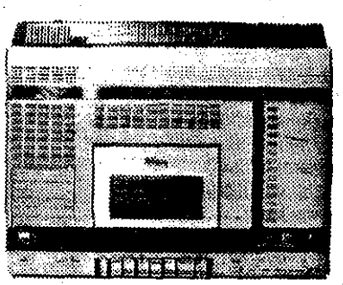
Lessons of the VCR Revolution

How U.S. Industry Failed to Make American Ingenuity Pay Off

Second of a series

By Boyce Rensberger
Washington Post Staff Writer



RUDE AWAKENINGS
THE CHALLENGE OF THE GLOBAL ECONOMY

The videocassette recorder is an American invention, conceived in the 1960s by Ampex and RCA. The first VCR for home use to reach the U.S. market, in 1971, was the American-made Cartri-Vision.

By the mid-1970s, however, every American manufacturer had judged the VCR a flop and had left the business.

Today not one American company makes VCRs. All of the 13.2 million units sold in the United States last year—36,000 every day for a total of $5.9 billion—were made in Japan or Korea.

Even RCA, once a proud, patent-holding pioneer of the new technology, is now simply a middleman, buying Japanese VCRs and reselling them under its own label.

The story of the VCR, according to many experts, illustrates some of the reasons why American industry is losing its global competitiveness. It challenges the popular notion that a loss of innovative capacity lies at the heart of this country's eroding economic position. While there is evidence that American innovation may have lost some vigor and that other nations are gaining fast, many experts believe the United States is still the world leader in scientific and technological innovation.

"The problem is not so much with American innovation," said Harvey Brooks, a specialist in technology and public policy at Harvard University. "Our scientists and engineers still lead the world in the origination of new ideas. The problem is what happens after that point. Where we're falling behind is in the ability to develop new ideas into products and to manufacture them to the high standards that we've come to expect from the Japanese."

The VCR is an example.

In the early '70s several companies in the United States, Holland and Japan unveiled VCR prototypes with great fanfare. Industrial-sized video recorders were already common in television studios, and the key to the home market seemed to be scaling down size, cost and complexity of operation. Most of the problems seemed near solution when the prototypes were demonstrated.

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Despite the Japanese and Dutch activity in VCR development, the American firms did not think of

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themselves as involved in an important global competition. It was an insular stance, common in many U.S. industries, that would later be seen as one of the causes of America's mounting trade deficit.

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Within two years, both Sony and JVC (Japanese Victor Corp.) developed two-hour VCRs. Rising to beat the competition, Matsushita came out with a four-hour machine.

Pattern of U.S. Reluctance

What would come to be called the VCR revolution, accounting for an appreciable share of the U.S.-Japan trade imbalance, had been won by the Japanese. The United States lost, according to many analysts, not because American scientists and engineers had abandoned their heritage of Yankee ingenuity but because American industrial managers were unwilling to invest the resources to apply that ingenuity long enough to make a good idea pay off.

"It's not as if the United States is caught by surprise by what the Japanese or anybody else is doing," Brooks said. "Our people know what's possible. What we've been surprised by is the rapid commercialization of ideas in Japan."

Brooks said a common U.S. pattern is to avoid investing in new products that aren't fairly sure to return profits quickly and to withhold marketing a new advance in an existing product line as long as its predecessor is selling well. And, until recently, U.S. companies have not planned seriously to compete in international markets.

Japan, by contrast, holds global economic dominance to be a national goal, invests long and heavily in research and development and devotes far more of its best engineering expertise to sophisticated manufacturing methods.

Such factors have given Japan the advantage even though its scientific and technological innovativeness remain well behind that of the United States in all but a few narrow fields.

Although the United States spends more in total dollars on research and development (R&D) than Japan and the next two closest competitors, West Germany and France, combined, according to figures gathered by the National Science Foundation, those competitors have been increasing their spending dramatically in recent years.

In relation to the size of each country's economy, all four countries are now investing about the same in science and engineering research.

In 1986 the United States spent 2.8 percent of its gross national product on R&D, only a modest increase from the 2.6 percent spent in 1970.

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Some experts note that it is not necessary to be the creator of a marketable idea to make money manufacturing the product. "Americans and especially members of the scientific community have exaggerated the purely economic benefits that flow from leadership at the scientific frontier," Stanford economist Nathan Rosenberg said.

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Different Cultures at Work

Many observers attribute much of Japan's rise to what amounts to a cultural difference between the way U.S. and Japanese scientists and engineers work.

American engineers often prefer to work in research and development rather than in manufacturing. In the United States, the engineer who invents a product holds higher status and earns more money than the engineer who figures out how to manufacture it to high standards and keep it profitably low in cost.

One painfully obvious result, according to many, is that while the United States still spawns plenty of brilliant ideas, there are too few first-rate engineers to design good products based on the ideas. And when they are designed, those products often contain many times more defects than do Japanese counterparts.

"The relatively lower status and lower pay that have characterized careers in [U.S.] manufacturing represent an impediment to attracting first-rate people. Engineering departments in colleges and universities have largely ignored the field until very recently," a panel of the National Academy of Engineering concluded in a 1985 report. "In sharp contrasts, in both Europe and Japan the status of technical education and of careers in manufacturing is higher."

By having better brains in manufacturing, the Japanese and the Europeans are able to develop superior manufacturing methods and technology.

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Another important difference, cited by many analysts and illustrated by the history of the VCR, is the greater willingness of Japanese firms to spend money over longer periods of time to bring a new product idea to fruition. U.S. firms are often run by professional business managers, untrained in engineering, who make decisions to maximize short-term profits.

In Japan, which has no business schools, high-technology firms are more likely to be run by engineers who showed management skills and who have advanced up the corporate ladder. They plan much further ahead and are willing to forgo short-term profits for a long-term advantage.

"American investors need earnings trends quarter to quarter. The Japanese are much more patient," said G. Stephen Burrill, head of a high-technology consulting group at Arthur Young, an accounting firm.

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Electronics has been one of Japan's oldest arenas of high-tech competition. One of the newest is biotechnology, another field pioneered chiefly in the United States and which promises a multibillion-dollar market supplying medicine with more effective drugs and diagnostic tools and supplying agriculture with various products to enhance crop yields. Japan's approach to biotechnology illustrates what many scientists see as another of that nation's advantages—Japan's method of creating government-supported consortiums of private corporations.

U.S. biologists invented gene splicing, also called recombinant DNA technology, and developed most of the methods of applying the technology. Although a swarm of new American entrepreneurial biotech firms has emerged, the Japanese are pushing hard to capture much of the market. Many leaders of U.S. biotech firms believe it will be hard, though not impossible, to stay ahead of Japan.

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"No MITI consortium in Japan, no industrial combine in the U.S. or elsewhere can duplicate or compete with the basic research capabilities of America's great research universities," Schneiderman said.

While such corporate-university collaborations are developing, there is controversy as to whether industry's need for proprietary secrecy conflicts with the traditional openness of university research.

Most university-based research in biotechnology is funded by federal grants and some industry leaders, such as Ronald E. Cape, chairman of Cetus Corp., a California biotech firm, worry that spending in this area has not grown significantly in several years. Because Japan's spending on basic biotech research is continuing to grow, Cape forecasts that Japan will take the world lead in biotechnology in the 1990s.

"In 10 years, if what I'm saying is correct," Cape says, "I bet we'll have hearings in Congress and a lot of American industrialists will bitch and moan about how the Japanese have done unfair things in trade. But that is not the case with biotechnology. The Japanese are doing the right thing."

NEXT: The role of education

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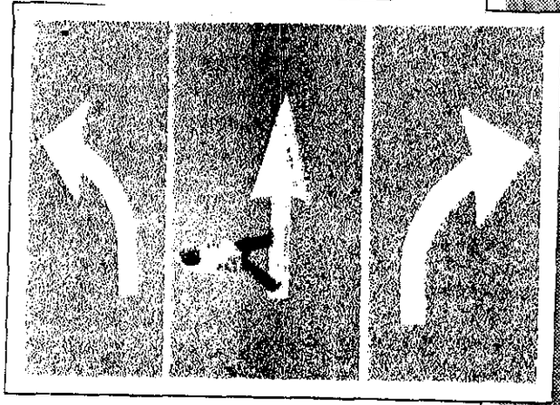

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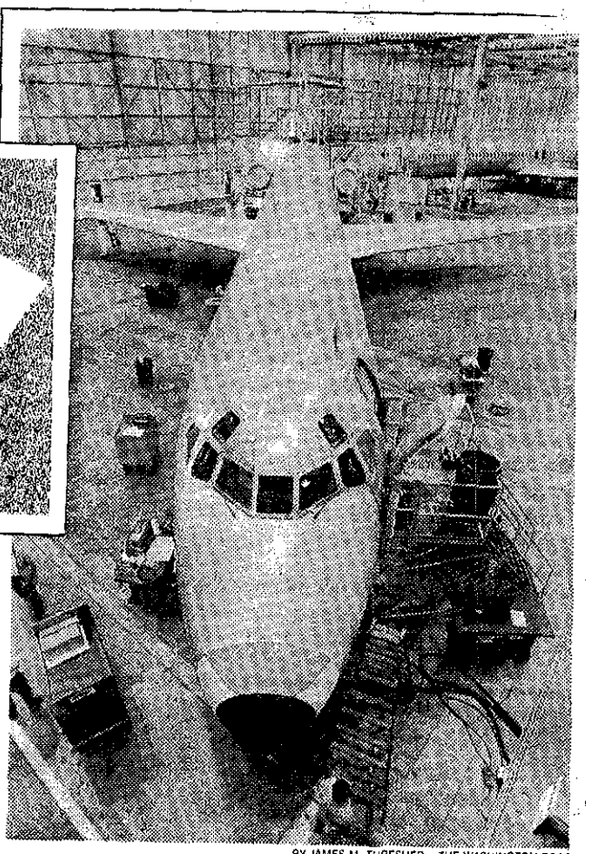

BY JAMES M. THRESHER—THE WASHINGTON POST

An MD80 jet nears completion at a McDonnell Douglas plant in Long Beach, Calif. Britain invented the jet engine, but U.S. imitators, including McDonnell Douglas, improved on the idea and reaped most of the economic benefits—doing to Britain what Japan now does to the United States.

MISSED OPPORTUNITY

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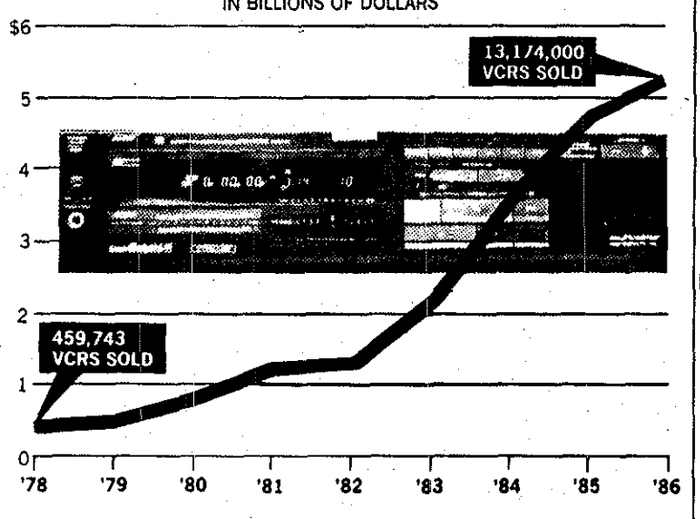
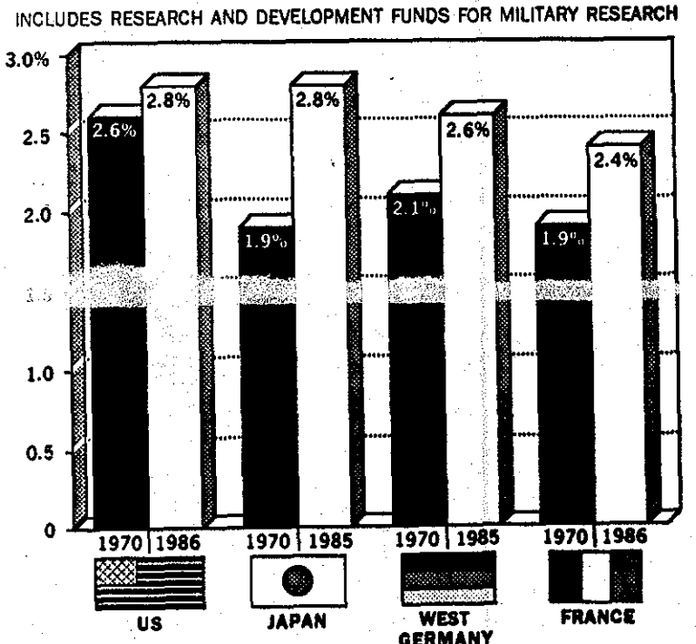


OURCE: Electronic Industries Association

BY JO ELLEN MURPHY—THE WASHINGTON POST

PERCENTAGE OF GNP SPENT ON RESEARCH AND DEVELOPMENT

INCLUDES RESEARCH AND DEVELOPMENT FUNDS FOR MILITARY RESEARCH



SOURCE: National Science Foundation

BY TOBEY—THE WASHINGTON POST

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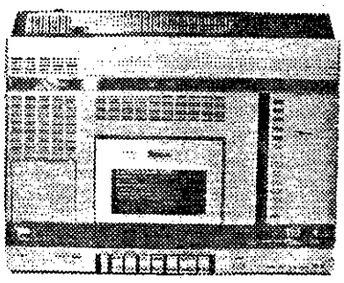

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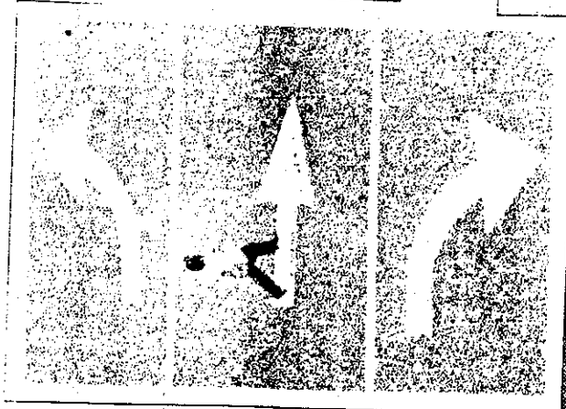
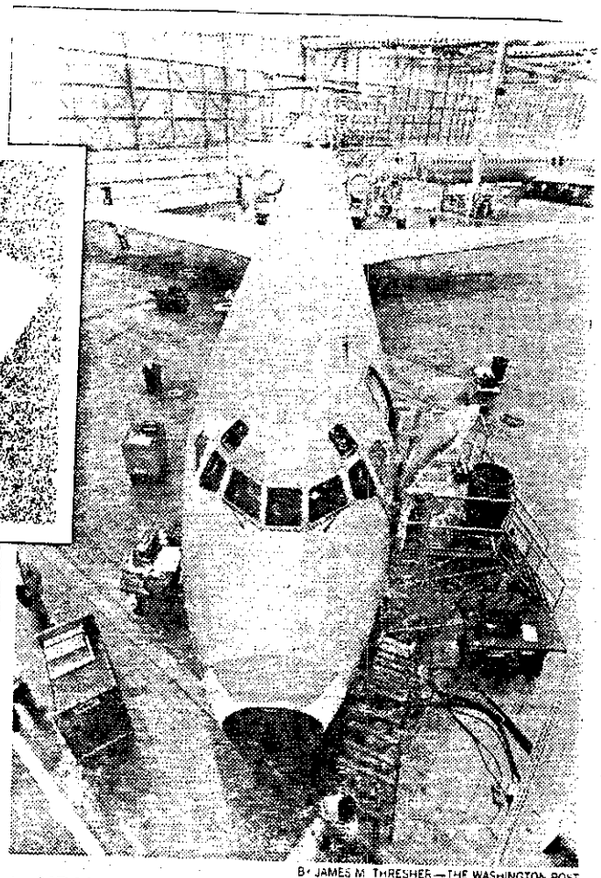
RUDE AWAKENINGS



The United States may have lost the VCR revolution because industrial managers were unwilling to invest resources long enough to make a good idea pay off.

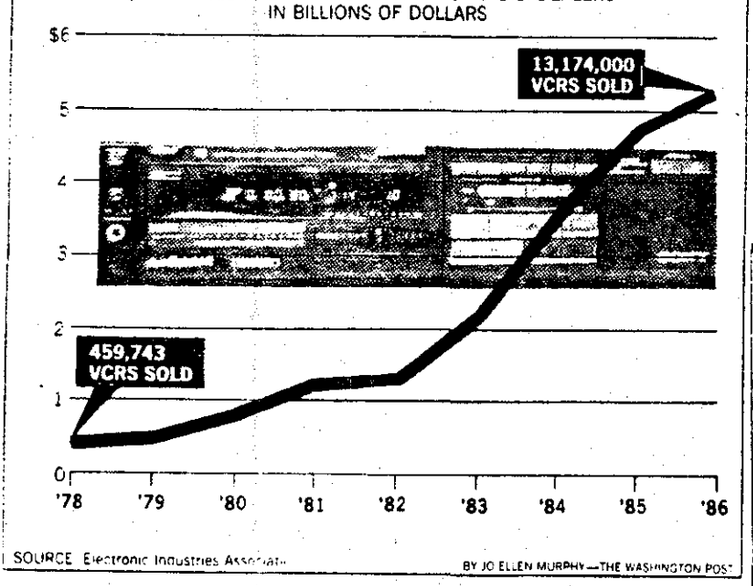


BY JAMES M. THRESHER—THE WASHINGTON POST

An MD80 jet nears completion at a McDonnell Douglas plant in Long Beach, Calif. Britain invented the jet engine, but U.S. imitators, including McDonnell Douglas, improved on the idea and reaped most of the economic benefits—doing to Britain what Japan now does to the United States.

MISSED OPPORTUNITY

VCR SALES FROM MANUFACTURERS TO U.S. DEALERS
IN BILLIONS OF DOLLARS

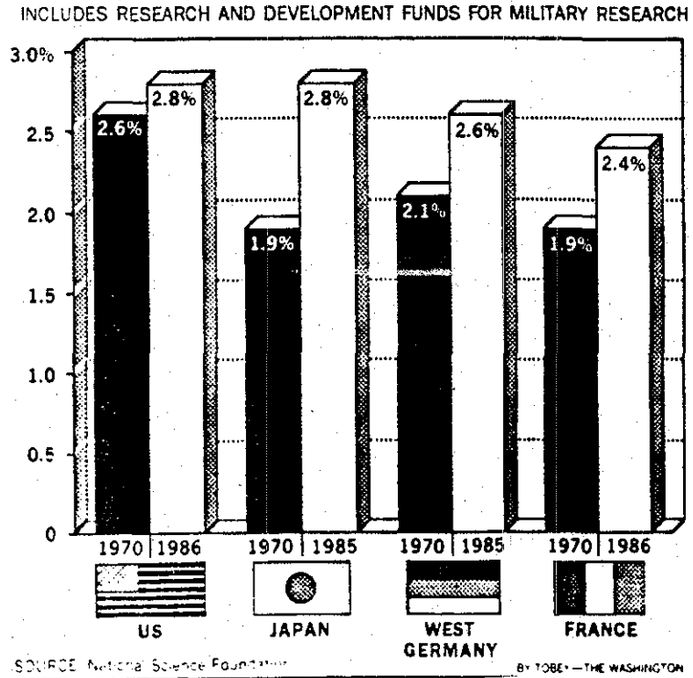


SOURCE Electronic Industries Associat...

