have grown too big and have too much invested in the old technology to risk cannibalizing themselves in a bet on the future. And history has left them behind.

Semiconductor Companies Formed World-Wide (1957-1986)



Source: Dataquest

So, are we really looking at a U.S. chip industry being brutalized by the predatory practices of foreign competitors? Or is that just camouflage for the reality of a bunch of once-famous firms now reaching the end of their business cycles?

Frankly, it is too early to know. But even that answer should be more than sufficient to make legislators step back and take a second look before charging into a Pacific Rim trade war over the semiconductor business. If these chip start-ups are indeed the leaders of the '90s, wouldn't it be a good idea to find out what *they* need? The Dataquest survey is a good start. Here are some of the facts it uncovered:

- While the U.S. has seen the creation of 113 semiconductor companies since 1977, Japan has seen a grand total of four. This is particularly remarkable when one notes that even Taiwan saw two start-ups, and Australia and Brazil one each. And a dozen other U.S. firms, the vanguard of a new generation of superconductor companies, are expected on the scene within a year.
- While 70 of the U.S. start-ups are in Silicon Valley, 23 others are in the Southwest, seven in the Northeast, and 13 in other parts of the country.
- In 1980, world-wide revenues of semiconductor start-ups totaled $20 million. By the end of this year that total will reach nearly $2 billion—all in the teeth of one of the worst recessions the industry has ever known.
- Of the 113 U.S. semiconductor start-ups, more than one-third have strong affiliations (manufacturing contracts, technology transfers, joint ventures, etc.) with Asian companies, many of them Japanese. As Mr. Tatsuno and Ms. Sue noted, "whereas larger U.S. vendors are hesitant to enter alliances with Asian companies, start-ups are jumping into alliances en masse." For example, Chips & Technologies Inc. of Milpitas, Calif., has technology agreements with, among others, Ricoh, Oki Electric and Exar of Japan, as well as Korea's Samsung.

Chips & Technologies' president, Gordon A. Campbell, doesn't mince words: "One of the reasons we've seen large U.S. semiconductor corporations in deep trouble recently is that those firms failed to do what they did so well in the past: identify trends and markets. . . . They've developed hardening of the arteries. By comparison, the Japanese companies entered the semiconductor industry late; they didn't have preconceived notions, and they haven't had the tunnel vision U.S. companies had. Now, what [the large U.S. firms] are trying to do with legislation in Washington is to save these stodgy old companies that can't figure out how to compete with Japan. And what is really going to happen is that these new laws are going to stomp all over a lot of little companies that may be this industry's bread and butter tomorrow."

This new breed of semiconductor company looks almost nothing like its better-known predecessors. For one thing, it doesn't build much. Because building a fabrication laboratory is too great a capital investment—and because the older U.S. firms aren't much interested in the work—much of the actual manufacturing of the new U.S. chips is done at "silicon foundries" in Korea and Taiwan. This has led some observers to complain that the new firms are not creating enough new domestic employment.

Reversing the Flow

Well, certainly not as much as they would with better capital-gains rules and more support from older U.S. chip companies. But the alternative is no jobs here at all. And the brainpower is remaining in the U.S. Best of all, for once the flow has reversed, and the Asians are providing the raw materials and labor and the U.S. firms are skimming off the value-added profits. Unfortunately—as in the case of a U.S. chip house importing a $100 Japanese silicon wafer, then reselling the finished product domestically for 10 times the amount—this advantage doesn't always show up in positive balance of trade.

All of this points to a fundamental difference between the old-line U.S. chip firms and the new wave of start-ups: a move from provincialism toward a more global perspective. These characteristics also suggest that the needs of the new chip companies may be fundamentally different from their well-known predecessors.

For one thing, their geographical diversity argues that now, without the requirement of full manufacturing facilities at every firm, it may indeed be possible to build high-tech enclaves like Silicon Valley throughout America. It also hints that if the government really does want to subsidize semiconductors it ought to restore those capital-gains breaks that led to the venture-capital boom that built these new firms—or at least put the bucks up for some state-of-the-art silicon foundries here in the States. This recent burst of domestic semiconductor entrepreneurship is the best refutation to the claim that America's chip business is dying.

Meanwhile, their meager number of start-ups means the Japanese are going to fight the next round with the huge electronics firms they've already got. And for all their much-vaunted manufacturing prowess, there is no reason to assume those companies are any more immune to the semiconductor business cycle than our own—particularly when, short of cutting our own throats, we make them play fair.

This is not to say we should ignore our older semiconductor companies. It is just that we should not ransom our technological future for firms that, by not remaining innovative, have become part of the past. If the old chip companies want to stay in business, let them adapt to the new rules. Finally, the quantity and quality of the many new U.S. chip firms hints that the best thing the government can do for America's semiconductor industry is what the now-crying old-line chip houses themselves asked it to do just a few years ago. And that is to stay out of the way.

Mr. Malone writes frequently on high technology.

Verification: The Impossible Dream

By James T. Hackett

Ronald Reagan and Mikhail Gorbachev are close to an arms-control agreement that would eliminate short- and intermediate-range nuclear missiles in Europe. On the surface this sounds desirable, but there

Even the most optimistic arms-control enthusiasts concede that effective verification is essential. But don't worry; the State Department says it can all be worked out. That must be gratifying to the Kremlin's experts in arms-control cheating, who

duce, toasters, but how do we know they don't have another missile factory somewhere else that they're not telling us about? And what's to keep them from starting a new missile production line next week?

posed to be eliminated are effective against targets 300 to 600 miles away. Even if such missiles were outlawed, battlefield missiles with a range of as much as 240 miles still would be permitted. The Soviets have an aging battlefield missile

Adm. Inman In Command At Consortium

MCC Research Team Ready for Business

By Michael Schrage
Washington Post Staff Writer

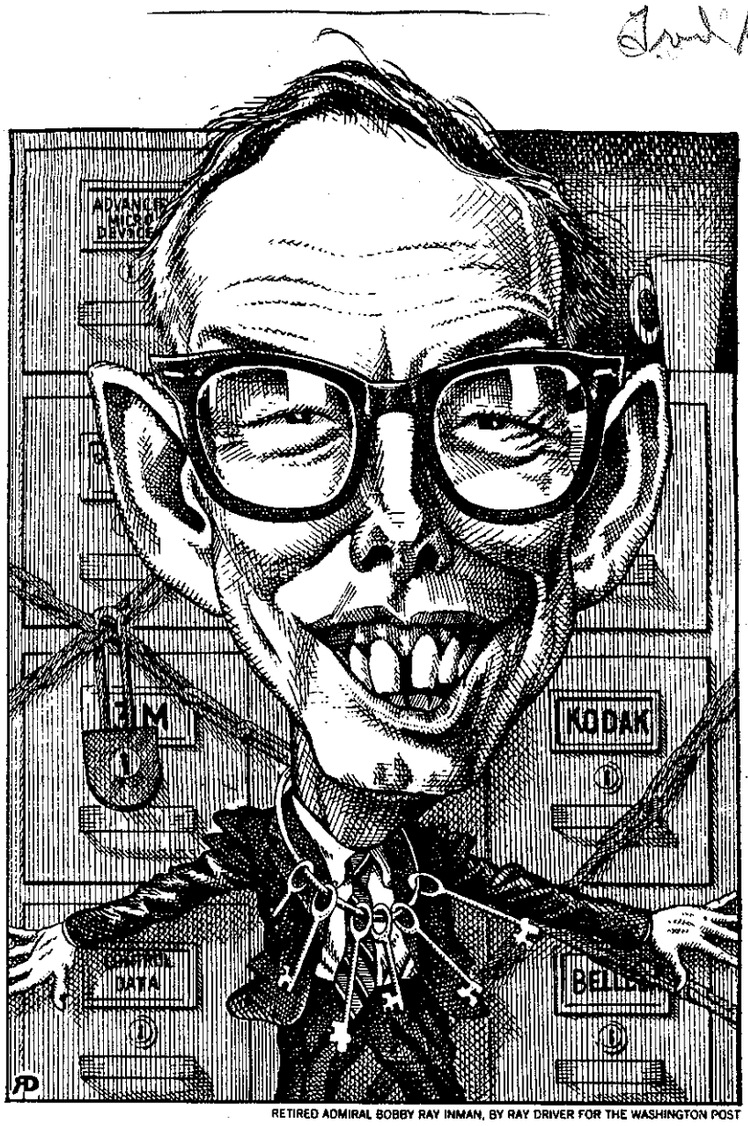
AUSTIN, Tex.—With the skill and savvy that once made him Washington's consumate high technocrat, retired admiral Bobby Ray Inman has turned his talents from the classified to the proprietary.

The man who managed this country's most sophisticated national security technologies—he ran the National Security Agency from 1977 to 1981 and served as deputy director of the CIA—has glided smoothly to the private sector, where he now bids to become the unofficial U.S. ambassador of innovation.

"Much to my surprise, I haven't needed to adapt my management style at all," said Inman, with a disarming deployment of his gap-toothed grin. "The management skills I've acquired through trial and painful error are serving me well here."

Inman is chairman and chief executive officer of MCC—the Microelectronics and Computer Technology Corp. research consortium—which presents itself as the American computer industry's response to Japan's highly publicized "Fifth Generation" computer challenge for global supremacy in the information-processing industry.