BY JO ELLEN MURPHY—THE WASHINGTON POST

PERCENTAGE OF GNP SPENT ON RESEARCH AND DEVELOPMENT

INCLUDES RESEARCH AND DEVELOPMENT FUNDS FOR MILITARY RESEARCH



SOURCE National Science Foundat...

BY TOBEY—THE WASHINGTON

U.S. Competitiveness: A Campaign Code Word

Can It Spark Offensive on Complacency?

Fifth of a series

By David S. Broder
Washington Post Staff Writer

"Competitiveness," said Secretary of Labor William E. Brock, a longtime student of political fashions, "is the new code word in Washington, and Washington needs code words. It doesn't think in sentences very often."

Brock's comment at a recent conference reflects both the

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sexiness of the competitiveness issue and its lack of precision. Substantively, the issue is one of the most complex. But talking to voters such as those The Washington Post interviewed this week in Knoxville, Tenn., it comes down to two very simple, basic, human questions:

- What kind of jobs will there be for our children here, where we live?
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The fear that gnawed at many Americans in those living-room interviews is that the Land of Opportunity is becoming a Nation of Reduced Expectations and Limited Options, because of its inability to meet the challenge of economic competition.

The shock effect of the trade deficits of the last few years has been compared with that of the Soviets' launching of Sputnik in the late 1950s. The question is whether a national effort to end what is perceived as economic-scientific-educational "complacency" will result.

A response is visible in many local communities and a growing number of states. Many would

See COMPETE, A14, Col. 1

welcome seeing the next president act to push such programs to the national level, but there is a risk of government once again promising more than it can deliver.

Alice Rivlin, the Brookings Institution economist and former director of the Congressional Budget Office, argues that "competitiveness is the wrong word," because it implies that through some stratagem Americans can reassert economic supremacy in the world. "There's no way to recreate the advantages the United States had at the end of World War II," she said.

"For the future, 'winning' means advancing together through expanded trade with other major countries, and realizing that we can't always be the leader, but we don't always want to be the follower."

At the other end of the political spectrum, Heritage Foundation president Edwin J. Feulner Jr., asked, "Who can be against competitiveness? It's a meaningless word."

Maybe, but in the political realm it is thought to have a potency which encourages possessiveness. "If there's one issue I'd like to have royalties on in the next 18 months," said Democratic pollster Harrison Hickman, "it would be competitiveness."

Robert Teeter, whose surveys are used by many Republicans including Vice President Bush, remarks, "It may not be a red-hot issue right now, but it could be at any moment, especially if the economy turns down. And the candidates and parties want to be sure they don't get caught on the back of the wave."

That may explain why, when the Congressional Caucus on Competitiveness announced it was open for business at the start of the 100th Congress last January, more than 190 House and Senate members signed up.

Charles McMillion, the policy director of the caucus' support group, the Congressional Economic Leadership Institute, identified through a computer search more than 5,000 "competitiveness bills" introduced in the last Congress. "And that," he adds, "was before it got hot."

'A Sense That We Are Falling Behind'

"Among the voters we interview," said Democratic pollster Geoff Garin, "there is an increasing tendency to think of the economy in global terms . . . and a sense that we are falling behind. There is very widespread resentment about unfair restrictions [on American goods] by other countries. But Americans are also saying that we could have done better as a country, we should have done better, and we better do it now. And they're ready for someone to call America to a higher standard."

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Massachusetts Gov. Michael S. Dukakis (D), whose state is the textbook model other governors cite for their own efforts at job-producing economic development strategies, shares Hart's skepticism about protectionist measures, and even argues that the oil-import fee Hart advocates is "as protectionist as you can get."

But in recent months, the other second-tier candidates—each hoping to establish himself as Hart's main rival—have almost leapfrogged each other in finding rhetoric and proposals close to the AFL-CIO position.

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The issue has been less debated among Republicans. Their leading presidential prospects all have warned about protectionism in trade policy as a threat to national prosperity. Vice President Bush told a Canadian audience last year, "We are trying as hard as we can to derail the protectionist juggernaut now sweeping through the United States Congress . . . . Our goal is to knock down trade barriers, not build them up. We stand for free, and yes, fair trade."

The same stance has been taken by former secretary of state Alexander M. Haig Jr. Citing his experience as a business executive, Haig argues that reducing the federal budget deficit and opening the channels of international trade will be far more useful than any retaliatory threats in improving America's competitive position.

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A Muddle of Public Opinion

Public opinion is less firm than the emotional rhetoric of trade and competitiveness debate would lead one to suppose.

In a survey 18 months ago, The Washington Post and ABC News found respondents split almost evenly—49 to 43 percent—for the proposition that the federal government should try to preserve American jobs by imposing taxes and limits on foreign imports, even if that meant higher consumer prices. But by a 55-42 percent margin, they rejected the "Buy American" theory, saying they should not be expected to pick U.S.-made products over foreign-made products of higher quality.

When it came to explaining the trade deficit, 64 percent of those polled mentioned the higher wages and benefits of American workers, 61 percent cited foreign restrictions on the entry of American goods, 60 percent mentioned the budget deficit and 57 percent the high valuation the dollar then had.

A CBS News-New York Times poll last April found 53 percent of those surveyed believed Japanese restrictions on imported American goods were unfair, but a nearly identical 50 percent said Japanese workers are harder workers than their American counterparts.

The most recent survey, taken in January by the Roper Organization for U.S. News and World Report, found price and wage differentials between the United States and foreign countries cited far more often as the underlying reasons for the trade deficits than restrictive practices abroad or quality-differences.

Somewhat inconsistently, the most favored solutions, of seven alternatives offered, were to "tighten up our quality control standards," increase research and development funds to improve processes and products and "get much tougher with other nations and force them to open their doors to our products." A relatively narrow 50 to 39 percent majority said the United States should "shut our doors to imports . . . if they are hurting U.S. workers and companies."

The muddle of opinions confirmed the view of Republican pollster Teeter, who has studied public attitudes on the competitiveness issue for several business groups, that "because the issue is so complex, voters have a great deal of uncertainty." Teeter said protectionist sentiment peaked during the 1981-82 recession and could come back to swing "a ton of votes" in the next economic downturn. "Right now," he said, "most voters are saying, 'We have to compete better, and I think we can, but as an individual, I have no idea what I'm supposed to do.'

"I don't think the voters feel they have had much leadership from anybody, and they're hoping to get it from the 1988 election," he said.

Whether they get leadership—or just rhetoric—remains to be seen.

NEXT: Pressures of a new magnitude.

In recent years, many states have forged ahead with "competitiveness" initiatives that could serve as models in the national discussion.

Government aid for promising young companies or struggling older ones, has become commonplace in an array of state efforts. More than two dozen states, for example, have initiated venture capital programs that steer funds to budding entrepreneurs or existing smaller companies.

Connecticut created the first state venture capital firm in 1975. Its legislature has provided more than $27 million in appropriations since then to help companies develop nearly 100 new products.

About a half-dozen states have freed a total of more than $1.5 billion from public employe retirement funds to invest as venture capital. Others have created joint public-private venture capital operations or have devised tax breaks to spur more venturesome investments.

Ohio, New York, Pennsylvania and about a half-dozen other states have been stressing uses by existing industries of the technologies the states are helping to nurture.

"Michigan, for example, is sponsoring institutes to develop robotics for application to its durable goods manufacturing and biotechnology related to its forestry and agriculture industries," a recent Committee for Economic Development report notes.

"Colorado has established the Colorado Advanced Technology Institute to encourage basic and applied research . . . in such fields as advanced materials, microelectronics and telecommunications," it added.

States also have been increasing their effort to help firms sell their wares abroad or attract foreign investors.

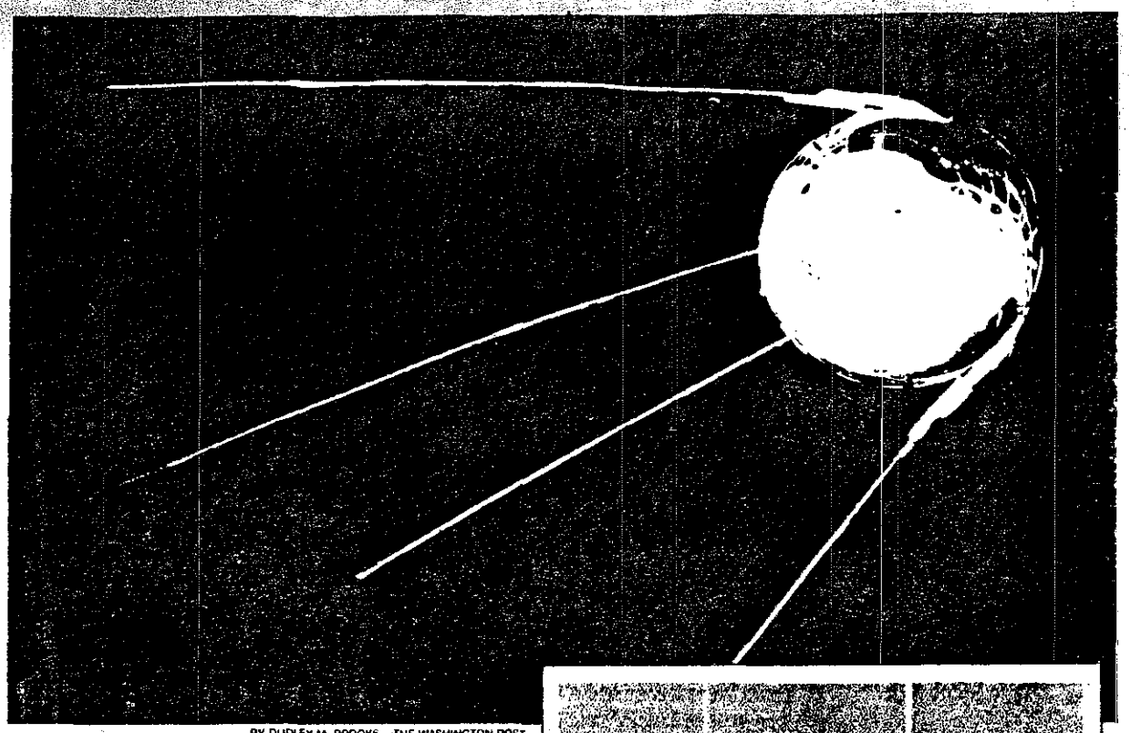
The University of Alabama has become known for aggressively helping to lure foreign investments and joint ventures. The Port Authority of New York and New Jersey has begun a government trading company called XPORT; it helps companies with the design, packaging, pricing, marketing and other needs of selling overseas.

The states have spent hundreds of millions of dollars for increased campus research capacity, technology centers, research parks and related programs, often promoting joint efforts among businesses, universities, labor and government in the process.

There is little reliable knowledge about which state efforts "work," however that is defined.

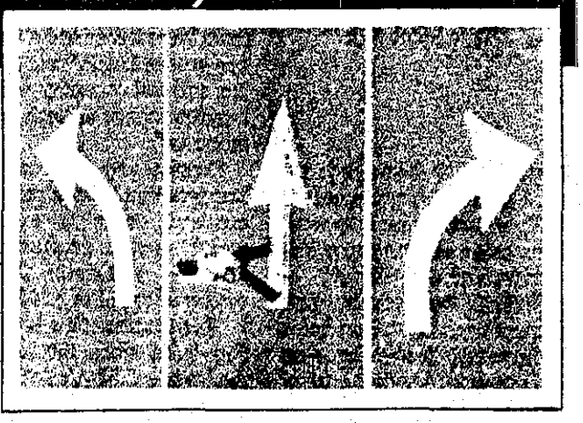
In a study issued last summer, for example, the National Governors' Association found that "hard data documenting job generation results is scant . . . and the result is that currently it is difficult to assess what works best."

—Noel Epstein



BY DUDLEY M. BROOKS—THE WASHINGTON POST

Sputnik I model at the National Air and Space Museum.



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The muddle of opinions confirmed the view of Republican pollster Teeter, who has studied public attitudes on the competitiveness issue for several business groups, that "because the issue is so complex, voters have a great deal of uncertainty." Teeter said protectionist sentiment peaked during the 1981-82 recession and could come back to swing "a ton of votes" in the next economic downturn. "Right now," he said, "most voters are saying, 'We have to compete better, and I think we can, but as an individual, I have no idea what I'm supposed to do.'

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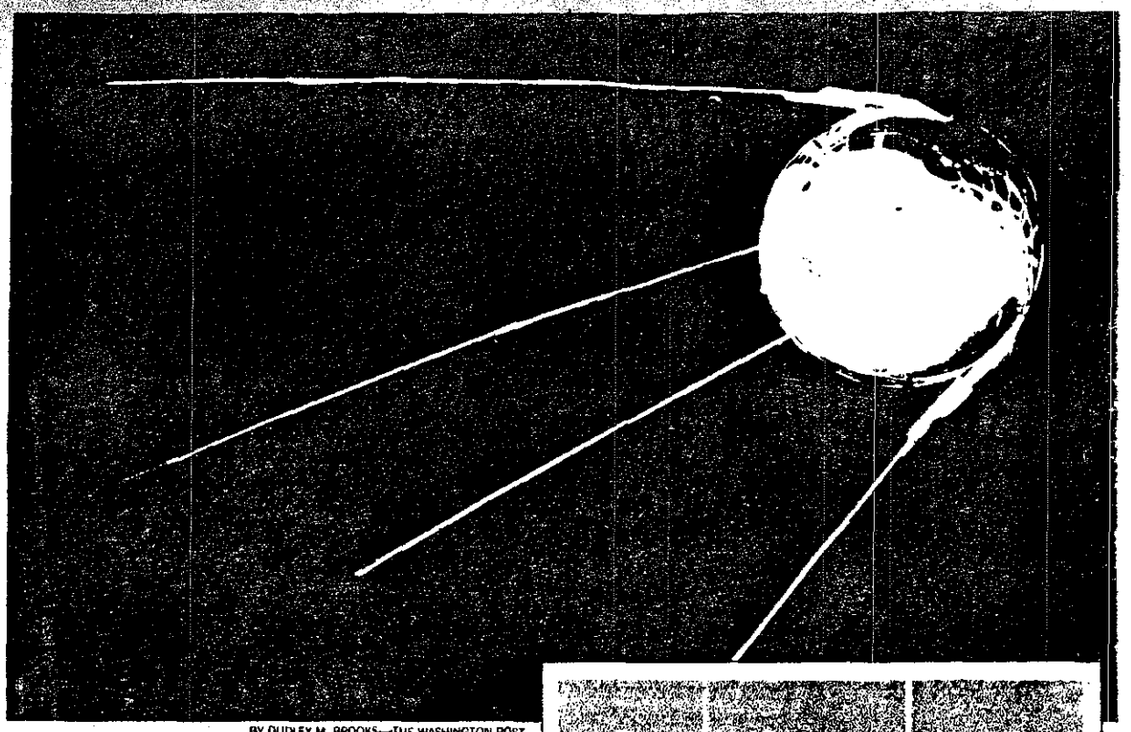

BY DUDLEY M. BROOKS—THE WASHINGTON POST

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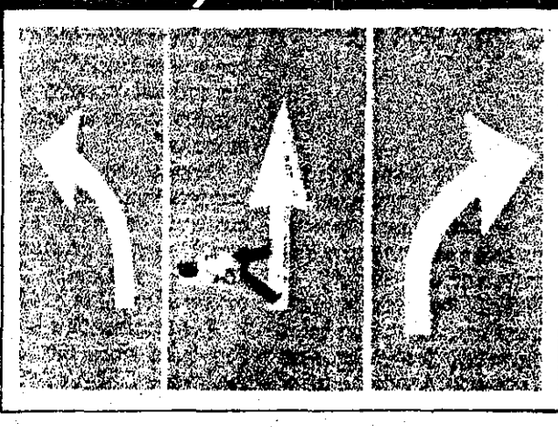

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U.S. Competitiveness: A Campaign Code Word

Can It Spark Offensive on Complacency?

Fifth of a series

By David S. Broder
Washington Post Staff Writer

"Competitiveness," said Secretary of Labor William E. Brock, a longtime student of political fashions, "is the new code word in Washington, and Washington needs code words. It doesn't think in sentences very often."

Brock's comment at a recent conference reflects both the sexiness of the competitiveness issue and its lack of precision. Substantively, the issue is one of the most complex. But talking to voters such as those The Washington Post interviewed this week in Knoxville, Tenn., it comes down to two very simple, basic, human questions:

- What kind of jobs will there be for our children here, where we live?
- What is the chance of maintaining the American standard of living for that next generation?

The fear that gnawed at many Americans in those living-room interviews is that the Land of Opportunity is becoming a Nation of Reduced Expectations and Limited Options, because of its inability to meet the challenge of economic competition.

The shock effect of the trade deficits of the last few years has been compared with that of the Soviets' launching of Sputnik in the late 1950s. The question is whether a national effort to end what is perceived as economic-scientific-educational "complacency" will result.

A response is visible in many local communities and a growing number of states. Many would

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RUDE AWAKENINGS
THE CHALLENGE OF THE GLOBAL ECONOMY

welcome seeing the next president act to push such programs to the national level, but there is a risk of government once again promising more than it can deliver.

Alice Rivlin, the Brookings Institution economist and former director of the Congressional Budget Office, argues that "competitiveness is the wrong word," because it implies that through some strategem Americans can reassert economic supremacy in the world. "There's no way to recreate the advantages the United States had at the end of World War II," she said.

"For the future, 'winning' means advancing together through expanded trade with other major countries, and realizing that we can't always be the leader, but we don't always want to be the follower."

At the other end of the political spectrum, Heritage Foundation president Edwin J. Feulner Jr., asked, "Who can be against competitiveness? It's a meaningless word."

Maybe, but in the political realm it is thought to have a potency which encourages possessiveness. "If there's one issue I'd like to have royalties on in the next 18 months," said Democratic pollster Harrison Hickman, "it would be competitiveness."

Robert Teeter, whose surveys are used by many Republicans including Vice President Bush, remarks, "It may not be a red-hot issue right now, but it could be at any moment, especially if the economy turns down. And the candidates and parties want to be sure they don't get caught on the back of the wave."

That may explain why, when the Congressional Caucus on Competitiveness announced it was open for business at the start of the 100th Congress last January, more than 190 House and Senate members signed up.

Charles McMillion, the policy director of the caucus' support group, the Congressional Economic Leadership Institute, identified through a computer search more than 5,000 "competitiveness bills" introduced in the last Congress. "And that," he adds, "was before it got hot."

'A Sense That We Are Falling Behind'

"Among the voters we interview," said Democratic pollster Geoff Garin, "there is an increasing tendency to think of the economy in global terms . . . and a sense that we are falling behind. There is very widespread resentment about unfair restrictions [on American goods] by other countries. But Americans are also saying that we could have done better as a country, we should have done better, and we better do it now. And they're ready for someone to call America to a higher standard."

That call—in varying notes—is being sounded by almost all the prospective 1988 presidential candidates. And it is a theme of the closing phase of the Reagan administration.

In February, just before the Tower commission issued its critical report on the Iran affair, the president sent Congress a bulky package of competitiveness proposals, involving 13 separate bills and amendments to seven other existing pieces of legislation.

President Reagan, who has emphasized market forces as the main instrument for economic progress, went further in this set of measures than ever before in defining a role for the federal government in education and training, in basic research and in remedying predatory trade practices by other nations. The Democratic cochairmen of the Competitiveness Caucus, Rep. Buddy MacKay (Fla.) and Sen. Max Baucus (Mont.), welcomed the president's initiative but said it could only be the starting point for a long-term agenda.

"Not sufficiently aggressive," MacKay said. "Weak tea," Baucus agreed.

Many of the Democratic presidential hopefuls are vying to show themselves tougher than their rivals in the trade legislation debate which is central to the competitiveness issue.

The front-runner, former senator Gary Hart of Colorado, early on chose to define himself as a critic of "the new protectionism" that he said some of his fellow-partisans were offering as "snake oil medicine" for curing trade imbalances. Import restraints, he warned in a speech last year, "enshrine U.S. industrial weakness, sanction inefficiency and concede the superiority of our competition . . . . The new protectionism is the new economic defeatism and isolationism . . . ."

Hart advocated retaliatory measures only against specific, proven violations of international trade rules and cautioned that "if we could somehow wave a wand and abolish all the illegal trade barriers, the trade deficit would only fall about 10 percent." An overvalued dollar and uncompetitive industries are far more fundamental problems, he said.

Competitiveness A Complex Issue On 1988 Agenda

Protectionism and Wooing Labor

Hart's position has left his rivals in the Democratic race both room and incentive to take positions closer to that of its largest allied interest group, organized labor, particularly the American Federation of Labor and Congress of Industrial Organizations (AFL-CIO), which has argued for years that foreign governments and foreign businesses are raiding U.S. markets and stealing U.S. jobs.

Massachusetts Gov. Michael S. Dukakis (D), whose state is the textbook model other governors cite for their own efforts at job-producing economic development strategies, shares Hart's skepticism about protectionist measures, and even argues that the oil-import fee Hart advocates is "as protectionist as you can get."

But in recent months, the other second-tier candidates—each hoping to establish himself as Hart's main rival—have almost leapfrogged each other in finding rhetoric and proposals close to the AFL-CIO position.

Rep. Richard A. Gephardt (D-Mo.) has taken advantage of his post on the House Ways and Means Committee to sponsor labor's favorite trade provision, a proposal that would levy stiff penalties on goods from nations such as Japan that fail to reduce their trade surpluses with the United States by a prescribed amount. In his announcement speech, Gephardt said he was not willing to "rely on the untender mercies of our trading partners," and said he would make U.S. military assistance conditional on lessened competition from such countries as South Korea.

Another second-tier challenger, former Arizona governor Bruce Babbitt, has gone a step farther. When he declared, Babbitt said he would "tear up all the complicated [trade] agreements" negotiated in the past and require each nation to balance its trade accounts—or else. If a nation failed to eliminate one-third of its trade surplus with the United States each year, it would face tariffs on its exports rising from 33 percent to 100 percent in three years.

Jesse L. Jackson, planning a second assault on the Democratic nomination, spotted another danger in letting "foreign goods enter our markets without many restrictions." The profits from those sales, he said in a January speech, let foreign firms buy or build plants in the United States, and "they have shown that they have little respect for the rights won by blacks, Hispanics and other minorities during the long civil rights struggles of the 1960s and the union organizing campaigns of the 1930s. They want to transform American society into a controlled society . . . ."

And Sen. Joseph R. Biden Jr. (D-Del.), expected soon to enter the field, told a recent meeting of AFL-CIO leaders that he was "not satisfied just to 'compete.' If you acknowledge that you have to become competitive, you've already acknowledged that you are losing . . . . It says your goal is equity, your goal is parity, your goal is to be as good as the other guy . . . . The Japanese, the Europeans, the Koreans—they don't want to compete; they want to beat our brains out . . . . I don't want to 'compete;' I want to win, flat-out win."

Watching the Democrats try to outdo each other, Competitiveness Caucus cochairman Baucus wryly remarked, "You do get a sense that organized labor has a large role in organizing the Iowa caucuses."

Republicans' Free-Trade Debate

The issue has been less debated among Republicans. Their leading presidential prospects all have warned about protectionism in trade policy as a threat to national prosperity. Vice President Bush told a Canadian audience last year, "We are trying as hard as we can to derail the protectionist juggernaut now sweeping through the United States Congress . . . . Our goal is to knock down trade barriers, not build them up. We stand for free, and yes, fair trade."

The same stance has been taken by former secretary of state Alexander M. Haig Jr. Citing his experience as a business executive, Haig argues that reducing the federal budget deficit and opening the channels of international trade will be far more useful than any retaliatory threats in improving America's competitive position.

Bush's leading rival in the early polls, Sen. Robert J. Dole (R-Kan.), helped block the enactment of the House-passed, Democratic-and-labor-backed trade bill last year by keeping it off the Senate calendar. But Dole has played a subtle role, leading congressional delegations to Japan to warn its officials of retaliation if their markets were not opened to American goods and services. Setting himself up for a bargaining role, this year he has sponsored both the administration "competitiveness" package, with its mild trade bill, and a stiffer trade bill drafted by Sens. Lloyd Bentsen (D-Tex.) and John C. Danforth (R-Mo.).

Dole's less-than-doctrinaire position has been criticized by another contender, former Delaware governor Pierre S. (Pete) du Pont IV. In an article last year for Policy Review, a publication of the Heritage Foundation, du Pont accused Dole of "using mystical buzzwords such as 'fair trade' and 'level playing field' to cloak his intentions."

Du Pont demanded: "Why doesn't someone stand up and say that even if the Japanese market were totally open to American goods, the resulting increase in our exports (less than $10 billion) would hardly put a dent in our trade deficit . . . ? Why doesn't someone point out that if the United States were to level its playing field, too (by repealing the protection on textiles, sugar, steel, etc.), the trade deficit might very well get worse, not better? Hasn't Bob Dole—a Republican leader—learned the Smoot-Hawley lesson, or the Mondale lesson of 1984, that pandering to special interests is a recipe for political disaster?"

Du Pont's program is to "reduce worldwide barriers to trade" and make the United States more competitive, primarily, he said, by continuing to cut income taxes and trimming payroll taxes.

Sharing the free-trade end of the Republican spectrum with du Pont is Rep. Jack Kemp of New York. In several speeches, Kemp has ridiculed the "industrial policy" proposals Hart and other Democrats have offered for targeting public and private investments to selected industries facing tough international competition.

"This is corporate welfare," Kemp complained. "The fund would quickly . . . subsidize failure and inefficiency. What a national industrial policy really means is constant collusion between big business and big government."

In the trade area, Kemp in February introduced with Sen. Phil Gramm (R-Tex.) a measure that he called an antidote to the prescriptions of both the "neo-protectionists" and the "wimpy free-traders," a bill "designed to force world-wide competition to lower trade walls, not raise them."

A key provision would permit the president to negotiate bilateral or multilateral free trade zones, on a reciprocal basis, with Canada, Mexico and the Caribbean basin, thus, he said, "making subsidies and protectionism . . . very expensive for Europe and Asia."

As a bar to protectionist bills, Kemp would require that "consumer impact statements" be part of any trade legislation coming before Congress—presumably to demonstrate how it raises prices for domestic buyers.

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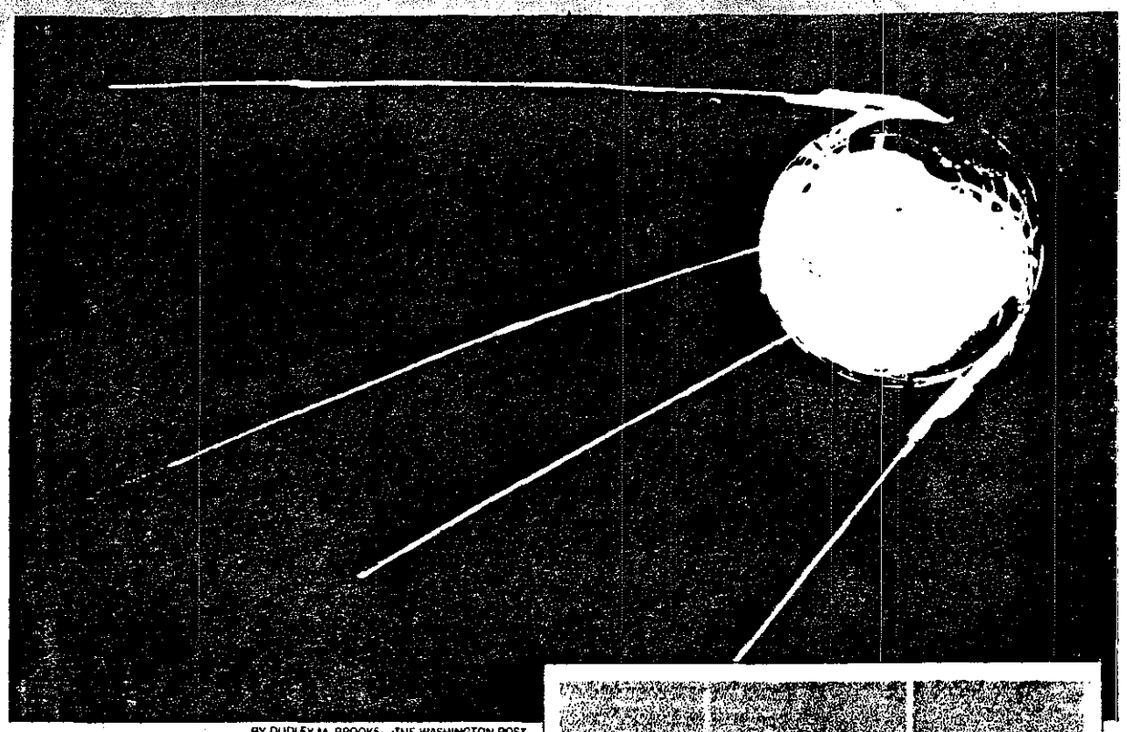

BY DUDLEY M. BROOKS—THE WASHINGTON POST

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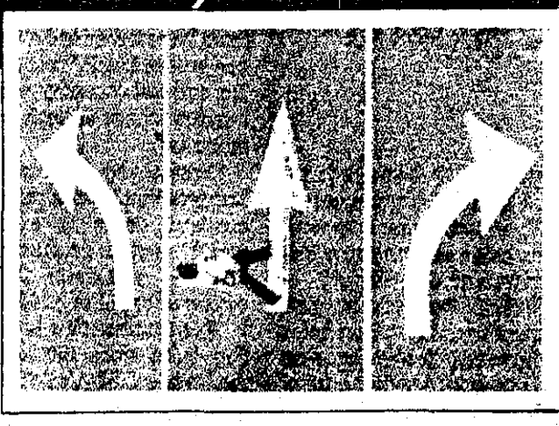

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America, the 'Diminished Giant'

As Rivals Strengthen, U.S. Dominance in World Marketplace Fades

Fourth of a series

By Stuart Auerbach
Washington Post Staff Writer

The first made-in-Korea Hyundai automobile rolled into the United States 14 months ago, driven off a Japanese freighter at the port of Jacksonville, Fla.

To those who still regard Korea as the underdeveloped nation depicted in the sitcom M*A*S*H, instead of a budding industrial giant, what happened next was perhaps a surprise.

The low-priced Hyundai swept through this country, setting a record for first-year sales by an imported car—168,882 sold in 1986—and quickly became a name to be reckoned with in the world auto industry.

The Hyundai sailed on winds of change that have drastically transformed the economic shape of the globe—establishing an entirely new relationship between the United States and the rest of the world, making it vastly more difficult for U.S. industries to compete in crucial global markets.

The changes have been so sweeping and have taken place with such astonishing speed—over just 15 years—that they are only partly understood by the American public and policy-makers in government.

RUDE AWAKENINGS
THE CHALLENGE OF THE GLOBAL ECONOMY

But virtually all the experts agree that the era of overwhelming U.S. dominance of the international economy—an era that began after World War II when much of the rest of the world was devastated—is over.

"We have come to a divide," said University of California political scientist John Zysman. "The economic changes we are watching will reshape the international security system. They are fundamental shifts of the power relations among nations."

In the United States, these changes have contributed to serious economic dislocation: the closing of steel mills and auto plants, the conversion of the industrial heartland into the Rust Belt, a loss of millions of manufacturing jobs.

They have raised questions, as C. Fred Bergsten, director of the Institute for International Economics, wrote recently in Foreign Affairs magazine, as to whether

See COMPETE, A18, Col. 1

U.S. Faces Up to Erosion Of Economic Supremacy

COMPETE, From A1

the United States can keep its mantle of world leadership.

At the same time, many experts believe that for all the pain caused in the United States by these changes, the world as a whole is a better place. "We have built a world system where we are now beginning to bring into membership at the highest levels countries which 25 years ago were in poverty," said Henry Nau, professor of political science and international relations at George Washington University.

The most visible symbol of America's loss of global economic supremacy is four years of towering trade deficits, which reached $170 billion last year, coupled with the transformation of the United States in the last year from a creditor nation into what Bergsten called "the largest debtor nation ever known to mankind." The United States now owes about $220 billion more abroad than foreign countries owe the United States.

By the end of this decade, he said, the United States will owe more than a half-trillion dollars and will be paying tens of billions of dollars a year in interest to foreign investors.

Many more signs illustrate how the United States is no longer the preeminent player in the world economy, and how other nations are coming up:

- In 1950, the United States produced 40 percent of the world's goods and services. By 1980, the U.S. share had dropped almost by half, to 22 percent. Meanwhile, Japan's share climbed from less than 2 percent to about 9 percent, and Europe's share rose from 21 percent to almost 30 percent.
- For the first time since World War II, the United States last year lost its position as the world's leading exporter, supplanted by West Germany, with Japan pressing on the United States in third place.
- Last year, again for the first time, the United States ran a trade deficit in high-technology products, considered the wave of the future for the U.S. economy and critical for U.S. national security.
- In 1974 the United States was responsible for the design of 70 percent of the advanced technology in the world. By 1984, this figure had dropped to 50 percent. According to estimates, it will slide further, to 30 percent by 1994.

The 'Four Tigers'

Most surprisingly, at least to Americans who were not paying attention, has been the emergence of a whole new phalanx of competitive nations—the "Four Tigers" of the Pacific Rim—Hong Kong, Singapore, Taiwan and South Korea.

These newly industrialized countries (NICs) join Japan, which a generation ago was considered a developing country, as the most vital growth forces in the world economy. Western Europe, meanwhile, is going through a period of sluggish growth, and most Third World nations have grown relatively poorer.

"The real stakes are the wealth and power of the United States," said Stephen S. Cohen, a Berkeley economist who is codirector with Zysman of the Berkeley Roundtable on the International Economy.

"We will have to get used to living in a world in which we are no longer No. 1 . . . , or at least not No. 1 by much," said Herbert Stein, chairman of the Council of Economic Advisers under Presidents Nixon and Ford who now is a senior fellow at the American Enterprise Institute.

The country, experts say, will also have to get used to a greater dependency on trade with the rest of the world than ever before. In 1960, sales abroad and U.S. purchases from foreign countries amounted to just 7 percent of gross national product. Twenty years later, trade accounted for 15 percent of U.S. GNP. Government officials estimate that 5.5 million jobs now depend on exports, and one in four farm acres produces crops for sale abroad.

The decline in both power and standard of living is difficult to accept in this country, which was born out of the limitless optimism of pioneers who saw the American dream as one of continued economic and social enrichment, said former deputy treasury secretary Richard Darman, a former specialist in public policy and management in Harvard University's department of government.

The American psyche, said Darman, is rooted in being No. 1, and most Americans alive today have never lived in a world in which they were not clearly the dominant force.

And, he added, "The day you accept being No. 2, psychologically you are on the way down."

This reordering of the world economomy generally is measured from 1971, when the United States registered its first merchandise trade deficit. But the seeds were planted much earlier, many of them by the United States itself.

There was, of course, the Marshall Plan, to reconstruct war-ravaged Europe.

In Japan, the U.S. occupation authorities set an artificially low exchange rate for the yen to boost Japanese competitiveness. The theory, expressed by then-Secretary of State John Foster Dulles, was that Japan made nothing that any other country wanted to buy.

The postwar institutions set up by the United States to mirror its view of the world also contributed. These included the World Bank and the International Monetary Fund, formed to finance a stable world, and the General Agreement on Tariffs and Trade, established to perpetuate free trade and make sure the world economy did not fall prey to protectionism as it did between the world wars.

"It's a remarkable story of postwar success," Nau said.

The dominance of the United States in world trade, many experts say they believe, was destined from the beginning to be temporary, because it stemmed from unique circumstances following the war, when the country "sat astride the world economy as the only large industrial power undamaged by war," said Commerce Undersecretary Bruce Smart.

Nevertheless, he continued, "we believed our national economic superiority was entirely of our own making, an inalienable right or entitlement, rather than a temporary phenomenon conferred upon us by a unique confluence of circumstances for which we could claim only limited responsibility."

This abnormal situation, some historians and economists believe, lulled the United States into complacency.

But if the United States thought it was entitled to economic preeminence, other countries refused to stand pat. In the new global environment, Japan, not the United States, is the model for other nations.

Korea and Taiwan, for instance, have achieved success following the Japanese model: a combination of free enterprise and competition among domestic producers; heavy protectionism to keep foreign goods out, and strong government guidance to develop the exports-oriented industries that fueled growth. Zysman and Cohen call this system of development "state-centered capitalism."

"Korea and Taiwan had the advantage of seeing Japan develop," said Lawrence Krause, a professor of international relations at the University of California at San Diego.

Singapore Ambassador Tommy T.B. Koh pointed out in a speech last February that the "Four Tigers" of Asia supplied 19 percent of U.S. imports of manufactured goods in 1980, compared with just 5 percent in 1962.

"The world is going to start looking like Japan, not the United States," Krause said. "The less-developed countries see that the way to succeed is through closed home markets and export-led growth," commented GWU's Nau.

Like anyone who has a good deal going, neither the Japanese nor the Asian NICs appear willing to modify their fast-growth economies for the greater good of the global system.

"Just as the U.S. citizen feels entitled to 1950-like preeminence in every field," observed Smart, "the Japanese citizen believes that the tilted playing field of the last 40 years is his by national right."

The current U.S.-Japan battle over semiconductor trade reflects the realization that retaliation may be the only way to force Japan to live up to its new global responsibilities.

The Reagan administration drew the line on semiconductors because they are the building blocks of all high technology. Without a strong semiconductor industry, a country loses the ability to develop more powerful computers and the supercomputers that are vital for national defense.

Underlying the trade dispute are fears within the administration that U.S. national security is at stake if American high-technology innovation is thwarted by Japanese protectionist policies at home and aggressive discount pricing in the United States—the heart of the semiconductor dispute.

A 'Diminished Giant'

The situation is painful for Americans, and the country may be suffering from what has been called the "diminished giant syndrome." But many experts believe that it is better for the world than what came before.

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"Can a small island nation [Japan] that is now militarily insignificant and far removed from the traditional power centers provide at least some of the needed global leadership? Can the United States continue to lead its alliance systems as it goes increasingly into debt to countries that are supposed to be its followers? Can it push those countries hard in pursuit of its economic imperatives while insisting on their allegiance on issues of global strategy? Can it hold its allies together in managing the security system?"