The creation of Control Data Corp. Chairman William C. Norris in 1982, MCC was seen as new cooperative venture by American companies to achieve breakthroughs in areas of basic research crucial to the evolution of information technology. The idea was that member companies would finance establishment of the venture, underwrite its research programs, and lend it some of their top scientists and engineers. Norris argued that a combined approach would prove more cost-effective than any one company's individual efforts in this risky and capital intensive industry.



RETIRED ADMIRAL BOBBY RAY INMAN, BY RAY DRIVER FOR THE WASHINGTON POST

In many respects, MCC is the forerunner and model of what may prove to be the next generation of industry research and development—a cooperative of companies that share first-level research and development efforts that later will become proprietary products. MCC has about 300 employes and an annual budget approaching $100 million but has not disclosed what is being spent on specific programs.

"Mid- and small-sized companies simply don't sustain long and broad-scaled research in an industry where the prospect for technological surprise is high," Inman said.

Inman, who had retired from public service in July 1982, was assiduously wooed by Norris and other MCC members. He formally came on board in January 1983.

A superb politician with an ability to implement an agenda, he surprised and annoyed many of the members of his board by consistently rejecting many of the researchers initially offered up by the member companies as simply not good enough.

Moreover, although MCC's seven research programs—which range from semiconductor packaging to new computer architectures to parallel processing—originally were supposed to be run by scientists from MCC member companies, it turns out that six of the seven are independent and highly re-

See MCC, D8, Col. 1

MCC Team 'Right on Schedule'

MCC, From D1

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Though MCC has been in operation for less than three years and has yet to publish any significant research, it already has captured some of the top researchers in computer science and a reputation as an intellectually exciting place to work. Teams of computer scientists are exploring futuristic forms of computer software that would imbue computers with a "common sense" capability at problem solving, for example. Other specialists are looking at computer-aided approaches to help crowd hundreds of millions of circuits on a silicon chip. Inman unabashedly asserts that MCC "is clearly a winner."

But MCC's member companies and Inman all concede that the real test of the consortium is just now beginning: Will MCC's research and development efforts ultimately translate into innovative products and services that give its members a technical edge in the marketplace?

"We've completed the start-up phase and it's now down to the business of research," said DEC's Fuller. "The hard problem is going to be technology transfer."

"My primary worry is technology transfer," said Inman. "I can't guarantee that all these companies will use these technologies."

In fact, that issue is of such paramount concern that Inman formed an ad hoc committee to force MCC members to address the technology-transfer questions within their own companies.

Even in the fast-paced high-technology industry, effecting a smooth transfer from basic research to prototype to production model has proven to be one of the thorniest problems facing American companies. Academic commentators on industry from Robert Reich to Ezra Vogel all comment that Japanese industry's skills at quickly bringing innovations to market give it a competitive edge.

"There's one resource that's scarce and that's time," said Paile Smidt, MCC's senior vice president of plans and programs. "There's more competition out there now. Revenue life cycles are down, product life cycles are down."

That creates an inherent tension in MCC, Smidt concedes. As computer product life cycles shrink with the pace of technological change, figuring out what constitutes useful long-range research becomes increasingly difficult. When does "long range" research blur into something with immediate commercial possibilities?

Inman and Smidt are leaving that up to the individual companies to decide.

"Our shareholders now have uninhibited access to the developmental know-how in their programs," said Smidt. "And in 12 to 18 months I think we'll see experimental uses and elements of our output in commercial use."

However, Inman concedes that MCC can succeed brilliantly as a research and development organization but ultimately fail in its mission if member companies are unwilling or unable to accommodate themselves to the flow of technologies that emerge from the consortium.

Indeed, Inman and Smidt agree that, with 21 major organizations participating, the odds are great that not all of them will prove adept at swiftly assimilating MCC technology. That could mean that four or five of the most aggressive corporations with a clear technology transfer plan reap the commercial benefits of the investments made by the other members. In essence, the slower companies effectively will have subsidized their competitors' advantage. That could lead to several companies choosing to drop out of the consortium.

In other words, MCC's very success could sew the seeds of discord. Inman says the consortium "could be viable with 14 or 15 members," but he hastens to add that he doesn't expect more than two or three of the 21 companies to drop out over the near term.

Actually, Inman seems more intent on attracting and keeping key researchers than mollifying certain shareholder problems. "I've tried to give them the feeling that they're the members of a club—an exclusive group, an elite group," far more so than he's done with his shareholders, Inman said.

The Austin location has not proven detrimental in attracting researchers from California or Ivy League climes, and Inman cleverly has secured a diversity of shareholders ranging from Boeing Co. to Eastman Kodak Co. to Minnesota Mining & Manufacturing Co. to assure that researchers have a broad market of companies for their innovations.

A random sampling of researchers affiliated with MCC reveals that they are happy with their working environment, adequately compensated and optimistic about the prospects for the application of their research.

"I think Inman has set the right tone for this place," said Doug Lenat, an artificial-intelligence researcher who came from Stanford University and the Xerox Palo Alto Research Center.

However, the tone also includes an overwhelming concern for the proprietary nature of the research. Elevators are equipped with special locking devices that prevent individuals without the appropriate card keys from having access to certain floors at the Austin complex of black glass buildings. Indeed, the seven programs are carefully partitioned so that companies not funding certain programs are expressly prohibited from receiving information from them.

Similarly, researchers—who traditionally have published papers and presented their findings in conferences—are reluctant to disclose anything beyond the sketchiest details of their work.

Indeed, Inman declines to publicly disclose the research milestones of MCC, arguing that, as a private enterprise, the organization is under no obligation to do so. Consequently, though, there is no real external way then of measuring how well MCC's disparate research programs are doing.

DEC's Fuller insists that "It's at least as ambitious as Japan's Fifth Generation" goals and that the 10-year research program is "right on schedule."

Inman visibly bristles at suggestions that this concern for secrecy reflects his national security background. He points out that he has a responsibility to protect his shareholders' investments—more important, he stresses that the lines between basic and applied research and development have blurred to the point that more information has to be considered proprietary and protected accordingly.

However, it may well be that MCC—as a consortium—helps define the new level of proprietary emphasis as companies increasingly rely on secrecy as well as innovation to protect a technical edge in the marketplace.

Rather than see secrecy emphasis as a threat to innovation, Inman sees it as a part of the reality of intensifying global competition.

The current membership is Advanced Micro Devices Inc., Allied Corp., BMC Industries Corp., Bell Communications Research (Bellcor), Boeing, Control Data , Digital Equipment, Eastman Kodak, Gould Inc., Harris Corp., Honeywell Inc., Lockheed Corp., Martin Marietta, 3M, United Technologies Corp., Motorola Inc., NCR Inc., Rockwell International Corp. and Sperry Corp. Reportedly, General Motors Corp., flush with its acquisitions of Electronic Data Systems Corp. and Huges Aircraft, also is exploring an MCC membership.

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New M.C.C. Chief's Strategy: To Speed Payoff on Research

NYT 6-24-87

By THOMAS C. HAYES

The consortium sees a wave of products just over the horizon.

DALLAS

GRANT A. DOVE built his reputation by finding ways to convert sophisticated research into money-making products during the last two decades at Texas Instruments Inc.

Those kinds of payoffs have been slow to develop for the 20 companies sharing research costs at the Microelectronics Computer and Technology Corporation, which was created four years ago in an effort to counter advances by the Japanese in electronics. Yet Mr. Dove, who will become the chairman and chief executive of the consortium, familiarly known as M.C.C., in two weeks, sees a wave of new products just over the horizon.

"Our programs have long-range goals, but you'll see me putting emphasis on setting up interim milestones, with more product spin-outs along the way," he said. "They'll be random, but you'll see more." M.C.C., based in Austin, Tex., and one of its members, the NCR Corporation, yesterday announced the first commercial product of a software technology developed by the consortium.

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For the United States, M.C.C. was an unusual business strategy when conceived five years ago by William C. Norris, founder of the Control Data Corporation. He saw Japan's reach toward the so-called Fifth Generation of computer technology as a threat both to the American economy and computer industry. Mr. Norris also believed that cooperation in jointly financed research was the best way for American electronics companies to stay competitive.

At the time, Japanese industry had pooled resources and threatened to outdistance American efforts in tackling the costly research needed to achieve the next stage of advanced computer operations. Many in this country doubted that American companies could find a way to cooperate and keep pace.

Indeed, some companies that joined M.C.C. complained for months of competitive jealousies. Yet, members say they generally acquiesced to urgings for cooperation from Adm. Bobby R. Inman, the former deputy director of the Central Intelligence Agency who was M.C.C.'s first chairman. He left last December.

The consortium, which has nearly 400 researchers and a budget this year of $75 million, has focused on applied research in four disciplines, all tied to building faster and more capable computers. They are computer-chip packaging, advanced computer architecture, software development and computer-aided designs for advanced computer chips called Very Large Scale Integrated Circuits.

At Mr. Dove's urging, M.C.C. soon will add a program in one of today's hottest research fields — superconductivity, a condition in which materials lose all electrical resistance. In the past this condition could be reached only at extremely low temperatures. More recently it has been reached at more moderate temperatures.

Three members of the consortium — Unisys, Allied-Signal and Lockheed Missiles and Space — have said they would quit at year-end, and a fourth, General Electric, said that while it would keep its yearly membership, it would withdraw from specific research programs.