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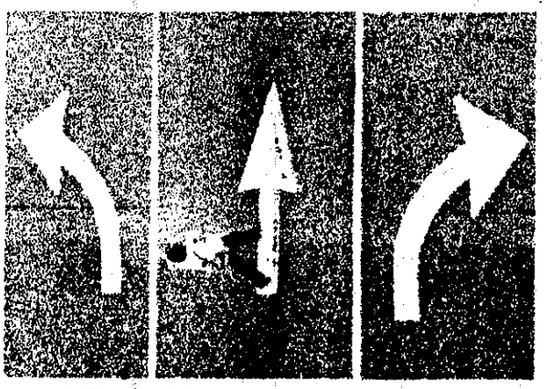

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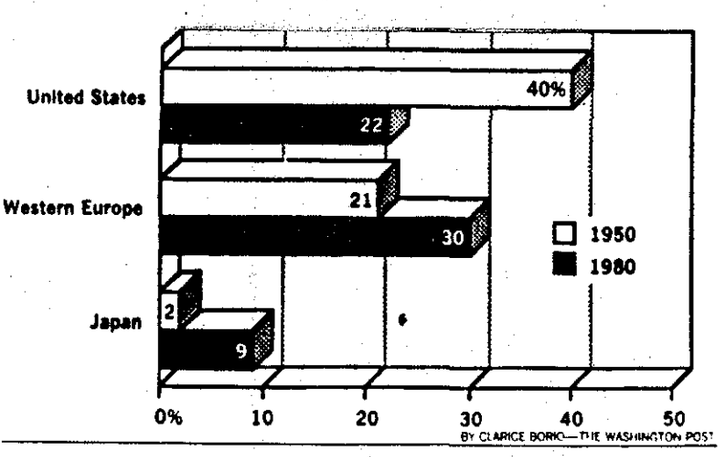

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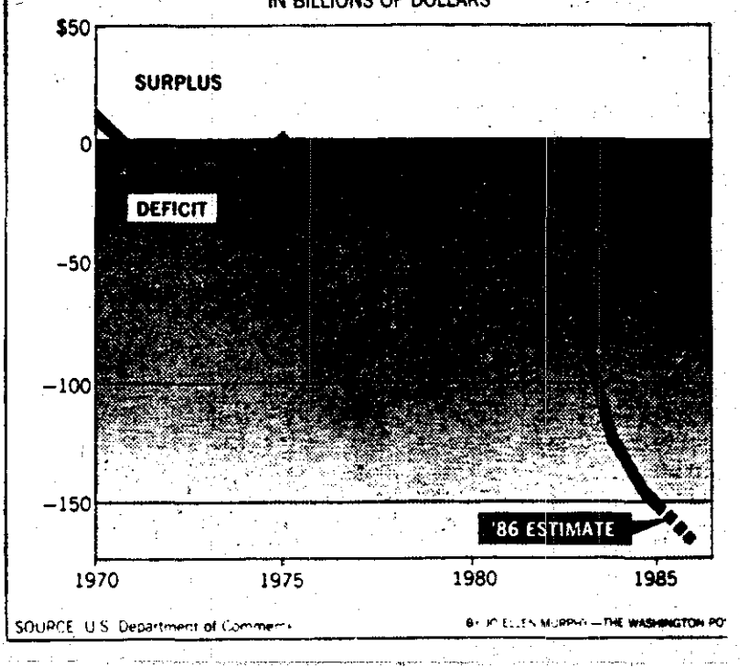

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BY JO ELLEN MURPHY—THE WASHINGTON POST

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The changes have been so sweeping and have taken place with such astonishing speed—over just 15 years—that they are only partly understood by the American public and policy-makers in government.

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But virtually all the experts agree that the era of overwhelming U.S. dominance of the international economy—an era that began after World War II when much of the rest of the world was devastated—is over.

"We have come to a divide," said University of California political scientist John Zysman. "The economic changes we are watching will reshape the international security system. They are fundamental shifts of the power relations among nations."

In the United States, these changes have contributed to serious economic dislocation: the closing of steel mills and auto plants, the conversion of the industrial heartland into the Rust Belt, a loss of millions of manufacturing jobs.

They have raised questions, as C. Fred Bergsten, director of the Institute for International Economics, wrote recently in Foreign Affairs magazine, as to whether

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COMPETE, From A1

the United States can keep its mantle of world leadership.

At the same time, many experts believe that for all the pain caused in the United States by these changes, the world as a whole is a better place. "We have built a world system where we are now beginning to bring into membership at the highest levels countries which 25 years ago were in poverty," said Henry Nau, professor of political science and international relations at George Washington University.

The most visible symbol of America's loss of global economic supremacy is four years of towering trade deficits, which reached $170 billion last year, coupled with the transformation of the United States in the last year from a creditor nation into what Bergsten called "the largest debtor nation ever known to mankind." The United States now owes about $220 billion more abroad than foreign countries owe the United States.

By the end of this decade, he said, the United States will owe more than a half-trillion dollars and will be paying tens of billions of dollars a year in interest to foreign investors.

Many more signs illustrate how the United States is no longer the preeminent player in the world economy, and how other nations are coming up:

- In 1950, the United States produced 40 percent of the world's goods and services. By 1980, the U.S. share had dropped almost by half, to 22 percent. Meanwhile, Japan's share climbed from less than 2 percent to about 9 percent, and Europe's share rose from 21 percent to almost 30 percent.
- For the first time since World War II, the United States last year lost its position as the world's leading exporter, supplanted by West Germany, with Japan pressing on the United States in third place.
- Last year, again for the first time, the United States ran a trade deficit in high-technology products, considered the wave of the future for the U.S. economy and critical for U.S. national security.
- In 1974 the United States was responsible for the design of 70 percent of the advanced technology in the world. By 1984, this figure had dropped to 50 percent. According to estimates, it will slide further, to 30 percent by 1994.

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Most surprisingly, at least to Americans who were not paying attention, has been the emergence of a whole new phalanx of competitive nations—the "Four Tigers" of the Pacific Rim—Hong Kong, Singapore, Taiwan and South Korea.

These newly industrialized countries (NICs) join Japan, which a generation ago was considered a developing country, as the most vital growth forces in the world economy. Western Europe, meanwhile, is going through a period of sluggish growth, and most Third World nations have grown relatively poorer.

"The real stakes are the wealth and power of the United States," said Stephen S. Cohen, a Berkeley economist who is codirector with Zysman of the Berkeley Roundtable on the International Economy.

"We will have to get used to living in a world in which we are no longer No. 1 . . . , or at least not No. 1 by much," said Herbert Stein, chairman of the Council of Economic Advisers under Presidents Nixon and Ford who now is a senior fellow at the American Enterprise Institute.

The country, experts say, will also have to get used to a greater dependency on trade with the rest of the world than ever before. In 1960, sales abroad and U.S. purchases from foreign countries amounted to just 7 percent of gross national product. Twenty years later, trade accounted for 15 percent of U.S. GNP. Government officials estimate that 5.5 million jobs now depend on exports, and one in four farm acres produces crops for sale abroad.

The decline in both power and standard of living is difficult to accept in this country, which was born out of the limitless optimism of pioneers who saw the American dream as one of continued economic and social enrichment, said former deputy treasury secretary Richard Darman, a former specialist in public policy and management in Harvard University's department of government.

The American psyche, said Darman, is rooted in being No. 1, and most Americans alive today have never lived in a world in which they were not clearly the dominant force.

And, he added, "The day you accept being No. 2, psychologically you are on the way down."

This reordering of the world economomy generally is measured from 1971, when the United States registered its first merchandise trade deficit. But the seeds were planted much earlier, many of them by the United States itself.

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In Japan, the U.S. occupation authorities set an artificially low exchange rate for the yen to boost Japanese competitiveness. The theory, expressed by then-Secretary of State John Foster Dulles, was that Japan made nothing that any other country wanted to buy.

The postwar institutions set up by the United States to mirror its view of the world also contributed. These included the World Bank and the International Monetary Fund, formed to finance a stable world, and the General Agreement on Tariffs and Trade, established to perpetuate free trade and make sure the world economy did not fall prey to protectionism as it did between the world wars.

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Nevertheless, he continued, "we believed our national economic superiority was entirely of our own making, an inalienable right or entitlement, rather than a temporary phenomenon conferred upon us by a unique confluence of circumstances for which we could claim only limited responsibility."

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Korea and Taiwan, for instance, have achieved success following the Japanese model: a combination of free enterprise and competition among domestic producers; heavy protectionism to keep foreign goods out, and strong government guidance to develop the exports-oriented industries that fueled growth. Zysman and Cohen call this system of development "state-centered capitalism."

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Like anyone who has a good deal going, neither the Japanese nor the Asian NICs appear willing to modify their fast-growth economies for the greater good of the global system.

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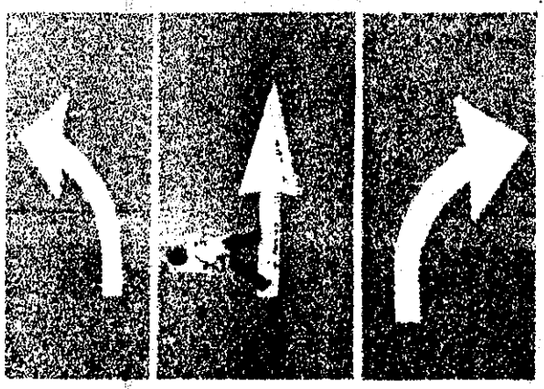

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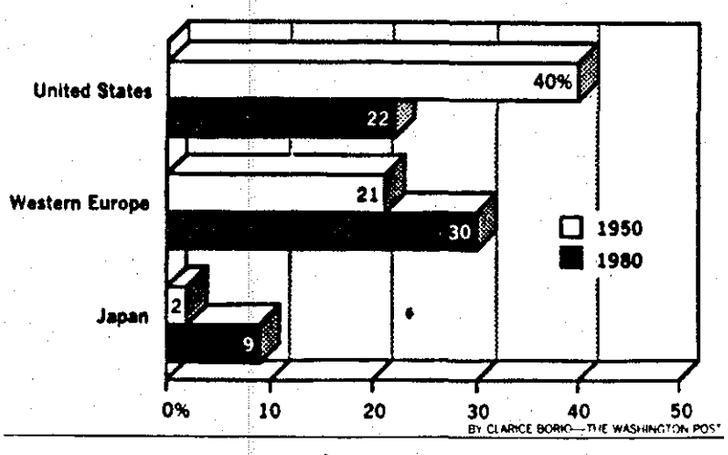

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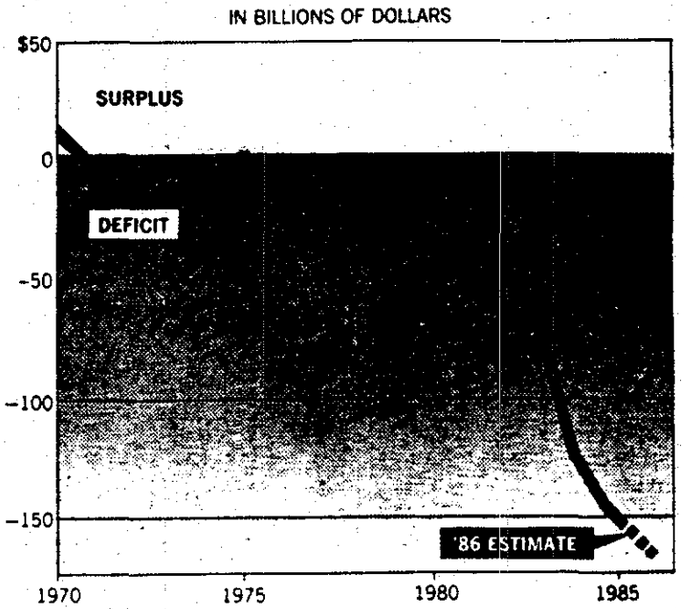

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"Can a small island nation [Japan] that is now militarily insignificant and far removed from the traditional power centers provide at least some of the needed global leadership? Can the United States continue to lead its alliance systems as it goes increasingly into debt to countries that are supposed to be its followers? Can it push those countries hard in pursuit of its economic imperatives while insisting on their allegiance on issues of global strategy? Can it hold its allies together in managing the security system?"

There is new pressure on the United States to change, to end what some see as a complacency and weakening of the human spirit and to begin to compete fully in the new world environment.

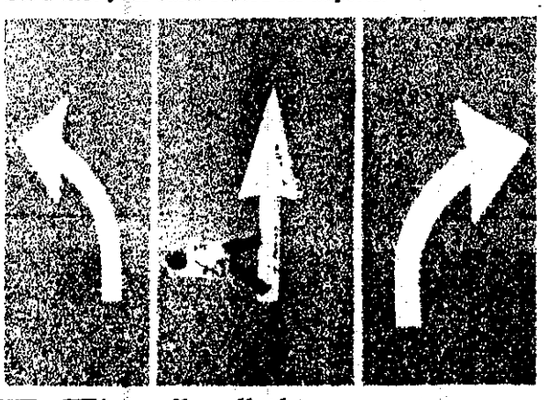
Now, Aho said, "we will see how much vibrancy this economy has."

NEXT: Politics of "competitiveness"

RUDE AWAKENINGS

BY JAMES M. THRESHER—THE WASHINGTON POST

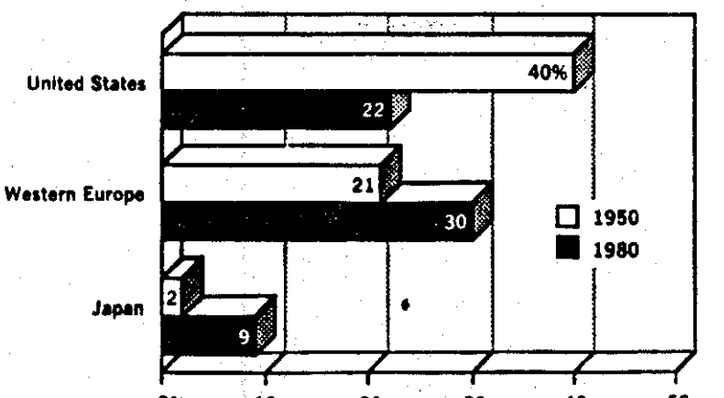
Korean workers prepare Hyundais for export to the United States and Canada. In the United States, the car set a first-year sales record for imports.



Virtually all the experts agree that the era of overwhelming U.S. dominance of the international economy, which began after World War II, is over.

A CHANGING BALANCE: THE U.S. SHARE OF WORLD GNP

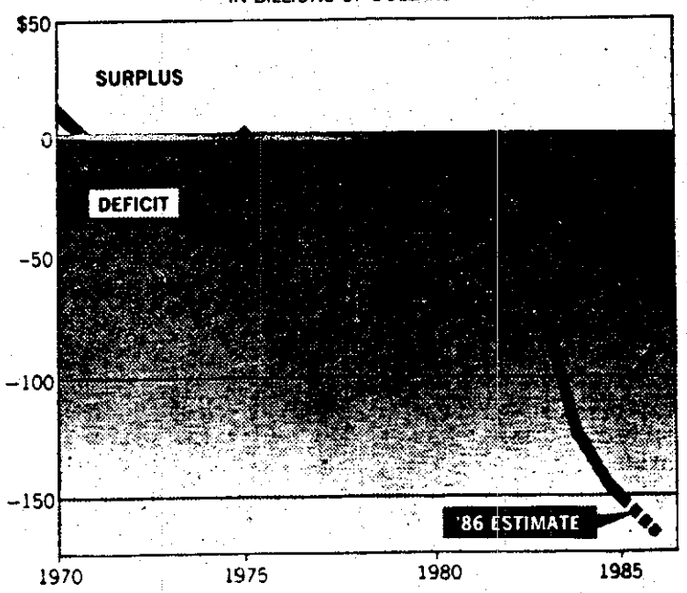
IN PERCENT



BY CLARICE BORKO—THE WASHINGTON POST

U.S. MERCHANDISE TRADE BALANCE

IN BILLIONS OF DOLLARS



SOURCE U.S. Department of Commerce

BY JO ELLEN MURPHY—THE WASHINGTON POST

Malcolm Baldrige The Washington Post, Friday, April 10, 1987

There Won't Be a Trade War

Economists—the chaps who come on the field after the battle is over to bayonet the wounded. (Or so says an accountant friend of mine. His judgment may be suspect, because he also describes actuaries as chaps interested in numbers who don't have the personality to become accountants.)

At any rate, these days some economists are disturbed. We are applying sanctions against some Japanese imports because the Japanese have not lived up to their semiconductor agreement with us. They have continued dumping chips in third-country markets to get them into the United States, and they have continued to deny U.S. manufacturers access to the Japanese home market.

The questions usually brought up are:

1) Is this a step away from free trade?

No. First, we are trying to open up the closed chip market in Japan, where U.S. manufacturers have been held to a 10 percent share for more than 20 years. Thus the Japanese have been able to reap the volume benefits from the two largest users in the world while restricting the United States to its own domestic market.

Second, such Japanese firms as NEC and Fujitsu were dumping chips in the United States by selling them at half their cost. Why? Not for love of the American consumer. Dumping is usually used to get rid of excessive inventory or to drive competitors out of business—after some initial losses the dumping companies, with the competition destroyed, can raise prices much higher.

This practice is anti-free trade and is illegal under U.S. laws as well as under the General Agreement on Tariffs and Trade. In short, sanctions against illegal dumping and for opening markets are pro-, not anti-free trade. I think what has drawn attention to the case and shocked some is not the $300 million of proposed sanctions—that is only half of 1 percent of Japan's trade surplus with us. The surprise has come because after 25 years of talk and complaints about unfair trade practices, this president is the first president to take any action.

2) Will there be a trade war between the United States and Japan?

Despite some nervous comments by observers who should know better, there is no chance of a trade war between us. The United States does not want one; we were forced to take the semiconductor actions when there was legal proof, and we did it more in sorrow than in anger. And the Japanese certainly do not want a trade war. The United States sells Japan $27 billion a year in goods; Japan sells the United States $85 billion a year. Whose interests would suffer most?

No, the biggest danger of all would have been not to act. Unfortunately, those who disagree with the president's action have uniformly failed even to discuss, much less face up to, the consequences of the only alternative to that action. The only alternative was to dismiss the semiconductor cases, let the Japanese keep on dumping and simply put up with the closed markets in Japan. Some would rather duck those issues than risk any confrontation at all, but that strategy would only put off the inevitable—and maybe until it's too late.

Dumping and predatory pricing have already been major factors in running six of the nine U.S. merchant semiconductor companies out of the dynamic random access memory chip business, at a loss of 35,000 to 40,000 skilled jobs. If dumping had continued, the three remaining companies told us, they would have had to close up shop on memory chips, the case in point. The more sophisticated logic chips would have been next. And the country whose industries control the technological lead in both memory and logic ships will control the technological lead in computers. We have strong and legitimate national-security as well as economic concerns in that area.

In short, if a government or a large parent company is able to finance the initial losses, dumping will bring volume. That volume will bring cash flow. Cash flow finances research. And research leads to technological advances. The computer industry in Japan has frequently stated its goal of passing IBM and the other U.S. computer companies to take the lead in the 1990s in supercomputers and artificial intelligence as well as the computer industry. If they can do this by free and fair trading, so be it. I do not think they can. If they want to get there by unfair trade, America's answer is "no." I think the Japanese now understand that, and future trade negotiations will be more productive because they do.

To have ignored the problem would have been no solution at all. Japan and the United States have too much at stake in our geopolitical alliance—one of the world's most important—not to work out an equitable solution to our trade problems instead of pretending they don't exist.

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Joe Allen
4837

TECHNOLOGY

Technology Transfer Isn't Working

The campaign to pass on the fruits of the federal research labs to industry could be a lost cause.

by Fred V. Guterl

In just a few years, a major new chip-manufacturing technology called X-ray lithography could well become the key to survival in the semiconductor industry. The question is, who will be the first to develop it?

Japan's Ministry of International Trade and Industry plans to spend $700 million on the problem this year. Among other things, it is funding the construction of four specialized synchrotrons for chipmakers to produce the X rays essential for research into the new technology.

In the U.S., the Department of Energy recently finished building the nation's first large-scale synchrotron at its Brookhaven National Laboratory in Upton, New York. But it is a general-purpose synchrotron used by about ninety academic and corporate research groups for a variety of projects. IBM Corp. is the only company using the synchrotron for X-ray lithography, and its researchers often have to wait in line to use it. "The IBM people are pretty unhappy with the schedule," says William Marcuse, director of technology transfer at the lab. "They spend a lot of time twiddling their thumbs."

The DOE plans to build two more synchrotrons for its labs, but neither one will be tailored to X-ray lithography. And to a growing number of industry leaders, government officials and scientists worried about the United State's flagging competitiveness in technology, this state of affairs is a vivid symbol of the inadequacy of the government's program for transferring R&D to industry.

The federal research labs constitute a formidable chunk of the nation's pool of talent and equipment. The 700-plus labs across the country spend more than $18 billion a year and employ one-sixth of the nation's research scientists and engineers.

By tradition, the labs disseminate technology to the public and issue licenses for their published patents to anyone who wants them. But American companies have used few of the thousands of new patents filed every year because they are loath to invest in a technology their competitors can obtain easily. It was a Japanese firm, for example, that developed solar cells for calculators from a National Aeronautics and Space Administration patent.

Since 1980 the Reagan Administration has been spearheading an ambitious campaign to make the fruits of the federal research labs available to private industry. One result is new legislation that now allows companies to license exclusive patents owned by the labs and encourages cooperative R&D programs for industry, government and universities.

These moves have been welcomed. But no significant technological benefits have yet accrued to industry, and the obstacles to implementing the transfer of technology now look so numerous and deeply rooted that it seems doubtful the government labs will ever be able to help industry fulfill its research needs. "The new laws are no panacea for getting technology into private industry," says William Burkman, director of physics at AT&T Bell Laboratories. "There are a lot of stumbling blocks involving the kind of priorities the labs have set up."

The basic problem is that the whole notion of working with private industry runs counter to the long-standing mission of the federal labs to serve the general public. For the better part of four decades, they have pursued their own agendas sheltered from the needs of the marketplace. Federal researchers have deepened the pool of scientific knowledge and enhanced the nation's weapons arsenal. Any benefit derived by industry has been a mere afterthought.

The need to keep classified weapons research under wraps has impeded technology transfer in the DOE and the Defense Department. That becomes a formidable barrier considering that defense will account for 72% of government R&D spending next year, up from 51% in 1980, and that the lion's share of the labs belongs to those two departments.

The DOE is particularly hostile to industry-directed research. It has refused to give its labs authority to license patents to companies—a step that industry considers crucial for making the technology accessible. The department's policy of reviewing every application for a patent license case-by-case, industry complains, is too much trouble and takes too long—anywhere from six months to several years—to pass through the labyrinth of DOE bureaucracy.

This procedure discourages companies from using the labs as a resource. Lee M. Rivers, who recently left the White House Office of Science and Technology Policy to represent the Federal Laboratory Consortium in Washington, says he is "up to my eyeballs" trying to get industry to take the labs seriously. "If a businessman has to take four months to figure out what he needs to do and then has to go through six layers of bureaucracy in Washington, that's going to be tough," he notes.

DOE officials insist they are proceeding with caution only until they learn more about technology transfer and promise to streamline the waiver process down to six months or so. Critics say they are stalling. And Bryan Siebert, DOE director of international security, admits, "I would err on the side of reviewing practically everything, even if it involves delays."

In fact, when Congress passed legislation in 1984 allowing universities and nonprofit organizations that operate DOE labs to license patents, the department tried to nullify the law by claiming that national security and nuclear nonproliferation took precedence. Its position led to an executive order by President Reagan last spring restricting the DOE's discretion to withhold patent licenses.

Regulations also limit the amount of money the DOE labs can spend on research for outside organizations to 20% of their budgets, with most of that going to other government labs. And no company can do research at a DOE lab if comparable facilities can be obtained elsewhere. Emphasizing the DOE's stand, Antoinette G. Joseph, director of field operations management, says, "People argue that there is this technology sitting on the shelf and that if you have a uniform technology transfer policy, the government can make it all available in one fell swoop. Well, it can't. The national defense mission is more important than the technology transfer mission."

The Defense Department has its own bureaucratic problems, but it has been more flexible in issuing licenses. For years, the DOD has allowed the companies it does business with to commercialize at no cost the patented technology they develop. These relationships, however, have existed primarily within the close-knit community of government contractors working on classified projects. "Everything done in the labs is documented and made available to people with the appropriate clearances," says Frank Sobieszczyk, chief of the DOD research program office. "The labs will call in defense contractors and give them a dog-and-pony show." Because of its fear of leaks, the DOD is reluctant to enter into cooperative R&D agreements with other companies.

In addition to the problem of classified R&D, identifying promising new

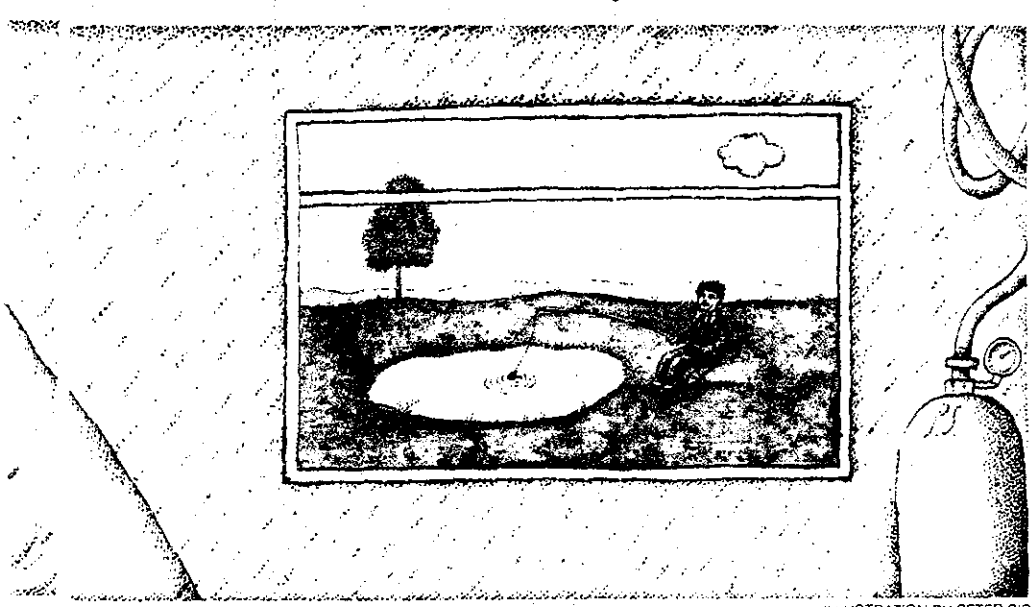

ILLUSTRATION BY PETER SIS

technologies for industry to exploit is a monumental task. Corporate R&D executives have largely ignored what goes on in the labs, viewing them as irrelevant and inaccessible. Reluctant to deal with the bureaucracy, they are unaware of helpful research buried within multimillion-dollar programs.

At the same time, most federal labs lack the staff necessary to sift through the enormous number of projects, ferret out the good ideas and target them for specific industries or companies. "There's a lot of research going on at the labs," says President A. Sidney Alpert of University Patents Inc., which sells university-owned patents to industry. "If they put enough manpower on it, there could be some good inventions. But you won't find them the way the labs are going about it."

It does not help that lab researchers must depend on their technology transfer specialists to explain their innovations to corporate R&D people. These specialists are in short supply—only one DOD lab has one, for instance—and they are a harried lot with responsibility for hundreds of different projects.

As intermediaries, they also are one more roadblock for industry. Hillard Williams, vice president for technology at Monsanto Corp., says that government tech transfer people lack experience in getting technology out to industry. John D. Hale, vice president for research at Kerr-McGee Corp., comments: "We have enough trouble transferring technology out of our own lab. How are we going to keep up with the technology coming from the federal labs?"

Even if industry had free access to the technology at the labs, raw research requires considerable development before it is applicable to new products, and much more input from the labs—information about manufacturing processes, the expertise and judgment of the original researchers, and so forth—is needed by a company planning to adopt a technology. "The basic research at DOE labs is one level less practical than the stuff that is done at universities, which isn't very practical" says University Patents' Alpert.

"If the government labs move slowly, they will become irrelevant."

The labs have limited resources to devote to the kinds of coooperative R&D programs that would help industry absorb basic research. And they have had trouble attracting financial support from industry because they lack the authority to issue patents in return for funds. (No longer true)

Companies are also put off by the government's inflexibility in negotiating cooperative research agreements. The agreements are often written like procurement contracts, with specific deadlines scheduled years in advance. Such tight schedules lead to misunderstandings when the research doesn't pan out the way it was originally planned. "Federal people don't speak the same language," says Monsanto's Williams. "Things get complicated, and industry tends to just give up."

Amid this bleak picture, there are a few hopeful signs. Payoff from exclusive patenting, for instance, is evident in Oak Ridge, Tennessee, where a dozen or so companies have sprung up to develop products—heat-resistant diesel engines, high-strength cutting tools and more—based on patent licenses granted by the DOE lab there.

"A kind of magic has set in," says William W. Carpenter, vice president for technology applications at Martin Marietta Energy Systems, which runs the lab for the DOE and aggressively pushed the patents through its licensing process. "In Oak Ridge, houses are selling, school enrollment is up for the first time in twenty years, a new missile plant has gone up. A great deal of that is due to our technology transfer program."

Inside the labs as well, there is some movement afoot to open the door. Eugene E. Stark, an engineer at DOE's Los Alamos National Laboratory, is one of a new generation of government researchers who now sees a unique opportunity to get the labs into the mainstream of technology.

In his spare time, Stark is chairman of the Federal Laboratory Consortium for Technology Transfer, an ad hoc government and industry group that is promoting technology sharing. "We can't wait ten more years to break down the institutional barriers to technology transfer," Stark says. "We're entering a period of restructuring in science and technology institutions. Whatever new relationships develop as a result of international competition will take place in the next three-to-five years. If the labs move slowly, they will become irrelevant."

Groundwork also has been laid for several cooperative agreements between industry and the labs. The Army's Electronics Technology and Devices Laboratory in New Jersey is setting up a consortium with several electronics firms to develop flat-panel display screens. And the DOE's Argonne National Laboratory and the University of Chicago are currently negotiating with companies to do superconductor research.

Meanwhile, the Defense Department is funding a study on building a synchrotron devoted exclusively to semiconductor research. And at the DOE's conference on superconductivity last July, President Reagan proposed a government-sponsored "Superconductivity Initiative," which would include, among other things, increased spending by the labs. In addition, DOD proposes spending $150 million over three years to apply superconductivity research to military ships and weapons.

How all the money is spent—whether industry gets to set at least part of the research agenda—may be the first real test of the technology transfer laws and the nation's resolve.

—with ANNE HOLLYDAY

U.S. DEPARTMENT OF AGRICULTURE
OFFICE OF INTERNATIONAL COOPERATION AND DEVELOPMENT

SCIENTIFIC AND TECHNICAL COOPERATION PROGRAM

The Scientific and Technical Cooperation program of the Office of International Cooperation and Development (OICD/STC) promotes international cooperation in agriculture and forestry through short-term (1-6 weeks) exchange visits of U.S. and foreign scientists. OICD/STC also coordinates one to three international workshops/symposia per year on high priority topics of mutual concern to two or more countries. Each year, OICD/STC negotiates a program of activities with each cooperating country based on proposals submitted by U.S. scientists, social scientists, and other specialists from USDA agencies, universities and private organizations. Proposal formats are attached. Proposals are reviewed for potential U.S. benefits, technical merit, and clarity of objectives and work-plan. If proposals are approved by OICD and the foreign government, OICD shares travel, per diem and some miscellaneous costs with participants' sponsoring institutions, and provides administrative support in planning the visit. Co-financing of workshops and symposia is determined on a case-by-case basis. OICD/STC encourages activities which combine participants from USDA, universities and private organizations. Individuals and teams whose proposals are selected are required to submit a detailed report within 60 days of the program's completion.

Participants on exchange visits generally undertake one or more of the following activities:

-- Exchange scientific, statistical and agroeconomic information and data;

-- Collect unique resources such as germplasm or biological control organisms, unavailable in the United States;

-- Learn about special research, conservation and/or production techniques and/or institutional structures;

-- Share new research findings;

-- Undertake field work and individual consultations on significant problems facing the U.S. agricultural community;

-- Plan future collaborative work.

Exchanges are not intended to cover costs of sabbaticals or to support specialists' attendance at international meetings, conferences or workshops not organized by OICD/STC. The program does not cover participants' salaries.

PROPOSAL FORMAT FOR EXCHANGE VISITS

A. TITLE AND PARTICIPANT(S)

1. PROPOSAL FOR JOINT ACTIVITY WITH _____ (name of country)

2. PROPOSAL TITLE:

3. PROPOSAL PREPARED BY: (Name, title, address, telephone number, date of preparation)

4. PARTICIPATING U.S. SPECIALIST(S) AND INSTITUTION(S): (include addresses and telephone numbers)

5. PARTICIPATING FOREIGN SPECIALIST(S) AND INSTITUTION(S): (include addresses and telephone numbers if known)

B. INSTITUTIONAL CLEARANCES:

Clearance must indicate that approving officers concur that a proposal has significant potential for U.S. benefits and understand that: a) in most cases, STC expects the specialists' organization to share travel expenses; and b) participation in a proposed program entails institutional commitment to allow for appropriate preparations, follow-up and possibly hosting foreign scientists visiting the United States.

1. For universities and private organizations, approval of appropriate administrative officials must be shown.

2. For USDA agencies, labs or institutes, all levels of required clearance must be shown, for example: Lab Chief, Area Director, Regional Administrator, International Coordinator, Administrator. It is the responsibility of the author to obtain all required clearances before the proposal is sent to OICD.

C. DETAILED DESCRIPTION

1. Background: Description of general scientific or technical issue. Present status of any current activities on this topic with this country; current funding level and involvement of participating institutions; contacts already established with foreign specialists.

2. Immediate Objective(s) of this visit: This should reflect the realistic workplan for a short-term visit described below in (5).

3. Benefits to U.S. Agriculture and/or Forestry: Expected scientific, technical, commercial and/or trade benefits to U.S. agriculture and/or forestry. Please give dollar estimate(s) if possible. List beneficiaries by sub-sector, region, crop, etc.

4. Benefits to Cooperating Country

5. Workplan: Step-by-step outline of proposed activities, including:

   - o Proposed dates of visit; include seasonal, geographic and other relevant considerations;
   - o Schedule of activities;
   - o Scientists, institutions or places to be visited;
   - o Methods of investigation, evaluation and recording information; and
   - o Description of each team member's specific contribution to the program if the team consists of more than two specialists.

6. Output: In addition to the trip report required by OICD/STC, list other outputs of this exchange visit. Examples of outputs are knowledge about a particular subject, germplasm, data, etc.

7. Plan for disseminating/using the output: Include possible publications, seminars and research applications.

8. Budget for this visit: Estimated cost (travel, per diem, miscellaneous expenses) and portion of total cost that the participants' organizations will cover. Ideally, OICD and participant's organization will split costs on a 50/50 basis. OICD/STC does not recognize salary and overhead costs as part of the exchange budget. However OICD/STC will consider special costs associated with exchanges such as equipment and/or chemicals and agents donated by organization for use during visit, and/or in special cases lodging, meals, and transportation costs involved in hosting foreign visitors during reciprocal visits.

9. Long-Term Objective(s) Impact(s):

   a. Long-term objectives
   b. Relationship to U.S. research efforts
   c. Other inputs necessary in order to reach long-term objectives (e.g. more exchange visits, commercialization of research techniques, policy changes, etc.)

10. Other Factors

PROPOSAL FORMAT for SYMPOSIUM or WORKSHOP

A. TITLE AND PARTICIPANT(S)

1. PROPOSAL FOR JOINT ACTIVITY WITH (name of countries involved)

2. PROPOSAL TITLE:

3. PROPOSAL PREPARED BY: (Name, title, address, telephone number, date of preparation)

B. INSTITUTIONAL CLEARANCES:

Clearances must indicate that approving officers concur that the submitted proposal has significant potential for benefiting U.S. Agriculture and understand that: a) STC expects the specialists' organizations to share expenses; and b) participation in a proposed program entails institutional commitment to allow for appropriate preparations, implementation, follow-up and possibly clerical and publication support.

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C. DETAILED DESCRIPTION

1. Background: Description of general scientific, technical or policy issue. Present status of any current activities on the topic with the participating countries; current funding level and involvement of participating institution; established contact with foreign specialist.

2. Immediate Objective(s) of the Symposia and Workshop: These should be ranked in order of greatest to least priority .

3. Benefits to U.S. Agriculture and/or Forestry: Expected scientific, technical, commercial and/or trade benefits to U.S. agriculture and/or forestry. Please give dollar estimate(s) if possible. List beneficiaries by sub-sector, region, crop, etc.

4. Benefits to Cooperating Countries

5. Plan for disseminating/using results from joint activity: Include possible publications, follow-up seminars, research applications, etc.

6. Long-Term Objective(s)/Impact(s):

a. Long-term objectives
b. Relationship to U.S. research efforts
c. Other inputs necessary in order to reach long-term objectives (e.g. additional discussions or visits, commercialization of research techniques, policy changes, etc.)

7. Number and Affiliation of Proposed U.S. Participants:

(attach list with names, title organizations, addresses and telephone numbers if known)

8. Number and Affiliation of Proposed Foreign Participants:

(attach list with same information as in (7) if known)

9. Workplan: Step-by-step outline of proposed activities, including:

- o Proposed date of activity; include seasonal, geographic and other relevant considerations;
- o Proposed location of activity;
- o Outline of activities;
- o Methods of interaction; (invited or open submission of papers, roundtable discussions, exhibitions, demonstrations).

10. Budget

A) Expenses

(i) Estimated Number of U.S. Participants
X Average Transportation Cost =
Total Estimated U.S. Travel Costs _____

(ii) Estimated Number of Foreign Participants
X Average Estimated Foreign Travel Costs =
Total Estimated Foreign Travel Costs _____

(iii) Total Number of Participants
X Average Total Perdiem Cost =
Total Perdiem Cost _____

(iv) Other Estimated Costs

Planning costs	_____
Conference Room and other Facility Expenses	_____
Activities Expenses	_____
Local Transportation Costs	_____
Clerical Support for Organization, Registration, etc.	_____
Mailing & Publicity Costs	_____
Publication Costs	_____
Other	
Grand Total Estimated Cost	_____

B) Proposed Sources of Funds - (Please specify what activities each agency/organization will cover)

(i) Sponsoring Organization	_____
(ii) Participants' Organizations (Conference fees, and other contributions)	_____
(iii) OICD/STC	_____
(iv) Other	_____
Total	_____

11. Other Comments

Current Bilateral Exchange Programs*
OICD/STC

FY 1988

East and West Europe	Developing and Pacific Countries
France	Argentina
Italy	Brazil
Netherlands	Mexico
West Germany	Venezuela
Turkey	
	Algeria
Bulgaria	Zimbabwe
Hungary	
Romania	
Soviet Union**	Japan
	People's Republic of China
	Philippines
	Thailand
	Australia
	New Zealand

*Ad hoc exchanges may also take place with South Korea, Malaysia, Uruguay, Chile, Costa Rica, Cote d'Ivoire, Kenya, Denmark, Finland, Sweden, Norway, Ireland, Israel, Greece and other selected countries during FY 88.

**All travel costs associated with the exchange program with the Soviet Union are the responsibility of each travelers' organization.

For further information please contact the staff members listed below: September 1987

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Room 315

* Responsibilities also include Algeria, Israel, Turkey and Cote d'Ivoire

** Responsibilities also include Kenya and Zimbabwe.

Japan Is Racing to Commercialize New Superconductors

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

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 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.'