Mr. Dove, who is 59 years old, has been an executive vice president at Texas Instruments since 1982. In his 28 years with the company, he had a hand in developing such sophisticated products as computer systems used in oil exploration, automatic pilots for low-flying military aircraft, and a computer used for weather forecasting and ballistic missile research. He also has been the senior executive directing Texas Instruments' investments in artificial intelligence research.

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John R. Hanne, head of M.C.C.'s computer-aided design project, has worked with Mr. Dove at Texas Instruments. He said Mr. Dove proved particularly adept in keeping long-range research headed toward marketable products.

"Grant is one of a very few people who are very accomplished managers of high-tech business projects," he said, echoing the comments of other Texas Instruments executives

Mr. Dove was particularly successful in achieving consensus in a company that has a reputation for confrontation. "If there is anything I've learned how to do inside T.I., it is to pull together diverse groups of people and move them toward a c[illegible]on

Speeding the Design of Some Chips

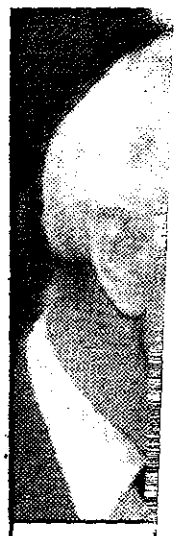
The NCR Corporation introduced a software system yesterday that its executives said should accelerate the design time for some kinds of custom computer chips.

The NCR product, called Design Adviser, is the first available based on technology created at the Microelectronics Computer and Technology Corporation. The research consortium, based in Austin, Tex., was organized four years ago by 12 American companies to cooperate in electronics research.

The new software uses an "expert system" that incorporates the knowledge of human engineers and is aimed at speeding the design of chips known as application-specific integrated circuits. These chips are one of the fastest-growing and most competitive fields of semiconductor manufacturing.

Dataquest Inc., a market research concern, said they accounted for 21 percent of worldwide semiconductor sales last year, or $4.9 billion. The figure is expected to increase to about $15 billion, or one-fourth of total chip sales, by 1992, with Japanese and American companies battling for most of the market share.

NCR created its program from sophisticated software work completed in 1985 by researchers in artificial intelligence at the consortium.



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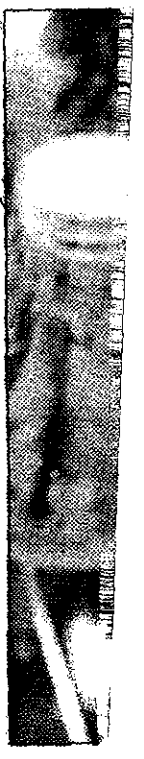

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The New York Times/Jim Wilson

Grant A. Dove

M.C.C.'s Research Agenda

Advanced Computer Architectures
Includes three areas — artificial intelligence, systems technology and designing easier-to-use software.

Semiconductor Packaging
Involves designing high-density chips covering connectors, materials, test and cooling technology and process reliability.

Software Technology
Includes research on how teams of designers, working simultaneously, can also work together to create large, complex software systems.

Very Large Scale Integrated Circuits and Computer Aided Design
Involves developing computer-aided design systems that reduce the amount of time and effort needed to design future generation electronic systems.

Superconductivity
Project specifications are undecided, but they are expected to deal with designs for faster and more powerful electronic systems.

goal," Mr. Dove said.

Asked to elaborate, he said he was trained as a systems engineer — he has an undergraduate degree in electrical engineering from Virginia Polytechnic Institute — but seemed to have a natural gift for management.

Colleagues at Texas Instruments said that Mr. Dove was both personable and a good listener, and sought consensus in management decisions. "I've never had problems giving credit where credit is due," he said.

Member companies collectively have about 100 people at M.C.C., monitoring research and manipulating ideas that might be worked into commercial products. Mr. Dove said he already has told member companies that he intends to quicken the pace.

Boeing, Honeywell and Minnesota Mining and Manufacturing, among other member companies, already have publicly discussed applications of M.C.C. technology in their research and production operations.

"M.C.C. has allowed us to get at things that are more risky, and broader-based, and has given us the ability to share in those risks rather than bear them ourselves," said Timothy D. Fehr, vice president for engineering at the Boeing Electronics Company.

Still, most companies have been secretive about their applications of M.C.C. technology, which Mr. Dove said he wanted to change. "It's important to get the word out," he said.

He said that Texas Instruments might join the consortium and added that he was also wooing many smaller companies and campaigning for current members to join more programs.

"The need for teamwork is much clearer now than it was even in 1984 and '85, when the whole idea was being debated," he said. "There are probably close to 50 different kinds of consortia under way now. The debate has been won."

Japan Is Racing to Commercialize New Sup

Discovery Prompts Frantic Research Effort; U.S. Response Is

By Stephen Kreider Yoder
Staff Reporter of The Wall Street Journal

TOKYO—In the corner of Prof. Shinichi Uchida's laboratory at the University of Tokyo, across from the bottles of liquid nitrogen, stands a bunk bed.

Until recently it was little used. Then, on Feb. 15, a University of Houston press conference announced the latest breakthrough in the science of superconductivity, a development with potentially enormous commercial applications.

The lab and its bunks here seldom have been empty since.

For three weeks Prof. Uchida's 12-researcher team worked around the clock, seven days a week to duplicate the Houston results. Sleeping in shifts, they cooked their meals in a tiny kitchenette while their latest batch of experimental ceramic pellets baked in the lab's kiln.

In other labs, in company board rooms and in the offices of the powerful Ministry of Trade and Industry, or MITI, the Houston breakthrough has galvanized Japan. Scientists, industrialists and government officials have responded frantically, convinced they can, and must, walk away with the commercial applications. "When it comes time to make something out of it," predicts Prof. Shoji Tanaka, who is Prof. Uchida's boss, "the Japanese will have the upper hand."

In the U.S., by contrast, the reaction has been more measured. Labs are busy, but there isn't any nationally coordinated drive for commercialization. Leaders in superconductivity research caution that much science remains to be done first. "You must keep in mind that the scientific scene is changing so rapidly that to decide (on specific applications) on the basis of what is known today would be a mistake," says John Armstrong, director of the research division at International Business Machines Corp. It would also be wrong, he thinks, "to turn this into a race between East and West."

Here in Tokyo, however, the race is already on, showing once again the competitive drive and speed with which Japan can seize on Western science.

New materials that conduct electricity at warmer temperatures with almost no loss of power, have "opened a fantastic world of future industries," says Masatoshi Urashima, a MITI official. Because previous superconductors operated only at extremely low and expensive-to-maintain temperatures, the new materials make economical the creation of tiny, superfast computers, magnetically floating trains, long-distance power lines that don't waste electricity and even appliances that use almost no power.

The discovery meshes with technologies Japan has refined for years. Japan has a train using superconductivity that is almost ready for commercial use. It travels at more than 250 miles an hour while hovering five inches above a track on a magnetic cushion created by superconducting coils. Japan's shipbuilders, meanwhile, have spent $23 million to build a fast ship propelled by superconducting magnets.

NEC Corp. and others already have produced prototypes of superconducting computer chips; the West gave up trying to do so four years ago. Such giant electronics concerns as Hitachi Ltd. are supplying the West with millions of dollars of superconducting equipment. And Japan's leading role in industrial ceramics will help it develop ceramic superconductors. "A lot of revolutionary things are going to come up and a lot of it is going to come from Japan," says David L. Keller, a technology analyst with James Capel & Co., a British securities firm. "The Japanese will dramatically lead the rest of the world."

The Japanese government already is organizing that. Four days after the Houston bombshell, Japan's Science and Technology Agency announced its intent to form a research consortium of Japanese companies, universities and government labs. A week later, the consortium was in place, including such industrial giants as NEC, Toshiba Corp., Nippon Steel Corp. and Mitsubishi Electric Corp. "We've gathered all the leading-edge researchers in superconductivity in Japan," says Koji Yamaguchi, the agency official overseeing research. "We need to get everybody together to share information and decide how to move."

'THE OBJECTIVE,' says Japan's leading business newspaper, 'is to organize industry to get the jump on the West in applications and commercialization for a huge new market.'

MITI, the agency that picks and funds national projects like the one that helped Japanese makers dominate the memory chip business, began moving on the day of the announcement. It already is polishing up an existing feasibility study on a superconducting power plant and plans to have a working model built by 1992.

"The objective is to organize industry to get the jump on the West in applications and commercialization for a huge new market," says Nihon Keizai Shimbun, Japan's leading business daily. The earliest application, researchers say, could be superconducting computer chips that would enable creation of a shoe box-sized supercomputer. IBM and most other U.S. companies abandoned research in 1983 on the chips, called Josephson Junction devices, partly because of the complications of cooling with helium. That left NEC, Hitachi and a MITI lab to refine the technology with little foreign competition.

Buying American: Toshiba Aide Says Ordering in U.S. Is Difficult

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For all the government-inspired organization, Japan's research labs didn't wait for government orders when they heard the news from Houston last month.

Elements of Surprise

At the University of Tokyo, Mr. Uchida sat his researchers down in front of a large periodic table of the elements. For hours they debated which elements Houston could possibly have used. While they were still guessing, a rumor came over the phone that the material was fluoric. Students ran out and bought fluorinated chemicals. For three days they tried out hundreds of combinations until they found the rumor was false.