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."

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.

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 coaching people to do this or that," Mr. Laudise notes. "But in this case we had people coming around from all different disciplines wanting to know if there was anything in this for their area," he says.

Too Soon for Applications

"We've had a lot of people going without sleep," Mr. Laudise says. But he agrees with IBM's Mr. Armstrong that it's still too soon for anyone to settle on specific applications of the superconductors. "We're not trying to make any specific devices or systems," he says.

Bell Labs researchers are, however, trying to fabricate various superconducting materials into experimental devices. At Wednesday's APS meeting they displayed a superconductor in the form of a flexible ceramic tape that can be formed and then hardened into a shape to fit a superconducting device.

Researchers at General Electric Co.'s big research and development center in Schnectady, N.Y., agree that it's too soon to jump into an industrial competition with anyone, including the Japanese.

Jury Is Still Out

"In the materials field, the events of the last several weeks have been quite spectacular, but in the applications sense, the jury is still very much out," says Michael Jefferies, manager in the center's engineering physics laboratory.

Until recently, the GE lab didn't have a group of scientists working on superconducting materials. "But we're now trying to confirm and duplicate the results that are being reported," Mr. Jefferies says.

Guy Donaruma, vice president for research at the University of Alabama in Huntsville, says governmental agencies and private concerns have shown a keen interest in the university's superconductivity research, which duplicated the Houston breakthrough.

"Wherever I go around town somebody buttonholes me and asks how we're coming along or when can we use this," Mr. Donaruma says. Some inquiries have come 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.

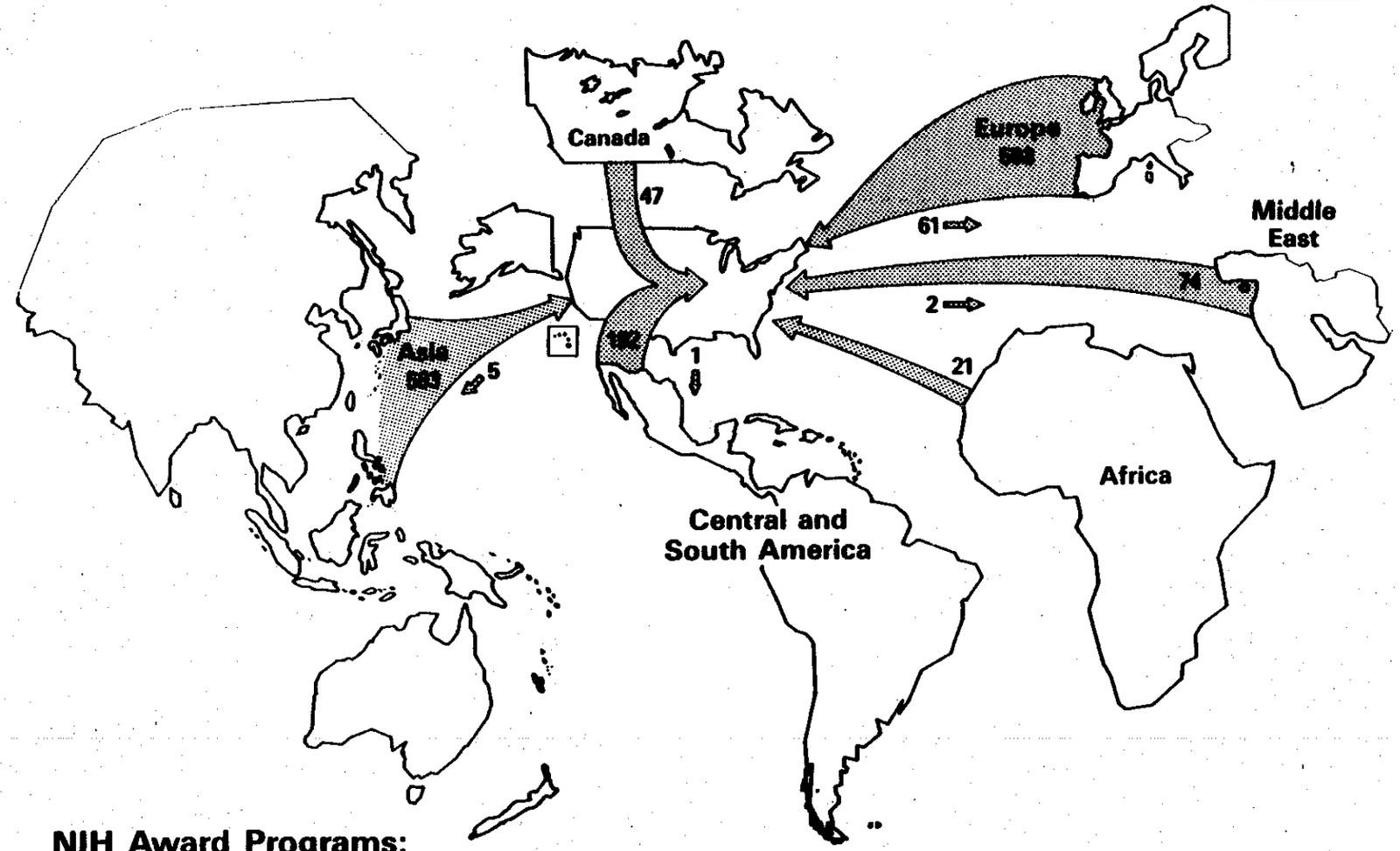
Aside from possible problems in forming brittle ceramic into wire, the new superconductor still can't handle enough current to be used in heavy applications such as power plants. Superconductors also don't work well with alternating current, the type of electricity used in most of the world's power equipment.

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

SCIENTISTS' MOBILITY, FY 1985



NIH Award Programs:

To the U.S.: International Research Fellows, Scholars-in-Residence, Exchanges, NIH Visiting Program Participants

From the U.S.: Senior International Fellows, Exchanges

TABLE 3

NATIONAL INSTITUTES OF HEALTH
INTERNATIONAL EXCHANGE PROGRAMS
DISTRIBUTION BY COUNTRY; FY 1985

Country	Foreign Scientists to U.S.	U.S. Scientists to Foreign Country	Total
Japan	397	3	400
Italy	196	2	198
United Kingdom	162	33	195
India	168		168
France	105	12	117
Israel	104	2	106
China, People's Rep.	92		92
Canada	81	11	92
Germany; Fed. Rep.	83	8	91
Australia	52	4	56
All others (65)	641	44	685
Total	2,081	119	2,200

IRI ADVISORY

TO: **IRI Membership**

FROM: ***Jacob C. Stucki***
Chairman
Federal Science & Technology Committee

Data presented by Dr. James Wyngaarden , Director of the National Institutes of Health at the 1986 fall meeting in Boston, Massachusetts, clearly demonstrates that NIH is greatly under-utilized by U.S. industry There are approximately 1,700 postdoctoral guest investigators at NIH at any given time; 1,000 of these are from foreign countries, and 700 from the U.S. Of the 1,000 foreign guest investigators, approximately 400 are from foreign industries, while of the 700 U.S. investigators, only 10 - 15 are from industry. Of those from foreign industries, approximately 100 are from Japan and 50 from West Germany.

This under-utilization of this country's best medical establishment by U.S. companies and relative over utilization by foreign countries, could have a significant impact on U.S competitiveness in health care, biotechnology, and related industries. The following suggestions for increasing U.S. industrial utilization of the NIH are submitted for individual corporations to consider:

There are many opportunities for industrial scientists to spend time (usually 1 year) in the laboratory of NIH scientists. These opportunities would be appropriate for:

New Hires, either prior to or very early in their career at the company;

For "fast track" scientists who would return to their company with broadened scientific capabilities or to research management assignments, and for

Senior industrial scientific staff who are making a career change, or who need or desire an update on newer approaches to their field of interest.

Companies may fund collaborations with NIH. Such collaborations could be initiated either by NIH or by industry, and typically would involve close interaction over a project lifetime, possibly 2 - 5 years. The Federal Technology Transfer Act of 1986, when fully implemented, will encourage such collaborations. Lab Directors will be allowed to sign agreements granting exclusive rights to companies that support the work. In addition, it provides motivation by returning all or a major portion of the royalties to the lab, and at least 15% to the inventors, as personal incentive for collaborations that result in patents which industry commercializes.

Corporate funding for other NIH programs is also encouraged These could include general support of training in areas of mutual interest, and funding for summer students or other similar programs. Industry benefits by insuring NIH programs that are important to them but inadequately funded, and increasing the general pool of trained persons for recruitment by industry.

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for Intramural Research
National Institutes of Health
Phone: (301) 496-1921 or

Dr. Philip S Chen
Associate Director for Intramural Affairs
Phone: (301) 496-3561

TABLE 1

NATIONAL INSTITUTES OF HEALTH
INTERNATIONAL EXCHANGE PROGRAMS
PROGRAM DISTRIBUTION; FY 1985

	Participants	$ Costs
Visiting Program	1,403 Foreign	$24,077,100
Guest Researcher Program	558 Foreign	-0-
Intl. Research Fellowships	100 Foreign	3,374,000
Senior Intl. Fellowships	46 U.S.	1,165,000
Eastern Bloc Hlth. Sci. Exch.	20 U.S. 6 Foreign	47,980
French, Swedish, Swiss, German and Irish Fellowships	49 U.S.	1,042,000
French CNRS Exchanges	4 U.S. 6 Foreign	110,448
Scholars-in-Residence	8 Foreign	476,697
Total	2,081 Foreign 119 U.S.	$30,293,225

TABLE 2

NATIONAL INSTITUTES OF HEALTH
INTERNATIONAL EXCHANGE PROGRAMS
DISTRIBUTION BY GEOGRAPHICAL AREA; FY 1985

Geographical Area	Foreign Scientists to U.S.	U.S. Scientists to Foreign Country	Total
Europe	988	108	1096
East Asia & Pacific	636	8	644
N. Africa/Near East/S. Asia	321	2	323
Latin America & Caribbean	107	1	108
Sub-Saharan Africa	29		29
Total	2,081	119	2,200

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Australia	52	4	56
All others (65)	641	44	685
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certainly a landmark case for the Department of Labor."

The money is to be distributed to service station workers and managers who were not paid overtime or were paid for fewer hours than they actually worked. The settlement covers all shifts worked from July 1, 1974, through Dec. 31, 1981.

The Labor Department said yesworked, O'Connor found that station managers were denied overtime pay and that cash and merchandise shortages had been made up by withholding part of the wages of all service station attendants. He ordered that Hudson award back pay to all affected employes.

Vandegrift, 74, of Mission Hills, Kan., pleaded no contest in August 1983 to felony theft charges for perceive their back pay from Hudson, the Labor Department said the government will hold mortgages on various corporate real estate assets until the obligation is fulfilled.

The government has two years to try to track down employes who are to receive the back wages, the department said, adding that it does not have current addresses for most of the workers.

NASA Letter Urged Firms To Lobby Senate Against Cuts

9-1-87 Post

United Press International

The National Aeronautics and Space Administration acknowledged yesterday that it improperly asked contractors for lobbying help to save its budget from deep congressional cuts that the agency said could delay major projects and force layoffs across the country.

The agency's office of industry affairs said in a memo dated Aug. 17, "NASA's budget is in trouble on the Hill," and asked marketing representatives to "help us work this problem."

An accompanying position paper detailed the difficulty with the Senate Appropriations Committee and said House members should be "notified of the negative impacts of the Senate's action. However, senators who have the burden of making the earliest decision in this case . . . need to hear your views soon."

The position paper said the Appropriations Committee has cut $818 million in fiscal 1988 funds for NASA and other independent agencies, and the paper said NASA might have to bear most of that cut.

"The question is: Should this one inconsistent action by the Senate committee be permitted to reverse the national effort to restore the United States to its rightful preeminence in space? Is this one action sufficient to default a U.S. leadership role to the Russians and others?" the memo asked.

The memo listed the names of 29 senators to be contacted.

It is a violation of federal law for government agencies to engage in lobbying efforts outside of appearances before congressional committees.

As soon as Administrator James C. Fletcher heard about the memo, according to a NASA source, he sent letters of apology to Senate Appropriations Committee members William Proxmire (D-Wis.) and Jake Garn (R-Utah).

In a statement issued yesterday, after the incident was disclosed by Aviation Week and Space Technology magazine and the Space Commerce Bulletin, NASA said: "We acknowledge there was an improper action by the agency and have taken all steps to remedy the situation."

In its position paper, NASA said the proposed budget cuts could have "a devastating effect" on the agency's plans.

SCIENCE AND TECHNOLOGY POLICY

STATE-OWNED PATENTS SPREADING ABROAD

Tokyo KOGYO GIJUTSU in Japanese Mar 86 pp 44-48

[Article by Mitsuo Suzuki, director of the Japan Industrial Technology Association]

[Text] Why International Technology Cooperation Is Now Important

With a turnabout from the first oil crisis, the focus of world technology development trend has been shifting toward lightness, thinness, shortness, and smallness [micro] from heaviest, thickest, longest, and biggest [macro]. Countries in the world are fiercely competing for the development of high technologies, amid the great surge of new technologies from the 1970's toward a peak in the early 2000's.

Emerging as advanced technologies are the technology for utilizing limited sources of energy on earth, electronics technology for fostering an information society, new materials technology for bringing about metamorphic progress in industries, and biotechnology with diverse potential.

The collapsing condition of the Japanese economy after World War II has achieved a marvelous recovery through the support of technical assistance from abroad and the concerted efforts of the people. As a result, Japan has now established a high technology level worldwide.

While Japan has currently achieved economic growth through active industrial activities based on high technologies, other countries have increasingly been seeking Japan's technical cooperation. Public opinion is taking root in that Japan should further promote contributions intellectual to the international society through technologies.

As regards technologies under such international circumstances, the recent activities concerning technology transfer and popularization of the Japan Industrial Technology Association (Inc.) (JITA) engaged in activities of spreading state-owned patents of the Agency of Industrial Science and Technology (AIST) at home and abroad will be outlined (see Figure 1)

Transfer of state-owned patents

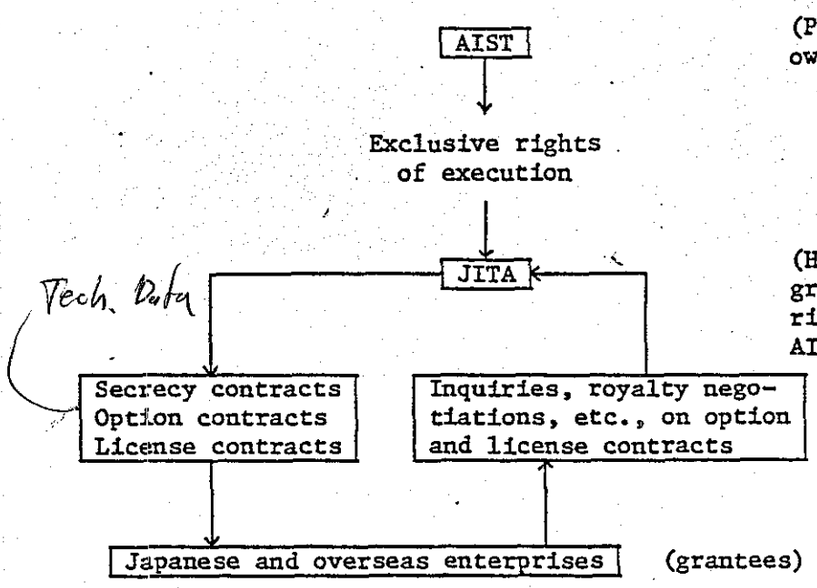

Figure 1. Technical Transfer System of AIST's State-Owned Patents

Activities of High Technology Interchange Missions

JITA has been sending missions to the various European and American countries annually since 1983 to introduce AIST's state-owned technologies in support of AIST and other quarters concerned. The dispatch of the missions is part of the technology interchange between Japan and the various European and American countries, and is also in response to criticism that Japan is not providing technology exports in comparision with the enthusiasm for exports of manufactured products. Among AIST's state-owned patents, 20 to 30 themes, which have been applied for industrial use by Japanese companies or those prospective technologies are selected annually for overseas supply upon approval for technical cooperation by the companies involved.

Missions comprising top technicians or leaders concerned in charge of technical development at such companies visited governmental organizations or research institutes of major enterprises in the various European and American countries to ascertain the needs of such countries (possibilities such as technology transfer and joint development). From this side, technical presentation was provided and at the same time relative discussions pursued.

Institutions visited by year follow:

1983	Sweden	(state) STU (Swedish Technology Development Agency) (private) ASEA Co., Volvo Co.
	West Germany	(private) Dynamite Nobel Co., Siemens Co.
	France	(state) CESTA (Advanced Technology System Development Center) (private) Toulouse City Chamber of Commerce and Industry
1984	United States	(state) Raleigh, North Carolina--Research Triangle Park (research consortium) (private) SWRI, IITRI, SRI (all nonprofit think tanks)
	Canada	(provincial) Montreal Urban Community (research consortium)
1985	Sweden	(private) IDEON (research consortium) (private) SKAPA (creative technology exhibit)
	Ireland	(state) IDA (Irish National Research and Development Agency)
	Britain	(state) BTG (British Technology Group, formerly NRDC) (private) Berkeley Tech Mart '85
	France	(state) CESTA (private) Rhone Poulenc Co.
	West Germany	(private) Bayer Co.

Fortunately, the dispatch of the missions over the past 3 years has resulted in steadily spreading state-owned technologies abroad due partly to the active cooperation of domestic licensee companies and various foreign governmental organizations and overseas companies. Among the themes presented, some concrete results are beginning to emerge, such as supplying information and samples, to include possibilities for future technology transfer and joint development, and the conclusion of secrecy contracts.

Table 1 shows typical technologies presented by the past three missions. A few examples among overseas responses to the missions were the request from Martin Marietta, a major U.S. enterprise, for a supply of several tens of kilograms of high-performance electromagnetic wave shield materials on a sample basis. Kuraray Co. and two other companies are now conducting experiments for practical application of the materials under the guidance of AIST's Industrial Products Research Institute. General Motors Corp. (GM), a major U.S. automaker, Alcan Canada Co. of Canada, Hinkley and ICI of Great Britain, and many other companies have shown interest in revolutionary fine ceramics processing technologies, and negotiations for a contract are now underway with a certain company. The ceramic technologies involved are the ceramics-metal

Table 1. Technologies Introduced Abroad Through State-Owned Patents

Category	Title of technology	Institute that made discovery	Year introduced		
New materials	High-performance electromagnetic shield material	Industrial Products Research Institute	1983	1984	
	Ceramics-metal bonding	Osaka National Industrial Research Testing Institute (NIRTI)		1984	1985
	Ceramics-ceramics bonding				
	Zirconia sinter	Nagoya NIRTI	1983		1985
	Easy-to-sinter alumina	" "		1984	
	Lubricating agent for die-casting, forging	Osaka NIRTI	1983	1984	
	Lanthanum-chromate for heating	Daikoshi NIRTI	1983		
	Carbon-ceramics compound	Kyushu NIRTI		1984	
	High-performance pitch carbon fiber	" "	1983	1984	1985
	Ultrahigh-molecular polyethylene gel yarn	Research Institute for Polymers and Textiles		1984	
	Hydraulic injection plastic molding	"		1984	
	High-flux precision filtration membrane and its system	National Chemical Laboratory for Industry, Kyushu NIRTI, Osaka NIRTI	1983	1984	1985
	Photocrosslinkage polymer and screen printing	Research Institute of Polymers and Textiles	1983	1984	
	Gas separation using polyimide hollow fiber	National Chemical Laboratory for Industry			1985
	Ion exchange fiber and rare earth metal separation	Research Institute of Polymers and Textiles	1983	1984	1985
	High-performance deodorant	National Chemical Laboratory for Industry	1983		
Biotechnology	Production of oils and fats by mycosis	National Chemical Laboratory for Industry	1983		
	Production of gamma linolenic acid by mycosis	"		1984	1985
	Production of heat-resisting lipase and dissolution of oils and fats	Fermentation Research Institute		1984	1985
	High-performance cellulase	"		1984	
	Solidification of oxygen by ultrafine fiber carrier	Research Institute of Polymers and Textiles			1985
	Solidification of oxygen by photocrosslinkable polymer	"			1985
	Production of fry feed from alcohol fermentation wastes	Fermentation Research Institute			1985
	Artificial joints	Mechanical Engineering Laboratory			1985
Electronics	High-performance amorphous silicon solar battery	Electrotechnical Laboratory		1984	1985
	Semiconductor magnetic sensor and its applications	"		1984	1985
	Assessment of amorphous silicon manufacturing process under CARS system	"			1985
	ICTS system for detecting crystal defects	"			1985
	Nonvolatile semiconductor memory with floating gate	"			1985
	High-output GGG laser	"			1985
	Optical disk pickup (SCOOP)	"			1985
	Magnetic garnet film for optical IC	"	1983		

bonding and ceramics-ceramics bonding where research for practical applications is being conducted by Sumitomo Cement Co. and Daihen Corp., respectively, under the guidance of AIST's Osaka Industrial Research Institute. Negotiations are also underway with (Reuter) Gas Werke Co., a major West German pitch processing company, concerning technology to manufacture high-performance carbon fiber now being developed for practical application by more than 10 companies, including Nippon Carbon Co. Regarding lubricating agents for forging and die-casting, Hanano Shoji (Inc.) has completed development of manufacturing technology, and is now being made practical with a large amount of samples being supplied abroad for testing, while Great Britain's (Fuoseco) is seeking technology transfer.

In addition not only enterprises, but also Britain's BTG (R&D agency) and France's CESTA (advanced technology center) are requesting long-term, deliberative cooperative relationships with JITA missions, and are showing an active stance toward future technology interchange with Japan.

Progress in R&D of those technologies have been conducted by research institutions under AIST's umbrella with the cooperation of private-sector companies. Behind-the-scene movements concerning technology transfer through various channels have also been observed, and attention focuses on future developments.

Technological Transfer Based on Trusting Relationship

"The more information is assimilated, the more its essence is improved," is a wise statement about data bases by Tokyo University Professor Hiroshi Inose, last year's Cultural Merit awardee. In technology transfer, too, a certain preparatory period is initially required for the exchange of technologies and related information and establishment of a relationship of mutual trust between the provider and the receiver of technologies. The first problem in negotiating transfer of state-owned technologies abroad is that it takes considerable time to establish such relations of trust. Perseverance is required as in an extreme case where the party completely lacking information mutually about the other party begins from scratch. In addition, based on relations of trust, the supplier and receiver of technologies must seek terms on conditions which will mutually benefit both sides from a long-term point of view. Under such circumstances, recent trends for the future technologies or in exploring new areas such as cross-licensing and other forms are increasing.

Next is the establishment of relations of trust regarding protection of patents. The state-owned technologies to be definitely transferred abroad at present are basically on condition that the technologies involved are patented in the recipient countries. Accordingly, it is important that such technologies are fully protected under the recipient countries' patent system and in the operation thereof.

In the various countries visited by JITA's advanced technology exchange missions in the past 3 years, hardly a problem occurred due to the high reliability of the patent protection measures. However, of late, Japan has been strongly urged to expand technology transfer to the newly industrialized countries (NICS) and developing nations. The problem of patent protection in those countries will therefore be an issue to be resolved in the future.

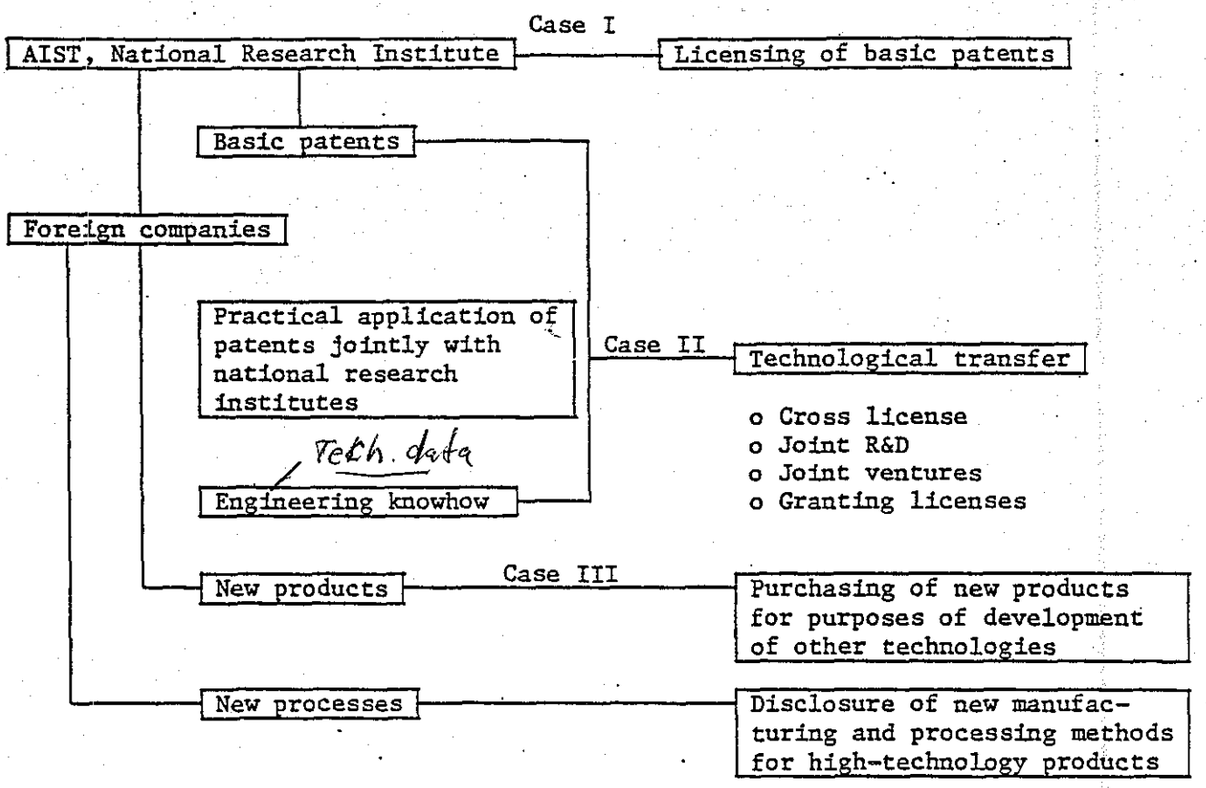

Figure 2. Technology Transfer of State-Owned Patents Abroad

Four Cases of Technological Transfer and Procedures for Transfer

Transfer of state-owned patents has various backgrounds depending on the technologies involved, which is not easy to generalize into one format. However, it can be classified roughly into four cases as shown in Figure 2.

Case I is the licensing of basic patents owned by the Agency of Industrial Science and Technology and of patents jointly owned by the national research institutes and private companies. Case II involves providing all the information necessary for commercialization ranging from basic patents owned by the AIST to related patents, manufacturing know-how and product specifications, etc., possessed by the implementing companies--in other words, the complete transfer of technologies. Depending on circumstances for the suppliers and the receivers of technologies, Case II can be subdivided into four types, i.e., cross-licensing mutually between companies, joint development by both companies for furtherance of technologies involved, establishment of joint ventures between companies based on mutual agreement and conditions for local production and sales, and the unilateral supply of all the technologies to the other country's enterprise in exchange for payment of certain remunerations.

In Case III foreign companies purchase products of technologies involved from the contract-implementing firms of Japan and use such items as a basis to develop new processes or new products. In Case IV foreign companies produce and process products on a contractual production basis, using high technologies developed from basic patents owned by the AIST. For example, one plan now under negotiation is the contractual production of special parts by a foreign enterprise using the "ceramics-metal bonding technology."

Table 2. Procedures for Technology Transfer

First stage Secrecy agreement	Providing secret information and samples necessary for assessment of technologies involved
Second stage Option agreement	Technical information including know-how, etc., data regarding economical phase, and samples or marketable products necessary for feasibility study
Third stage License agreement	All information necessary for practical application of technologies

Procedures for granting licensing of state-owned patents abroad are basically identical to those in Japan. The first stage, as shown in Table 2, is to cope with clients when they seek more detailed information and samples to be furnished so as to determine the industrial value concerning the nature of the technologies. In such case, if necessary, a secrecy agreement is concluded before providing them.

The second stage is for coping with cases where further concrete information beyond the first stage is sought by the clients such as information about economical feasibility, information concerning marketing and technical information to determine the industrial applicability of the technologies, as well as providing samples on a commercial basis, etc. Usually in this stage, information is furnished under an option agreement on the assumption that technologies involved will be applied for industrial purposes.

The third stage is the execution of technology transfer under a license agreement in which the contract discloses all technical information necessary for the application of technologies and the nature of the patents.

For the Future

Japan is a small country in terms of natural resources, energy, and food, but is substantially rich in intellectual resources. Using these resources, the country has accumulated industrial property and other technology assets since the end of the last war, making itself one of the leading technology-oriented countries in the world. Such intellectual assets will continue to serve as a bargaining power for Japan.

However, today's accumulation of technology assets has resulted from the introduction of technologies from advanced countries in Europe and America, and efforts for creative technology development. Moreover, in the background of facilitating Japan's introduction of technologies from European and American countries is the sense of trust when Japan was furnished technologies, being accustomed to assessing fair value of new, superior technologies which furthered the understanding of patent protection.

Meanwhile, Japan has been strongly criticized by various countries in Europe and America for its huge trade surplus stemming from expanding exports of manufactured products. Of course, free world prosperity lies in orderly exports and imports under the free trading system. However, Japan's export of its abundant intellectual resources, resulting in a surplus in the technology trade balance, would not create trade friction, but would rather contribute to the development and revitalization of the world economy. The conditions to smoothly transfer technologies overseas are as stated above. The three issues of relations of trust, mutual benefit, and patent protection have been proposed. However, these problems in the case of NIC's and developing nations are such that environments are yet to be sufficiently regulated. It is extremely important that Japan mutually cooperate in resolving these problems for future international cooperation.

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FYI

Our lives are often changed by the vision — and persistence — of individuals willing to pursue ideas

People Behind the Wonders

Condensed from
"BREAKTHROUGHS!"

JOHN M. KETTERINGHAM, PH.D.
AND P. RANGANATH NAYAK, PH.D.

THOSE little yellow pads whose pages cling to reports and telephones and kitchen walls without leaving a trace of adhesive are such a natural that it's hard to imagine how we got along without them. Indeed, 3M's Post-it notes have turned out to be one of the marketing wonders of the decade.

Yet virtually at every turn, experts lined up against the idea. For the individuals behind the project, it was a lonely struggle. And had it not been for the good sense of secretaries (they instinctively knew the idea was a winner) and a 3M chemical engineer who was also a choir member (he needed a sticky paper to mark songs in his hymnal), this idea might never have made it to the marketplace.

Creative Moments

THE ADHESIVE was spawned in the late 1960s by Spencer Silver, a chemist in 3M's Central Research Laboratories. Silver was working with a new family of pressure-sensitive adhesives. Knowing that science is one part meticulous calculation and one part "fooling around," Silver tried an experiment using an unusual combination of these adhesives.

The material that resulted was not "aggressively" adhesive. It would create what 3M scientists call "tack" between two surfaces but would not bond tightly to them. It may not have been very sticky, but Silver got very attached to it.

Silver presented his discovery to others at 3M, but they were looking for a better adhesive, not a worse one. And Silver wasn't sure exactly what his could be used for.

From 1968 through 1973, he quietly campaigned to capture the imagination of his colleagues. He went to every division at 3M that might be able to think up an application. Most of his colleagues said, "What can you do with an adhesive that doesn't hold?" But no one said to Silver, "Stop wasting our time."

In fact, it would have violated deeply felt principles of the 3M Company to have killed Silver's pet project. As long as he performed his assigned duties, there was no reason to discourage him.

Silver hoped to find someone with a *problem* to match his five-year-old *solution*. That person turned out to be Arthur Fry, chemical engineer, choir member and occasional mechanic.

"One day in 1974, while I was singing with my choir, I had one of those creative moments," Fry recalls. The slips of paper that he used to mark his place in the hymnal would inevitably flutter to the floor or disappear into the book. Fry thought, *If I had a little adhesive on these bookmarks . . .*

What Silver and 3M had not realized in five years, Fry realized in a flash. The primary application of the adhesive was paper to paper. He took the baton from Silver's weary grasp and carried it over a jumble of discouraging hurdles. Mechanical engineers said he couldn't uniformly apply the adhesive to paper. Fry said he could and assembled a small-scale machine in his basement that did.

Within two years 3M produced more than enough Post-it note prototypes to supply the company's main offices. The employees became hooked, but their enthusiasm did not impress 3M's marketing people. *Their* four-city test indicated the concept was hardly a sure winner. Geoff Nicholson, Fry's boss, knew that the notes were something you had to *use* to appreciate.

Nicholson had limited power to push Post-its outside the company, but he did what he had to do. He went to Richmond, Va., one of the test cities, and dragged his boss, Joseph Ramey, a division vice president, with him. Up and down the business district they introduced themselves in offices and said, "Here, try this." Ramey had gone with Nicholson because he liked him, not because he liked Post-it notes' chances. But the recipients' positive reaction was all the evidence he needed.

If there is a secret to breakthrough at 3M, it is that the values

of individuals are put above the values of the corporation.

Competitive Response

FOOT TROUBLE AND ATHLETES have been associated with each other from the time of Achilles' infamous heel. In the 1950s, jogging in the uncomfortable shoes that were available hurt—a painful fact that might prevail today if not for the efforts of a stubborn man in Eugene, Ore. His name is Bill Bowerman, and he helped invent the modern-day running shoe, fashioning with his own hands prototypes of the comfy footwear seen everywhere from Wall Street to Big Sur.

As the head track coach at the University of Oregon, Bill Bowerman knew that athletic shoes weren't very good. So he designed a lighter shoe with better support and traction and sent the design to leading sporting-goods companies. They all turned him down.

The rejections brought Bowerman face to face with his own philosophy of "competitive response." He had taught his athletes to value competition not so much for its prizes as for its intellectual and spiritual demands. When you lose, you obtain information that helps you next time—more knowledge about yourself, as well as the opposition.

The competitive response to Bowerman's problem was: "If you can't find someone to do it for you, learn to do it yourself." So he became a shoemaker.

Using old grocery bags as patterns, he kept drawing, cutting and shaping until he got the best design. Eventually he made his first pair of track shoes—sleek and light. And his runners won in his funny-looking, handmade shoes.

One of Bowerman's athletes, Philip Knight, believed athletes would embrace the superior shoes if he could find a manufacturer. But who? Bowerman had been turned down by the American companies he had approached.

In 1962 Knight traveled to Japan and called on Onitsuka Tiger, at that time one of Japan's best manufacturers of athletic shoes. Tiger made Knight an offer: they would manufacture shoes of his design and Knight's company would be their sole distributor in the United States. Knight hurried back to America desperately in need of $1000 to cover the first order and a company.

The company came together over Bowerman's kitchen table. And just over a year later, a shipment of 200 Bowerman shoes arrived in Oregon.

It was a shoestring operation at first, with Knight and Bowerman working part-time and a small but devoted team selling out of cars at track meets. But slowly, as Bowerman improved his shoes—adding features such as the heel wedge, nylon uppers and the "waffle" sole—the mystique of their product grew in the running world. Bowerman and Knight were poised to

ride the crest of the fitness movement about to sweep the country.

Then the bottom fell out. In 1972 Onitsuka Tiger cut off all supplies to their company. A court case confirmed that Tiger had established a separate distribution network in the United States. Within 24 hours Knight was on a plane to Japan. In 30 days he had lined up a new manufacturer. And today the company does $900 million in business a year. Its name? Nike, after the Greek goddess of victory.

Bowerman, Knight and the Nike team would not even contemplate defeat. Bowerman conveyed to Knight, and Knight conveyed to others, that a shared commitment requires outstanding individual performance and a willingness to contribute that performance to the group. By beating every other team in the country repeatedly, Bowerman proved this to his runners. Knight showed that it could be done in business.

The People Factor

AS A STUDENT at Yale University, Frederick W. Smith was captivated with the idea of overnight mail delivery—a rather revolutionary idea in the 1960s when highest-priority deliveries required up to three business days. Airports would act as hubs and truck routes as spokes. All day, trucks would gather parcels from businesses. At the end of the day, they would head to the airport, and a plane would fly the parcels to a bigger hub in the center of America. There all the planes would be emptied, the packages sorted, and the planes reloaded and flown back to where they had come from.

Smith developed this concept in a paper submitted to a business professor, who gave him a mediocre grade—interesting, he said, but not feasible. Smith grew more sure of his idea as the "experts" told him it was silly. He knew that if people had overnight delivery, they would come to depend on it. At age 21, however, Smith had few of the personal tools necessary to pull together such a large enterprise.

The leadership experience he gained during the Vietnam war would change that. Smith learned the importance of conveying respect to subordinates and the imperative of taking care of your people.

He also learned to value flexibility of intellect. Smith had seen men die because commanders could not or would not deviate from a plan even in the face of the unexpected. And he had seen common soldiers respond spontaneously to crisis. "Give ordinary people the challenge and they will rise to the occasion," he concluded.

Smith knew that as his company faced crises, he would not always be available to handle details. He was going to depend on other people for that, and he needed the right people—more than money or planes.

Arthur C. Bass, who was with the firm at the start, summed up Smith's leadership: "He brought

together people who were proud of what they were doing. Whether in a truck or a plane or in the hub, you were alone out there, but everybody was depending on you—and you had to come through."

His fledgling enterprise could have folded on "opening night," March 12, 1973, when its airplanes first flew into its national hub from all over the eastern United States—with a total of six packages. The company might well have folded at the end of April 1973, when its accumulated loss was $4.4 million.

It should have folded in September 1973, when a series of multimillion-dollar loans fell into default. (Smith sent a memo to employees: "With the most profound regret, we would like to request . . . that you not cash or deposit your payroll check until next Monday.")

As Smith's company fell $30 million in debt, his investors staged a coup, replacing him as head of the company with a former Air Force general. Smith fought back and regained the firm within a year.

Bankruptcy was a reality that threatened everybody—the boss and workers alike. And when everybody had to deal with financial crisis, it didn't seem so awful. Everybody in the company was an entrepreneur.

Once a courier set out on his rounds, he was expected to pick up packages on time and get them to the airport; nobody asked questions as long as the driver made it through. There are stories of couriers so committed to their mission that they pawned their watches to buy gasoline.

Recalls Tucker Taylor, a former employee: "The fact that the company didn't have any money wasn't really important—this was the great experiment! We were going to prove it could be done anyway."

Today Smith's company—Federal Express—is a multi-billion-dollar business. Its Memphis hub is a mechanical fantasyland with over 40 miles of conveyor and 4000 employees who handle more than 700,000 packages in less than 2½ hours. It is one of the most extraordinary business successes of our time.

SIGNIFICANT BREAKTHROUGHS—the creation of a unique adhesive or a revolutionary running shoe or an ingenious system to distribute mail—are more like works of art than commerce. And these innovations sometimes must be passed like a baton from person to person, with each lending the concept different talents.