Acting on another tip that the Houston material was dark green, the researchers mixed all the plausible chemicals that would become green when fired, again with no success. (The material needs to be fired further until it is black, they found later.) Then a news report said a Chinese lab had achieved superconductivity at 100 degrees Kelvin (minus 173 degrees Celsius) using a ceramic with ytterbium in it and researchers attacked that. The report proved wrong—the element was yttrium. (Ironically, the University of Tokyo lab later found, by coincidence, that ytterbium works. The lab patented the discovery.)

Finally at 2 a.m. March 1, they got superconductivity. "It was an other-worldly experience," says Prof. Uchida. They drank a toast and launched back into another week of experiments, this time to refine the resulting ceramic. On March 8 they announced a purified form. On Wednesday the lab finally took a holiday.

Meanwhile, labs at Tohoko University, Hokkaido University and a government research facility in Tokyo have burst forth with rapid-fire announcements of their advances in superconductivity. They and other labs have been snatching up the ingredients for superconductors so fast that there are shortages. Suppliers have run out of yttrium, for example, and labs must wait three weeks for orders to be filled.

'The Real Thing'

Prof. Uchida's lab has been flooded by calls and visits from companies. Sumitomo Electric Industries Ltd. researchers brought in some rudimentary wire made from superconducting ceramic. Engineers from Toshiba, Fujitsu Ltd. and Hitachi have visited the lab to keep watch on developments. "Company people have the conviction that this is finally the real thing. A lot are starting to pick it up. . . . They see that superconductivity is a sure thing and they want to get on to application," says Prof. Uchida.

Of course, there is scientific and commercial excitement in the U.S., too, but it's less frenetic and isn't centrally controlled. Scientists say indications of an incipient breakthrough came as early as April 1986, when researchers at IBM's laboratory in Zurich, Switzerland, reported they had achieved superconductivity in a new class of materials, the metal oxide ceramics. This galvanized researchers throughout the world. By November, the Japanese and Chinese had confirmed the IBM discovery and by December, scientists in Houston and at American Telephone & Telegraph Co.'s Bell Laboratories were reporting important advances with the new materials.

About 5,000 physicists jammed the ballroom of the Hilton Hotel in New York Wednesday night for an unprecedented special session on superconductors at the annual meeting of the American Physical Society. They listened to the presentation of 60 papers on superconductivity research done largely within the last two to three months. Although scientists from U.S. universities dominated the program, there were reports from IBM, Bell Labs, Westinghouse Electric Corp. and Exxon Corp. as well as from Japanese, Chinese and Canadian scientists.

The breakthrough generated tremendous excitement among Bell Labs scientists, says Robert A. Laudise, director of the laboratories' inorganic chemistry branch. "Usually, research managers are from the space and defense related agencies in the area, including the Marshall Space Flight Center and the U.S. Army Missile Command, he says.

In Palo Alto, Calif., where Stanford University recently announced a breakthrough in fabricating a superconducting thin film, useful in electronic devices, a news conference last week was packed with industry people. Several other scientists have called for more information for use in making a superpowerful magnet used by geological researchers. Niels Reimers, director of Stanford's technology licensing office, said, however, that he hasn't been fielding many industry inquiries.

Crash Programs

In Japan, however, companies that already sell conventional superconducting wire to the U.S. have begun crash programs to commercialize the new discovery. Fujikura Ltd. and Sumitomo Electric, for example, say they have developed rudimentary wire out of the new ceramic, despite skepticism among some scientists that the material won't lend itself to wire-making.

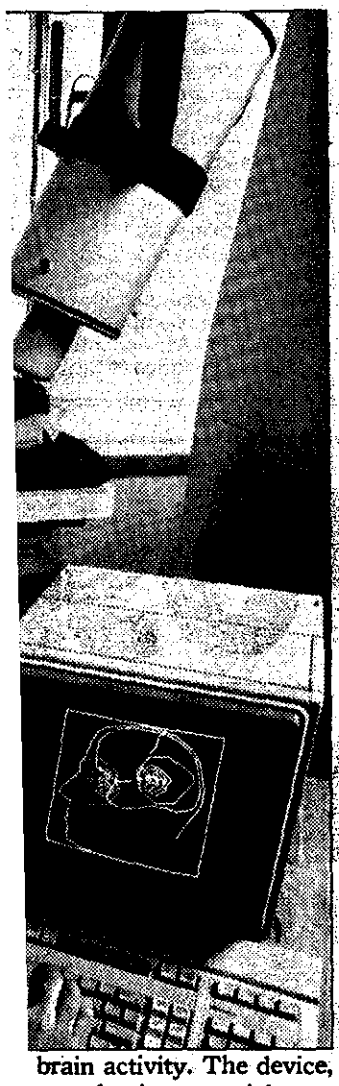
Like their U.S. counterparts, Japanese makers temper their euphoria with warnings that too little is known about the new ceramic superconductor to tell when and how the material will be commercialized.

Aside from possible problems in forming brittle ceramic into wire, the new superconductor still can't handle enough current to be used in heavy applications such as power plants. Superconductors also don't work well with alternating current, the type of electricity used in most of the world's power equipment.

But Japanese labs are convinced they can solve the problems over the next several years. Now that the West has made the basic breakthrough, they say, the ball is in their court. "It will be difficult and will take time," says Kasumasa Togano, a government scientist. "But that's precisely where Japan's labs and makers have the edge."

Still, he and other researchers admit to a twinge of hurt pride. "To be honest, we're following in the footsteps of the U.S.," Mr. Togano says. "Here, again, the originality is coming from the West. We have a measure of sadness about that."

JERRY E. BISHOP IN NEW YORK CONTRIBUTED TO THIS ARTICLE



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The Rich Promise Of Superconductors

By BARNABY J. FEDER

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"Superconductivity is extremely exciting," said Benjamin Rosen, chairman of the Sevin Rosen Management Company, one of the nation's most successful venture capital firms in the field of electronics. "It's one of those things we have been dreaming about."

Nevertheless, Mr. Rosen said, commercial applications of the new advances in superconductivity are "all too far off to be of real interest to us right now."

Other venture capitalists say they have already seen enough to begin gearing up to lead what is likely to be a multibillion-dollar wave of investment, even though there is more money available than places to put it.

"The plus of the new superconductivity discoveries is that the applications potential is mind-boggling," said Bob Daly, a partner at Boston-based TA Associates, a leading venture capital firm that said it was striving to get to know leading researchers in the field. "The minus is that the weekly announcements of new developments are making it hard to figure out where to invest."

Superconductivity — the state in which electric current passes through a material without resistance — was discovered in 1911. Until last year, however, it had been achieved only at temperatures so frigid that there was little practical use for it. Few investors gave it a second thought.

But early this spring researchers at an International Business Machines Corporation laboratory established that some ceramic-based materials become superconductive at temperatures above that of liquid nitrogen (-320.4 degrees Fahrenheit), a widely used and inexpensive industrial coolant.

It is still far from clear how durable these superconductors would be, what their magnetic characteristics are, or even exactly how they work. Nevertheless, venture capitalists are excited because superconductivity at such relatively high temperatures could have profound implications for the performance of everything from computer chips to electric utilities, and medical diagnosis to superfast trains.

At least one new company has already been formed. Tentatively named the American Superconducting Corporation, it will use seed money provided by American Research and Development of Boston and Rothschild Ventures Inc. of New York, two leading venture capital firms, to take the first steps toward developing a business based on the work of Gregory J. Yurek and John Vander Sande, two professors at the Massachusetts Institute of Technology.

Professors Yurek and Vander Sande disclosed at a Congressional hearing last week that they had developed a method to make the new superconductors out of metal, which would make them far easier to manufacture than the brittle, ceramic-based materials developed by other researchers.

Many venture capitalists compare today's superconductivity scene to the investment situation that evolved in 1973, following the news that researchers had discovered how to transfer genetic material from one living organism to another. Genetic engineering eventually attracted hundreds of entrepreneurs and billions of dollars of investment.

The venture capital community was much smaller in 1973 than it is today. This year, some 2,000 professional venture capitalists are managing a pool of more than $24 billion.

Venture capitalists are not the only ones with a stake in when and how investors will plunge into the superconductivity field. The United States is more reliant than any other industrial nation on the interplay between investors and entrepreneurs. Besides being the source of seed money and other early rounds of financing for many start-up companies, venture capialists are also a major supplier of management expertise.

Government officials and industry leaders, including venture capitalists themselves, have been wondering aloud whether superconductivity is too important strategically to be left to the kind of laissez-faire growth that has dominated biotechnology.

"This is an unusual case where commitments have to be made rapidly and wisely for international competitive reasons," said George McKinney, the American Research partner who was reached by M.I.T.'s Technology Licensing Office when Professors Yurek and Vander Sande decided they wanted to commercialize their work. "Venture capitalists are looking for an aggressive commitment by the Government. The problem is going to be who will pay for the one-mile test cable when we think we can build a superconducting one."

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But to whom will the Government make its commitments? Many of the early discoveries in high-temperature superconductivity have been made by researchers at I.B.M., A.T.&T. and other large companies. Venture capital experts believe that such large companies might lead the way in some capital-intensive applications, but they also see a major role for smaller companies and start-ups.

So far, however, there are few small companies involved with superconductivity to which venture capitalists or the Government can turn. Two companies backed by venture capital are currently marketing products using superconductors built with the "old" technology of cooling metals to well below minus 418 degrees Fahrenheit with liquid hellum. They are Hypres Inc. of Elmsforld, N.Y., which makes an oscilloscope for high-speed signal measurement, and Biomagnetics Technologies Inc. of San Diego, which makes devices that measure magnetic fields and brain activity.

Nor are many of the independent researchers who are best known for the recent breakthroughs currently looking for venture support.

"Many venture capitalists and others have contacted me and members of my team, but we have never gotten to a serious stage because I have been too busy with lab work," said C. W. Chu, whose University of Houston research team has been among the foremost in the field.

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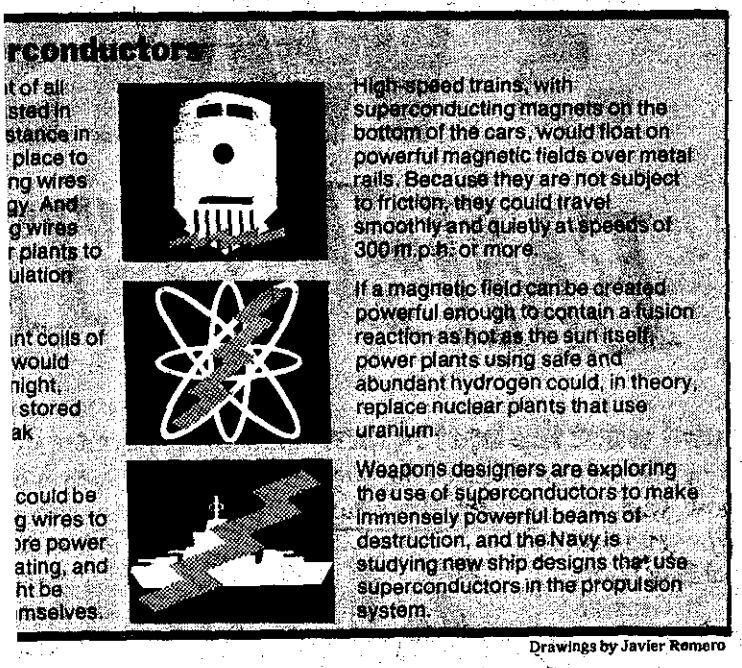
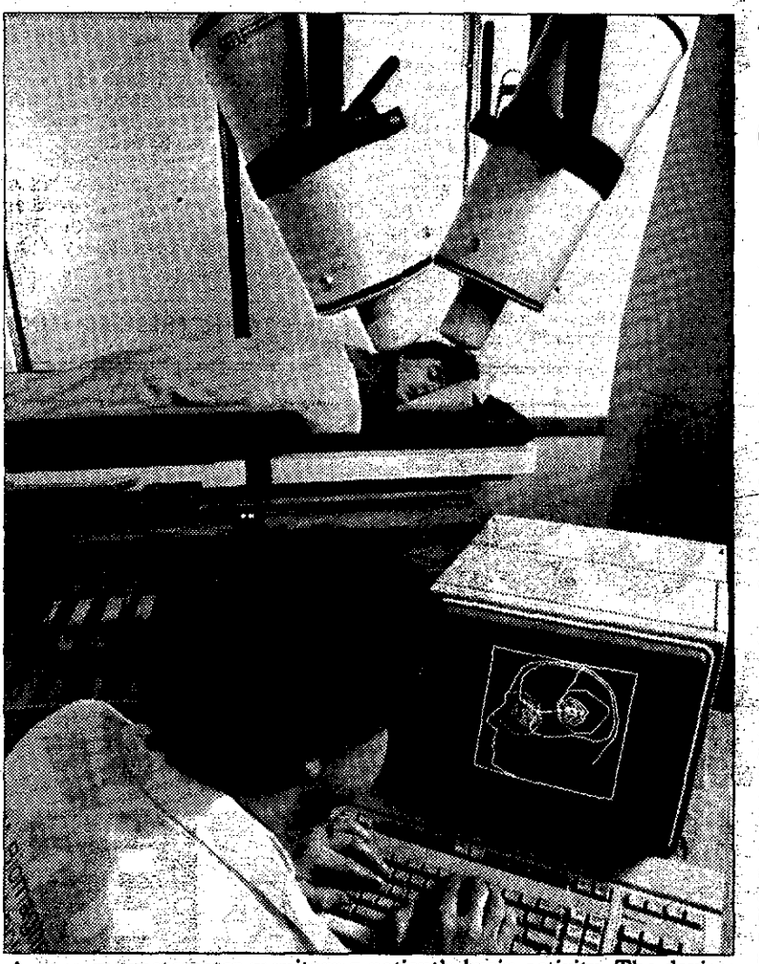


Drawings by Javier Romero

BUSINESS TECHNOLOGY



A neuromagnetometer monitors a patient's brain activity. The device, built by Biomagnetic Technologies, uses superconducting materials.

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By BAR

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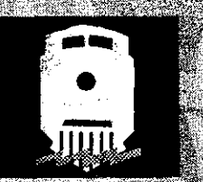

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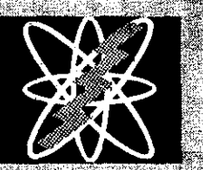

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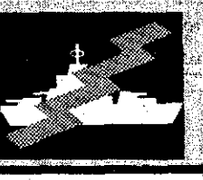

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$6 Billion Particle Accelerator Wins President's Endorsement

'Supercollider' Would Dwarf Existing Projects

By Cass Peterson
Washington Post Staff Writer

President Reagan has formally approved construction of a $6 billion, 52-mile-long nuclear particle accelerator, Energy Secretary John S. Herrington announced yesterday, calling the project a "momentous leap forward" in the exploration of matter and energy.

The "superconducting supercollider," as the device is called, would be 20 times more powerful than any existing accelerator and capable of producing, on a tiny scale, the kind of energy levels that many physicists believe existed at the moment of the universe's creation.

"In high-energy physics, the development of the supercollider is the equivalent of putting a man on the moon," Herrington said. "It will have spinoffs, discoveries and innovations that will profoundly touch every human being."

The supercollider would be the most costly piece of research equipment ever built for any purpose. Reagan's decision is certain to set off a fevered competition among the states for the honor of hosting the massive accelerator, its high-technology work force of 3,000 and its annual operating budget of $270 million. More than 40 states have expressed an interest in the project. Some have spent millions of dollars developing proposals.

Herrington said there is "no front-runner" for the site. A selection plan is being drafted and will be announced later, he said.

The fate of the supercollider has been hanging at the White House for months, caught in a heated debate between scientists and budget officials over whether the nation can afford such a costly research tool at a time of high federal deficits.

While Energy Department officials said they could take from other programs the $60 million envisioned for design work in fiscal 1988, the project will require hundreds of millions in construction funds in succeeding years.

Officials said Reagan resolved the question at a meeting of the Domestic Policy Council Thursday, yielding to arguments that the United States faced losing its leadership position in high-energy physics if the project were not built.

See COLLIDER, A6, Col. 4

WASH POST TUES 31, 1987

IINGTON POST

$6 Billion 'Supercollider' Wins President's Approval

COLLIDER, From A1

The United States has the world's most powerful accelerators in operation at the Fermi National Accelerator Laboratory in Illinois. A European consortium is planning a larger machine, however. And Japan is expected to start operating a major accelerator this year.

The Soviet Union has two large accelerators under development, including a device, to be in operation by 1995, more than three times the size of the largest Fermi accelerator. The U.S. supercollider, which would dwarf all those accelerators, is targeted for completion in 1996, if funding is approved by Congress.

"This is a watershed for America's scientific and technological leadership and another clear sign that President Ronald Reagan is committed to keeping this nation on the cutting edge of world leadership and competitiveness," Herrington said.

There are no immediate commercial goals for the supercollider. Herrington emphasized yesterday that it has "no military application. This is not a military project." Scientists contend, however, that similar research has yielded significant benefits in nuclear medicine, computer development and other high-technology fields.

The supercollider would be in an underground tunnel the shape of a race track, 10 feet in diameter and 52 miles in circumference, encircling roughly as much area as does the Capital Beltway.

Inside the tunnel, powerful magnets would propel beams of protons along separate tracks in opposite directions. When the protons reached nearly the speed of light, electromagnetic chutes would open and direct the two beams into each other head-on with an energy of 40 trillion electron-volts.

An ordinary household flashlight battery is capable of 1.5 electron-volts, which is a unit of energy measurement. By contrast, 40 trillion electron-volts exceeds the instantaneous output of all the power plants on Earth.

In that instant of collision, scientists say, the supercollider could approximate in a tiny space the energy level that marked the moment after the "big bang," a theory that holds that the expansion of the universe began with a gigantic explosion.

The energy would be sufficient to create particles that can now only be theorized, enabling physicists to delve more deeply into the fundamental nature of matter and energy. Scientists now know, for example, that the protons and neutrons that make up the nucleus of the atom are made of more basic constituents called quarks.

Physicists say they think that the supercollider will enable them to identify even more elementary particles in their efforts to understand and explain the origins of mass.

Herrington said the United States intends to seek "cost-sharing" commitments from other nations, as well as from state and local governments wherever the accelerator is located.

The "superconducting" in the accelerator's formal name refers to the kinds of magnets developed to guide and move the beams of protons. Essentially the magnets are cooled with liquid helium to the point that electrical resistance ceases. Without such "superconductivity," the magnets would draw massive amounts of electricity and would produce only one-third as much magnetic power, meaning that the accelerator's race track would have to be three times as long.

THE FEDERAL

'Super Collider' Project: A $4.4 Billion Timetable

Site Proposals Due at DOE by August

By Boyce Rensberger
Washington Post Staff Writer

Energy Secretary John S. Herrington yesterday announced the timetable that will govern what is already shaping up as a fierce competition among the states to land one of the largest federal construction projects in history—the Superconducting Super Collider (SSC), a $4.4 billion atom smasher, or particle accelerator, 52 miles in circumference.

Proposals from the states are due at the Energy Department by August, although a "preferred site" will not be designated until July 1988. If the chosen site passes an environmental impact review, the selection will become final in January 1989.

During the main years of construction, a seven-year period beginning with fiscal 1989, spending will run nearly $600 million a year. The construction work force is expected to peak at 4,500. Once the SSC begins operation, which is scheduled for 1996, it will employ a permanent work force of 2,500, with about 500 visiting scientists at a time. More than 100 U.S. universities are expected to use the facility, and annual operating budgets are expected to run about $270 million.

The SSC has been a dream of many physicists for years, but the long-awaited presidential go-ahead did not come until Jan. 30. When complete, the super collider will be the world's most powerful and most expensive scientific instrument. Although the 52-mile ring will be underground, there will be a number of above-ground buildings.

Although large, costly and complex, the SSC's basic function is simple: to accelerate subatomic particles called protons to velocities approaching the speed of light as they circle in opposite directions inside separate rings of magnets, and then to divert the protons into head-on collisions.

Upon collision, the protons will have so much momentum that they will transform themselves into a more concentrated form of energy than has existed since the earliest moments of the Big Bang that gave birth to the universe. In what might be called a Little Bang, physicists expect to see the SSC's energy transmute itself into previously undetected forms of subatomic matter.

By analyzing the exotic particles, physicists expect to come closer to understanding the fundamental nature of matter, both as it existed at the birth of the universe and as it may still exist, hidden within today's atoms.

Existing accelerators are similar but cannot propel particles fast enough to produce the energy concentrations needed, in effect, to break apart the most tightly locked components of atoms.

Though it will have no predictable practical payoff, Herrington said "the super collider will be a beacon for America's science and technology that will be known around the world."

He called the SSC "a major plum" for the winning state and said several have spent millions of dollars on their proposals, all of which include providing the land without charge. Among states waging the most visible campaigns thus far are California, Colorado, Illinois, Ohio, Texas, Utah and Washington.

Although the siting of federal construction projects is often subject to political influence, Herrington pledged that the SSC will be different. He said the site selection process "is designed to be fair, equitable to all parties—absolutely open and above-board."

JOHN S. HERRINGTON
... states seeking "a major plum"

Beginning in August, he said, a Department of Energy task force will select the most promising proposals and turn them over to a panel of the National Academy of Sciences and National Academy of Engineering. In December this panel will recommend finalists to DOE, which will settle on a preferred site by July 1988. A review of potential environmental impacts is expected to take six months, leading to a final selection in January 1989.

Herrington said funding for research and development, originally budgeted for $16 million in fiscal 1987, will be increased to $20 million. The request for 1988 will be $35 million. He said both sums will come from "reprogramming" existing DOE budgets.

Beginning in fiscal 1989, however, DOE will begin seeking appropriations for the SSC under a separate line item. For that year the funding request will jump to $348 million. In 1990 it will jump again, to $615 million, and remain above $600 million a year through 1994.

Top Aic

Latin Expert S

By John M. Goshk
Washington Post Staff Writ

Francis J. McNeil, on State Department's mos respected Latin America has retired as the dep deputy director of int charging that his assess U.S. policy in Central made him the victim of an in McCarthyism" by Elliot assistant secretary for int ican affairs.

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McNeil, 54, ultimately onerated of charges that confidential departmental to The Washington Post vided false information U.S. ambassador in Ven the media there.

McNeil also asserted rams' vehement opposition vented his nomination as dor to Peru even thoug been tentatively recomm the post by senior depar ficials, including Deputy John C. Whitehead.

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Smaller, faster computers could be built using superconducting wires to connect chips, allowing more power without dangerous overheating, and superconducting films might be used to make the chips themselves.

High-speed trains, with superconducting magnets on the bottom of the cars, would float on powerful magnetic fields over metal rails. Because they are not subject to friction, they could travel smoothly and quietly at speeds of 300 m.p.h. or more.

If a magnetic field can be created powerful enough to contain a fusion reaction as hot as the sun itself, power plants using safe and abundant hydrogen could, in theory, replace nuclear plants that use uranium.

Weapons designers are exploring the use of superconductors to make immensely powerful beams of destruction, and the Navy is studying new ship designs that use superconductors in the propulsion system.

Drawings by Javier Romero

NEXT

DRAFT

Possible Presidential Initiatives on Superconductivity

Background

° Recent developments and breakthroughs in superconductivity are evidence that the Administration's emphasis on Government support for basic research, bolstered by a market oriented R&D effort by industry, has created an effective environment for promoting increased technological progress, economic growth, and U.S. competitiveness.

° The breakthroughs in superconductivity were initially the result of private initiatives supplemented by cooperative research efforts at Federal labs and university labs supported in part by Federal funds, e.g., superconductivity developments at the University of Houston and the University of Alabama. No special Government incentives were required to induce the private sector efforts that have achieved these dramatic developments.

° Subsequent to the announcements of these breakthroughs, there has been growing evidence that a number of firms and labs in the private sector are initiating new research efforts and accelerating their ongoing efforts on superconductors to be able to capitalize on the potential rewards resulting from commercializing results of the breakthroughs. Venture capital firms indicate that they are already gearing up to provide seed capital for commercial applications, and at least one new company has already been formed to utilize the results of work performed at MIT which permit superconductors to be made from

metal alloys that are easier to fabricate than ceramic-based superconductors developed by others. This increase in private sector activity is evidence that market incentives are effective and work to direct resources into promising areas.

° It is important to emphasize that these developments and private sector efforts are not the result of a Federal Government industrial policy where the Government decides what research and development should be done and by whom. Rather, it is evidence that the Government can be -- and has been -- a powerful catalyst and stimulus for technological and economic progress simply by creating the proper environment in which the private sector is encouraged to seek out technological breakthroughs because of their potential for rewards. This environment results from policies that encourage market oriented activity, including the Government's R&D policy which places primary emphasis on funding for basic R&D.

Presidential Statement

° This "message" or theme can be exploited in a Presidential statement that highlights the effectiveness of the Administration's progress in promoting the research activities of the private sector -- with the emphasis being on the private sector initiative and the Government's role as a catalyst and stimulus -- and emphasizes the need for further Federal efforts to increase (superconductivity) technology transfer.

- In addition to extolling the positive impact of Federal R&D and market incentives on private sector R&D activities, a Presidential statement might announce some or all of the following initiatives as representing areas where a Federal role could be helpful, especially in shaping the climate for U.S. exploitation of the commercial potential inherent in the advances suggested by the recent technological breakthroughs in superconductivity. Most of these initiatives have the full support and backing of the Working Group. As indicated below, a few of the initiatives are somewhat controversial and the Working Group is divided in their support.

Noncontroversial Initiatives

The following initiatives are generally noncontroversial and are supported by the Working Group.

1. Advisory Group on Superconductivity

An advisory or "wise men" group consisting of leaders from the private sector could be established to provide advice to the President's Science Advisor on issues related to superconductivity. Members of the group would be senior level individuals from industry and academia who are intimately involved with the most recent developments in superconductivity. The advice sought would have the perspective of independent and unbiased observers. The

group would provide insight into both the strengths and problems associated with Government's role in superconductivity.

In view of these criteria, it is proposed that the White House Science Council (WHSC) be designated as an advisory group to the President for superconductivity. The Council is composed of a group of eminent scientists, industrial executives, and academicians from leading research institutions such as IBM, Bell Labs, MIT, and Federal labs.

The WHSC has the advantage of being an established White House advisory group and, in its entirety or as a select subgroup, could be activated immediately as an advisory group on superconductivity.

2. Centers for Superconductivity Research

The Federal Government is engaged in significant basic research activities. This research is so widely distributed, however, that it is difficult for industry to know where a specific type of research is being conducted. Superconductivity research could be brought into focus through the establishment of superconductivity research centers with responsibility and funding shared between industry, academia, and Government.

Executive Order 12591, "Facilitating the Access of Science and Technology," encourages the movement of new knowledge from research laboratories into the development of new products and processes. Two important sections contained in the Executive Order relevant to superconductivity and collaborative research efforts are: (1) the Transfer of Federally Funded Technology and (2) the Basic Science

and Technology Centers. Establishment of superconductivity research centers in conjunction with Federal laboratories could well address both of these sections. At the same time, Centers would have the capability of collecting, assessing, and disseminating relevant information, thereby relieving industry of this duplicative burden and enhancing the technology transfer process.

To be effective, superconductivity research centers should meet four requirements:

1. They should have a scientific staff that is familiar with (a) current technology and (b) research in the field worldwide.

2. They should be active participants in superconductivity research.

3. A well-defined procedure should exist for dissemination of information about ongoing basic research to universities, industry, and Federal laboratories.

4. Procedures should exist to allow feedback from the private sector concerning this information to ensure timeliness and relevance of basic research activities.

Several agencies have suggested proposals for Centers in superconductivity research:

Department of Energy

The Department of Energy has proposed to establish formal and highly visible locations where information relevant to superconductivity can be obtained by U.S. industry or other organizations. These Centers would serve as sources from which industrial organizations could obtain nonproprietary information and thus could be in a better position to compete effectively in the end product market. The Centers should have name recognition in the field of superconductivity, have resident experts to assist in the analysis and transfer process, and have successful experience in dealing with outside organizations. Three Centers and a computer data base would be established, including:

1. Center for Superconductor Applications - at the Argonne National Laboratory.

2. Center for Thin Film Applications - at the Lawrence Berkeley Laboratory.

3. Center for Basic Scientific Information - at the Ames Laboratory.

4. Computer Data Base on Superconductivity - to be located at Oak Ridge National Laboratory.

Department of Commerce - NBS

The Department of Commerce has proposed the establishment of a Center located in the National Bureau of Standards laboratory in Boulder, Colorado that would focus on electronic applications of high temperature superconductivity. The Center's program would include key activities in materials research, surface science, and technical data generation.

Other

The Department of Defense, NASA, and the National Science Foundation also would cooperate in establishing Centers for superconductivity research.

Dissemination of research results on superconductivity through Centers would enhance the technology transfer process. Because of differences in patent regulations here and abroad, however, the dissemination of research results has the potential to transfer intellectual property rights to foreigners and to frustrate the intent of Executive Order 12591 and the Technology Transfer Act of 1986. Therefore, it will be necessary to assure that when these Centers are established, provisions are made to safeguard the patentability of results of federally supported research. The agencies should consult with the Director of the Patent and Trademark Office in designing and establishing these safeguard provisions.

3. Antitrust Reform

The Administration has submitted to Congress legislative proposals for reforming our antitrust laws and improving economic efficiency. Congress should act on the Administration's pending antitrust reform package, which would revise the antitrust laws, inter alia, to detreble damages in many cases and otherwise to reform antitrust remedies, thereby discouraging frivolous lawsuits that are designed to stifle, rather than to promote, innovative and aggressive methods of competition in domestic and international markets.

These general changes in our antitrust laws would provide broad benefits to many firms and industries, including firms or joint ventures involved with superconductivity. If the Congress is reluctant to act on these general antitrust reforms, the Administration should seek more specific reforms that directly would benefit firms involved in superconductivity activities.

More specifically, the National Cooperative Research and Development Act (NCRA) of 1984 provides that R&D joint ventures which are reported to the Justice Department will not be considered per se antitrust violations. Instead, they will be subject to the "rule of reason", taking into account all relevant factors affecting competition, including, but not limited to, competition in properly defined relevant markets. In addition, parties to these joint ventures will be liable only for single rather than treble damages. Finally, the NCRA allows defendants to collect costs and reasonable attorneys' fees from private party plaintiffs if the plaintiffs' suit is found "unreasonable."

However, the NCRA currently covers only R&D, up to and including the production of models and prototypes. The Act explicitly excludes joint production. Yet the ordinary process of commercializing new technologies often entails a substantial amount of risk (and learning) in the "early production" stage. The commercialization efforts of U.S. firms could substantially benefit from extending the NCRA to cover joint production on a commercial scale.

4. Strengthened Process Patents

United States patent laws provide protection for both new products and for production processes, but many developed and developing countries do not recognize process patents and feel free to operate using U.S. patent processes without benefit of a license. Technology pirating is a growing practice.

Last year and again this year the Administration proposed legislation to increase protection of process patents in the U.S. by making it more difficult to import into the U.S. products made in other countries in violation of U.S. process patents. If enacted, it would strengthen the incentives for firms to invest in improving manufacturing processes across a wide range of products, eventually including those that will develop in the area of superconductivity.

Early enactment of the Administration's proposed legislation is recommended.

5. Accelerated Patent Processing

At present the Patent Office will accelerate the processing of patents in certain designated areas at the request of a patent applicant. Most superconductivity-related inventions would fall within one of these currently designated categories and could be accorded accelerated treatment, if the patent applicant so requests. Effective patent protection begins when an application is filed and ends 17 years after the date on which the patent is granted. Therefore, the Patent Office will accelerate processing in designated areas only if requested to do so by applicants who are willing to accept the shorter period of effective protection. It is estimated that accelerated processing would halve the current two-year processing period.

In order to facilitate the application of superconductivity developments it is recommended that any superconductivity-related invention should be accorded accelerated treatment, if the applicant requests it.

6. Federal Conference on Commercial Applications of Superconductivity

The Office of Science and Technology Policy and the Department of Energy are jointly sponsoring a "Federal Conference on the Commercial Applications of Superconductivity" to be held in Washington, D.C., on July 28 and 29, 1987. The Conference is cosponsored by the Department of Commerce, the Department of

Defense, the National Science Foundation, and the National Research Council of the National Academies of Science and Engineering.

The objective of this Conference is to inform leaders in the business community about the developments in superconductivity, many of which are being generated in Government-funded laboratories. In doing so, the desire is to stretch imaginations and anticipate applications of superconductivity. Invited attendees will be drawn largely from senior management of U.S. industry as well as leaders from the Administration, Congress, Federal laboratories and universities.

The Conference would provide the President an excellent opportunity to publicize the important role the Federal Government is having in superconductivity research and to encourage the private sector to take advantage of the opportunities to capitalize on our preeminence in basic research by creating innovative and marketable applications of superconductivity.

7. Assessment Of The Effectiveness Of Private Access To Federal Laboratories

A number of Federal agencies have reprogrammed research activities to place more emphasis on superconductivity. While some of this research is being conducted through grants to individual researchers and universities, by far the largest portion is being conducted within the Federal laboratories.

Executive Order 12591 on Facilitating Access to Science and Technology directs, among other things, that the head of each

executive department and agency delegate authority to the director of each Government-owned Government-operated laboratory to enter into cooperative R&D agreements with state and local Governments, universities and the private sector and to license rights to intellectual property. It also directed the head of each executive department and agency to identify and encourage persons to act as conduits for the transfer of technology developed from Federally funded research.

The Executive Order requires the Director of the Office of Science and Technology Policy (OSTP) to convene an interagency task force, comprised of the heads of representative agencies and the directors of representative laboratories, to identify and disseminate creative approaches to technology transfer from the Federal laboratories.

Executive Order 12591, while directed to all Federal laboratory research, is of relevance to concerns about superconductivity in light of the rapid pace of scientific discovery. The interest in developments in superconductivity on the part of venture capitalists and industrial firms can be more efficiently satisfied when Federal laboratories have effective means of obtaining patents and for licensing those patents to private sector users. In the absence of effective programs, the transfer of Federally sponsored research and technology will be delayed or may not occur at all. Therefore, it is vital that Federal laboratories move quickly to develop the mechanisms required in the Executive Order for transferring technology to the private sector.

Recommendation

1. The heads of departments and agencies should be urged to move quickly to implement the technology transfer steps in Executive Order 12591.

2. Request the Director of OSTP and his task force, in their report to the President, mandated by the Executive Order, to highlight technology transfer issues related to superconductivity.

3. Provide greater exposure for the opportunities for Government-industry-state and local Government cooperation that are made possible by the Executive Order and the Technology Transfer Act of 1986. Using superconductivity as a vehicle to accelerate this proposal, a document or series of documents would be prepared to define and condense the opportunities now available for access to federally funded technology. The information would be made available to industry, academia, and local, state, and Federal Government. The Commerce Department is requested to perform this work.

8. Industrial Standards For Superconductivity

Industrial growth is facilitated by the existence of standards by which products are measured and described. Such standards

provide an agreed upon basis for communication among engineers and planners regarding existing and new products; standards are also an important basis for communicating product information to customers. Of equal importance is the need for devices that can accurately measure these standards.

The National Bureau of Standards plays a key role in developing standards and developing methods to measure industrial standards. Devices and other developments will be required to measure and characterize the high currents and magnetic field interactions associated with superconductors, to establish material standards for the measurement of superconductivity in thin films, wires and other forms, and to utilize the new high temperature superconductors for improved methods of measurement and for improved standards to replace existing standards and methods.

We recommend that the National Bureau of Standards accelerate its work leading to industrial standards related to superconductivity as well as to assure compatibility with the work being conducted by organizations involved in developing international standards.

Controversial Initiatives

One or more members of the Working Group have some concerns about the following initiatives, but the initiative is supported by a majority of the Working Group.

9. Proposed Legislation For The Freedom Of Information Act

Alternative 1.

A wealth of inventions and information is generated by U.S. scientists and engineers engaged in all areas of research including superconductivity. The inventions that arise as a result of this research can be protected by patents, but technical information that does not directly lead to an invention often is not offered the same degree of protection. Only certain types of information are protected by other provisions of law such as those involving classified or private proprietary information.

Under the existing provisions of the Freedom of Information Act (FOIA), all agencies of the Federal Government are required to make records, including those containing technical information, available to any person upon request, unless they are exempted by provisions of the act or other statutes. There are no current provisions to prevent the dissemination of Government generated technical information with commercial value that upon disclosure could result in an adverse economic impact to U.S. competitiveness.

Accordingly, it is proposed that certain technical information with commercial value to the United States be exempted from disclosure through a separate statute. The intention would be to have the statute apply under exemption 3 of FOIA which states that disclosure does not apply to matters "specifically exempted from disclosure by statute". The objectives of the statute would be twofold:

(1) To serve the national interest in preserving economic security by authorizing an agency to withhold certain highly sensitive technical information that upon disclosure would result in an extremely adverse economic impact to U.S. competitiveness.

(2) To protect the interests of the U.S. taxpayer in federally funded research by requiring the dissemination of technical information with commercial value only to "certified" requestors. Certified requestors could be American companies that have demonstrated a legitimate need for the data and full intention to use the information in the operation of the company.

Provisions of the statute would have to be carefully drafted to prevent the formation of a "cottage industry" of American companies that would simply redirect information to foreign users. Disincentives could be applied by making individuals of the company subject to the penalties of the statute if intentional disclosure were made to foreign nations or representatives of foreign nations. The information would be treated essentially as "U.S. Government proprietary information".

PROS

° The statute would, for the first time, provide a national exclusive right to requestors for technical information with commercial value.

- The statute would stem the flow of technical information from Federally funded research to foreign nations that could then enjoy a competitive advantage at the expense of the U.S. taxpayer.

- The national economic security could be preserved in cases where dissemination of information would severely impact U.S. economic interests.

CONS

- Withholding technical information from foreign researchers could violate the reciprocity provisions of existing Science and Technology Agreements and the U.S.-Japan Agreement on Science and Technology that currently is being reviewed before it is renewed (see Initiative 11, Science and Technology Agreements With Other Nations).

- Withholding technical information could lead to retaliation by foreign countries who might restrict access to their technical information by U.S. researchers.

- Difficulties arise in the definition of a U.S. company, and how joint ventures and U.S. companies owned by foreign firms would be affected.

- The additional paperwork burdens of certifying U.S. companies could be costly and time consuming.

- The burden of certification might serve to dampen efforts by some small U.S. companies to cooperate with Federal laboratories and universities engaged in federally funded research.

Alternative 2.

Alternatively, access to Government generated technical information with commercial value might be restricted without regard to the nationality of the individual or group requesting access to such information. If the information has commercial value, Government owned and operated labs should have the discretionary authority to sell such information for a price, even if the intended user is a domestic individual or company. Government labs could sell the information to the highest bidder. If the highest bidder is a foreign user, the lab should take into consideration whether the sale would have an adverse economic impact on U.S. competitiveness. Exemption 3 of the FOIA, which states that disclosure does not apply to matters "specifically exempted from disclosure by statute," e.g., classified or proprietary information, would continue to be applicable.

Thus, under this alternative the FOIA would be amended so that:

> Technical information of commercial value shall be exempt from dissemination under the FOIA. Rights to the use and

transfer of such information will remain with the originating Federal laboratory.

PRO

° Federal laboratories should be permitted to profit from the sale of technical information if there is a market for such information.

CONS

° The transfer of technical information to a foreign national, even for a price, could affect adversely U.S. competitiveness.

° Providing technical information to foreign countries only for a price might be construed to be inconsistent with the reciprocity provisions of our foreign Science and Technology Agreements.

10. Reprogram Funding for Superconductivity Research

Since 1981, the Administration has strongly supported basic research in a wide variety of fields, in recognition of the importance of such research to the nation's long-term economic competitiveness.

Several Federal agencies, notably the Departments of Energy (DOE) and Defense (DOD), the National Science Foundation (NSF) and the National Aeronautics and Space Administration have supported research in superconductivity (and related fields such as materials

science) for many years. These agencies were well-positioned to respond aggressively to the latest developments in high-temperature superconductivity.

Federal support for superconductivity research (including that related to high-temperature superconductivity) will total more than $40 million in FY 1987. About half of this total has been redirected over the last 7 months from other activities, nearly all of it for the new developments. For example:

- NSF has redirected $600,000 for "quick start" grants for research on processing the new superconductivity materials into useful forms and their total R&D spending on superconductivity has about doubled.

- DOE has nearly doubled its funding for superconductivity research to $25 million, including materials processing and applications for the new superconducting materials.

- DOD has increased its R&D spending on superconductivity by $5 million to an annual rate of $10 million.

If the scientific opportunities in superconductivity research continue to expand, agencies should be (encouraged) (directed) to continue to redirect existing resources into this exciting new area. Overall, the President's FY 1988 budget proposes a 12 percent increase in Federal support for R&D. This growth should provide ample opportunities for agencies to allocate additional

funding to superconductivity research both in 1988 and during the development of the 1989 President's budget.

PROS

° Reprogramming funds for superconductivity activities allows agencies to encourage the acceleration of developments in this area without violating the Gramm-Rudman-Hollings restraint on the budget deficit.

° Although some people believe the amount of additional funds the R&D community can efficiently absorb in the short run is relatively small, these reprogrammed amounts would still represent a substantial percentage increase in Federal funding for superconductivity.

CONS

° Reprogramming funds to superconductivity could deprive other worthy R&D activities of needed funding.

° Some people believe the amount of funding presently allocated to superconductivity is relatively small, and reprogramming will not increase this amount significantly.

11. Science And Technology Agreements With Other Nations

Since World War II our research and education establishments

have been open to foreign scientists, engineers, and students. This has produced enormous benefits, both economic and political, for the U.S. and for other countries.

The output of our basic research enterprise is widely available and disseminated to the world's scientific community, and both our Government and private sector have developed an extensive network of international agreements in science and technology that provide foreign researchers with access to American state-of-the-art facilities including those actively engaged in superconductivity research. As technological advances have become vital to continued economic prosperity both in the U.S. and abroad, it is crucial that countries maintain open access to their institutions that conduct research in basic science. Governments also must reciprocate in providing access to and participation in publicly sponsored research in applied science and technology.

The need to renew the U.S.-Japan Agreement on Science and Technology affords an opportunity to explicitly recognize the obligation of each Government to:

- reciprocate in facilitating access to its science and technology enterprise.

- provide adequate and effective protection of each other's intellectual property rights, including providing for the intellectual property rights to research in Government sponsored exchange programs.

Inclusion of these in a new U.S.-Japan Science and Technology Agreement that would generally govern science and technology exchanges between the two countries will make it easier for agencies to implement the objective of Executive Order 12591 to secure reciprocal access to science and technology activities when negotiating specific research or technical agreement with Japanese Government agencies. Such an agreement between the United States and Japan could be a model for U.S. agreements with other countries on science and technology.

PROS

° Would provide Federal agencies a clear overall framework for negotiating specific agreements with Japanese agencies.

° Would facilitate increase in U.S. access to Japan's S&T enterprise.

° Could provide an impetus for increased protection of U.S. intellectual property rights in Japan.

CONS

° Could complicate negotiations for some specific U.S. agency projects.

- The Government of Japan may not want to give explicit recognition to such obligations.

- Since U.S. firms in the past have not been willing to commercialize a number of new S&T developments, this suggests that a lack of access to new S&T developments (in Japan or elsewhere) is not a factor limiting commercialization of new technology by U.S. firms.

- Lack of access may not be a real problem in view of already existing programs for U.S. scientists and engineers to participate in Japan's S&T enterprise.

12. Rewarding Commercial Advances

American scientists are in the forefront of recent developments relating to basic research in superconductivity. Private sector initiatives to commercialize this new technology are underway. However, Government involvement may be needed to induce more rapid development. The question is how to do this while avoiding the creation of economic distortions and the need for large Federal expenditures.

One possibility would be to award, annually, prizes for significant scientific and engineering accomplishments in superconductor technology in the following categories:

1) Transportation

2) Energy generation, transmission, and storage

3) Computers and communications

4) Medical and scientific technology

5) Other applications

To be considered, a working prototype must exist, blueprints alone would not be acceptable. Since the objective of these annual prizes is to encourage U.S. commercialization, eligibility should be restricted to permanent residents of the United States and to U.S. corporations.

A panel of experts would determine the winning technological applications in each area and the winners would receive an honorarium high enough (perhaps $5 million) to be meaningful in terms of the costs involved in developing the technology. The winners would retain all proprietary rights to their inventions. Prizes would only be awarded when, in the opinion of the panel, a significant advancement has been achieved.

PROS

° A program of this sort would cost less than subsidizing all superconductor research.

° Avoids the need to modify the tax code to provide an incentive; could induce our best scientists in both the corporate sector and in universities to engage in applied research and commercial applications of superconductivity.

- Maintains a high profile for superconductivity research while making visible the Government's commitment to the development of this technology.

CONS

- The incentives may be weaker than those provided by direct subsidies.

- Would create economic distortions by altering the allocation of research and development resources.

- A potentially costly precedent for awarding prizes in other fields (e.g., biotechnology).

  Could cause political criticism that the President is willing to give significant monetary awards for superconductivity to the private business/academic sector but hasn't offered such rewards for the development of vaccines or cures for AIDS and other serious health problems that affect human life.

13. Accelerated Development of Superconductivity Prototypes

Agencies that have ongoing work on superconductivity or have recently initiated work in this area are urged to accelerate the development of prototype devices that embody high temperature superconductivity where prudent to do so. In particular:

CONS

° The Federal Government would be involved in what many believe is the responsibility of the private sector.

° Could require additional funding unless there is reprogramming.