Along the way these people face resistance and skepticism. But they respond with tenacity and unbounded energy as they take their breakthroughs to the marketplace—where the fruits of their persistence can touch us all.

The bird a nest, the spider a web, man friendship. —William Blake

Through self-management and private ownership, residents of some of the country's worst public-housing projects have broken the cycle of crime and dependency

Up From Public Housing

BY MARTIN WOOSTER AND JOHN FUND

IN ST. LOUIS, the Vaughn housing project is a monument to despair. Built by the federal government nearly three decades ago, its four high-rise buildings look out over ugly vacant lots. Its brick walls are covered with graffiti and drenched in urine; its playgrounds are overgrown and littered. Dozens of young men loiter in the project's trash-strewn yards, making drug deals or playing endless games of basketball.

Cochran, another St. Louis public-housing complex, is even older. But its 12 buildings, home to 3600, are well-kept, securely guarded and have freshly trimmed, spacious yards. Its apartments are newly painted and full of well-maintained appliances and furniture. Most of its teen-agers are in school.

Although the projects are only eight blocks apart, they look as different as East and West Berlin. The reason: Vaughn is managed by a government agency, the St. Louis Housing Authority. Cochran is managed by the people who live there.

Most government-subsidized housing projects in inner cities resemble Vaughn. Unlike private landlords, public-housing authorities have little financial incentive to keep up their properties. And unlike homeowners, tenants are limited in their ability to make their apartment complexes livable. But in city after city—aided by foundations, corporations and federal grants—public-housing tenants are taking the situation into their own hands. As they learn self-reliance, their neighborhoods are becoming islands of safety in a sea of urban

A National Interest in Global Markets

SUMMARY: This much has not changed: The Pentagon keeps a short leash on those who wish to export technology, and measures are being directed at keeping U.S. companies competitive with foreign firms. Yet advances in high technology are increasingly being made through cooperative international efforts. The United States is finding a major challenge in balancing two essential, oft-conflicting interests: selling U.S. products abroad while maintaining national security.

ELI MIYAZAWA / BLACK STAR

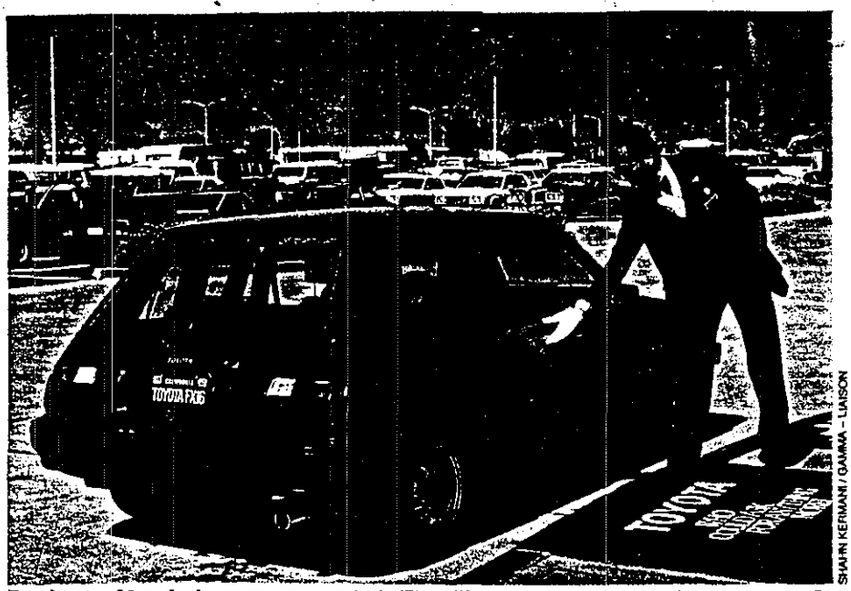
Workers from the United States (left and center) are trained at a compact disc factory in Kawasaki, Japan.

The first shot in the superconductor revolution was fired by two European scientists working for a U.S.-owned multinational firm in Switzerland. Sometime, somewhere, someone might sort out the tangled genealogy of that first discovery — and the dozens of breakthroughs all over the world that have followed it in the past few months. But right now it seems pointless. Americans, at the present moment — at Paul Chu's laboratories at the University of Houston, at Wayne State University in Detroit, at IBM's research facility near New York — hold sway in the superconductivity race.

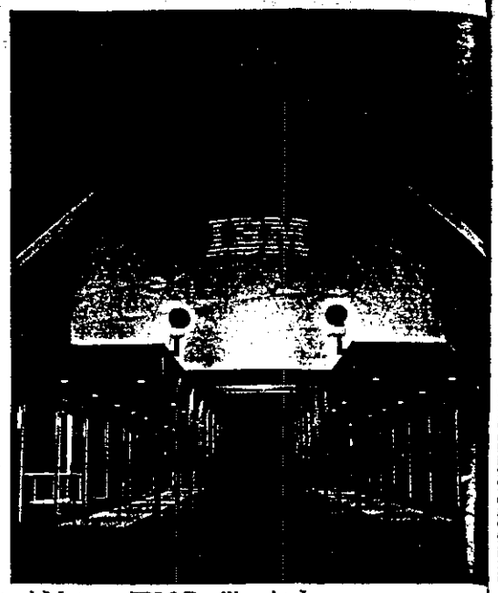
But in a few months' time the pendulum might well swing toward Japan, where two special superconductor committees have already been set up by the government's Science and Technology Agency. Or perhaps it will swing to Western Europe, where scientists and engineers have been as consumed by the promise of superconductivity as their counterparts elsewhere.

There is little geographic logic to the pace of scientific discovery. New breakthroughs flow quickly and easily through national and political barriers, with endless and confusing permutations. The next frontier in superconductivity could be explored by a Japanese graduate student working for a U.S.-funded lab at a European university. This is a world only science can conjure, a world without borders.

When the new realities of superconductivity pass from research laboratories to private industry in the next few years, there is little doubt that the United States and Japan will lead the rest of the world in commercial exploitation. But separating the efforts of the two, and defining precisely what their leadership actually entails, may prove as difficult then as it is now. The U.S. chemical giant Du Pont Co. employs 180 scientists at a lab in Yokohama, Japan. International Business Machines Corp. has thousands of researchers at facilities in Tokyo and Yamato City. On the flip side, Japan has thousands of graduate students in U.S. universities, sponsors millions of dollars' worth of research at them and puts up still more millions in



SHAHN KERMANI / GAMMA – LIAISON



CHARLIE COLE / PICTURE GROUP

Products of borderless venture capital: First U.S.-made Toyota, under deal with General Motors; IBM Pavilion in Japan

venture capital for American high-tech companies.

New cross-licensing and joint venture agreements between Japanese and U.S. firms are reached at a dizzying pace. General Motors Corp. and Toyota Motor Corp. make cars together in California. Texas Instruments Inc. makes advanced microchips in Japan. U.S. electronics giant Motorola Inc. swapped secrets with Toshiba Corp. late last year.

As more and more high-tech firms implement such strategic alliances," Lenny Siegel, editor of Global Electronics newsletter, says, "competition . . . will be less between the U.S. and Japan and more between transpacific corporate alliances, each containing one or more American and Japanese firms." What's the likeliest scenario for superconducting microchips? Try a mixture of Silicon Valley technology, Japanese manufacturing know-how and international venture capital.

Twenty and 30 years ago it was true that if a government made an investment in research and development, or in the country's scientific base, it could be reasonably sure of reaping the benefits itself. That is no longer true. But this does not mean that in today's global environment individual governments have given up on high-tech policies. In fact — and this is the paradox of the internationalization of science and technology — the demands of the new world economy have made the countries of the developed world pursue their national strategies more aggressively than ever before. Not all of these nationalist strategies will work. Some will simply be the product of reflexive protectionism or of nativistic fears. But there remain, even in a globalized economic environment, legitimate areas of individual government action. Finding those, and striking a balance between national interest and international competitiveness, may well be the principal political challenge of the 1990s.

Why has Tokyo stepped in to coordinate research and commercial activity surrounding the superconductor race? "We are working to assure that all this will not be just a fad," explained Mitsuig Chiba of Japan's Science and Technology Agency. "We want it to be a solid, feet-on-the-ground campaign." Officials in Washington publicly shy away from advocating so bold an exercise in government management. "We have a secret weapon that will overwhelm [the Japanese] process," said William Graham, head of the White House Office of Science and Technology Policy. "We call it the free market. It's far better to let industry make the investment decisions for profits and to let government devote its resources to the basic research and underpinnings."

But Graham's words belie a federal effort as pragmatic and interventionist, in many ways, as Japan's. The U.S. government has $29 million earmarked for superconductor research this year, with much of that going to federal labs and Defense Department offshoots — such as the Defense Advanced Research Projects Agency — which have always worked closely with private industry. In the air in Congress is talk of a special superagency to coordinate industry activity in certain high-tech areas and dole out research money. Frank Press, president of the National Academy of Sciences, expresses a common nationalistic sentiment: "Superconductivity has become the test case of whether the United States has a technological future. That future depends on our ability to commercialize our scientific discoveries. If we lose this battle, it will wound our national morale."

This idea of an affirmative national policy — what Harvard economist Robert Reich calls "technonationalism" — does not always sit easily with the realities of the modern world economy. Reich says that many of the measures suggested and implemented in the past year in behalf of U.S. "competitiveness" actually are unworkable or even absurd in the light of the worldwide diffusion of science and technology.

Suggestions have been made in Congress, for example, to increase federal research and development funding for various scientific and industrial endeavors on the condition that those resources be limited to U.S. engineers, scientists and companies. But what, in the age of the strategic alliance, is an American company? What if a U.S. citizen is working for a Japanese company? In 1984, roughly 2,000 scientists and engineers immigrated to the United States from the developed world. Some of them are in the States only on temporary visas; most are not yet U.S. citizens. Would they qualify?

It makes little sense to base public policy on technonationalism, Reich argues, when our institutions are organized on a global model. Nor is it in America's long-term interest to bar foreigners from the fruits of its research and development. Technology is not a "scarce commodity," Reich says. "Rather than guard our technological breakthroughs, we should learn how better to make use of breakthroughs wherever they occur around the globe."

He has a point, but the fact is that in many cases the United States has little choice but to follow technonationalistic policies. As William Schneider Jr., under secretary of state for security assistance, science and technology, has put it, trade policies "cannot be divorced from our broad political security objectives. . . . Our economic policies must support our key objectives of deterring Soviet adventurism, redressing the military balance between the

CHARLIE COLE / PICTURE GROUP

RICHARD HOWARD / BLACK STAR

Reich says United States should use breakthroughs "wherever they occur."

West and the Warsaw Pact and strengthening the Western Alliance."

The cost of the U.S. position as the military leader of the West has always been a need to sacrifice economic goals to strategic or national security considerations. Not surprisingly it is the Pentagon, not protectionist businessmen, that has been behind much of Reich's technonationalism. In January the Defense Science Board, a Pentagon task force, released a report titled "Defense Semiconductor Dependency," a worried look at the U.S. semiconductor industry. The task force saw the globalization of the electronics industry as a serious military problem, in that dependence on outside suppliers could threaten Pentagon access to leading-edge technology.

This was not so much of an issue in the early 1960s, for example, when the United States imported only about 5 percent of its gross national product and exported only about 9 percent. But in 1984 those figures were 30 percent and 25 percent respectively, and the Pentagon finds itself dealing with a world technology market increasingly beyond its control. Forty percent of the electronics in U.S. weapons systems comes from Japan, and by the early 1990s, according to some analysts, that figure will top 50 percent. "Ten years from now Japan will have a separate industrial base, one perfectly capable of carrying on without the United States," says Michael Borrus of the Roundtable on the International Economy, a research group at the University of California at Berkeley. "At that point reliance on Japanese technology may not be the best idea for the United States."

KEVIN T. GILBERT / INSIGHT

Graham: Benefits of a free market

The Pentagon does not want a global economy that puts U.S. interests at the mercy of its allies' trading policies. The Defense Science Board recommended that the Reagan administration put up $2 billion over five years to prop up certain key areas of the U.S. semiconductor industry. The Strategic Defense Initiative, in addition to its stated goals, also represents a multibillion-dollar attempt by the Defense Department to develop cutting-edge technologies in aerospace and electronics.

But building up a healthy domestic high-tech base is not the only concern of the Defense Department. The task force worried not just about promoting U.S. technology but also making sure such expertise stayed in the country. Why? Because the globalization of high technology makes it easier for the Soviets to obtain products and know-how. And when that happens, the report warned, "The U.S. could lose the considerable margin of advantage it holds over the U.S.S.R. in this critical area of technology — and upon which it relies to offset quantitative military advantages."

Restricting the flow of American expertise overseas, however, is not easy, and after 6½ difficult years the Reagan administration still has not struck a clear balance between national security and technology trade. Take the touchy issue of scientific freedom. Not long ago, the Defense Department seemed to know what it wanted. If scientists engaged in strategically important research or took Defense Department money, they would have to submit to department controls. In April 1985 the Society of Photo-Optical Instrumentation Engineers received word from the Pentagon that 43 of the 219 papers scheduled to be presented at a conference could not be given in open sessions. Three years before that the Defense Department ordered restrictions prompting the withdrawal of 100 papers from a similar conference in San Diego and intimated that more restrictions might be forthcoming. The actions caused a surge of outrage among scientists.

Today the issue has died down somewhat, with the Pentagon apparently respecting the desire of the scientific community that no controls be attached to either basic research or research conducted on a university campus. But the matter is far from settled. "DOD is pretty two-headed on this issue," says Stephen Gould, a project director of the Committee on Scientific Freedom and Responsibility at the American Association for the Advancement of Science in Washington. He points up the distinction in the Pentagon between those whose jobs are concerned with national security policy and those who are charged with advancing scientific and technological programs.

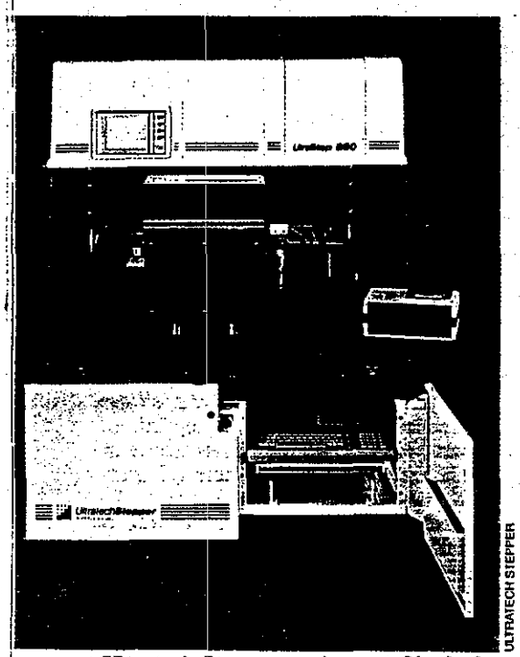
Insiders paint a picture of a Pentagon that talks tough on research controls but shies away from implementing regulations as aggressively as the language would allow. That may represent a victory for the scientists, but its impermanence leaves some of them nervous. And in the meantime the gap between rhetoric and reality has made it difficult for the Pentagon to articulate a position on what many scientists see as the next critical issue: whether, in the name of national security, it is even worth placing restrictions on applied research. One of the inventors of the atom bomb, Edward Teller, for example, has argued that all that is needed to keep U.S. science ahead of the Eastern bloc is to control the opportunity of Soviet scientists and engineers to work side by side with U.S. scientists. Any other method of technology transfer — scientific conferences, academic papers — Teller has said, is of little value to countries playing catch-up.

CHUCK NACKE / PICTURE GROUP / FOR INSIGHT

Perrone's company was stymied in sale of semiconductor technology to China.

More serious is the Reagan administration's attempt to control the export of what it deems militarily and strategically significant products and technology. Here the administrative framework is more convoluted. It revolves around two acts of Congress and has been disfigured by a turf war between the departments of Commerce and Defense. Also involved is a clumsy and largely ignored agreement among the major nations of the Western alliance to limit exports to the Eastern bloc.

The economic costs of restrictions are high. In 1985, according to the National Academy of Sciences, in the name of national security, these controls cost the most dynamic high-tech sectors of the U.S. economy some $9 billion in lost sales and 200,000 jobs. The administration wants to inhibit Soviet access to high technology, but there is a growing body of criticism that says the existing export control system in the United States just doesn't work.



ULTRATECH STEPPER

Ultratech Stepper equipment: No deal

"The whole theory of export control is based on a notion that's completely outdated," says Bill Maxwell, director of international issues for the Washington-based Computer and Business Equipment Manufacturers Association. Ten or 15 years ago, forbidding the export of American high tech meant that foreign countries did not get high tech. Today it means they buy it from someone else.

Export controls are supposed to be lifted if it can be proved that the technology in question is readily available elsewhere in the world. But that rarely happens. A blue-ribbon commission appointed by the National Academy of Sciences to study export controls concluded, in a report published earlier this year, that "foreign availability has had virtually no impact on the objective of achieving decontrol." In the past four years, 20 technology areas have been thought to be sufficiently global to be worthy of decontrol. Only three have been dropped from government lists.

This has had a substantial effect on a number of U.S. manufacturers. The Andover, Mass.-based GCA Corp., for example, used to be one of the world leaders in making the sophisticated equipment used in manufacturing semiconductors. But, says economist George Gilder, who is writing a book on the semiconductor industry, "Right at the moment that Nikon and Canon entered the market and Asia became the fastest-growing semiconductor area, GCA was prohibited from selling overseas for national security reasons." The result? The Japanese got a free pass to the world chip equipment market, while GCA was handcuffed. "It was a really unfortunate policy that had no defense justification whatsoever," says Gilder. "The whole thing has been incredibly badly conceived."

The critics of export control do not doubt the national security justification for the program; they just think that the controls are administered unwisely. "Technology moves very rapidly," says Lou Perrone, vice president of the California electronics firm Branson-IPC, "and it's difficult for a government the size and complexity of ours to keep up with it." Perrone's company made a deal to sell a few million dollars' worth of what it felt was obsolete equipment to the People's Republic of China in late 1984. The sale was blocked by the Reagan administration, and Perrone still does not know why.

"If China, or any Eastern bloc country for that matter, came to us for state-of-the-art equipment, I would say forget it. I wouldn't even bother to ask for an export license; I'm not stupid. But here was a logical case of some technology and some capability that had little fundamental use elsewhere in the world, except in parts of the Third World and developing countries." This spring, after more than two years of time-consuming and costly pleading in Washington, parts of the deal were approved.

Ultratech Stepper, another California firm, also made a deal to sell what it thought was obsolete equipment to China two years ago. In its eyes there was no reason to believe that an export license would be denied: U.S. firms had already sold comparable equipment to China; the Chinese could easily get more sophisticated equipment from Hong Kong; and when the Pentagon sent an expert to examine the proposed equipment for export, he agreed that it was obsolete. So why is Ultratech Stepper still waiting for a license? "It's not a technological issue anymore; it's a political issue," says Kay Mascoli, a company spokesman. She charges that the Defense Department did not understand the technological issues and let its national security concerns determine the result.

The experience of Ultratech and Branson-IPC is not typical. The average processing time of an export license in the United States is, according to the Pentagon, one to two months. What does seem to be typical, however, is the role played by the Pentagon in the decision making process. The Export Administration Act of 1979, which governs the export of com-

"Why should we buy controlled American chips that come with all kinds of strings attached when we can buy uncontrolled Japanese chips?"

mercial and military technologies, is supposed to be administered by the Commerce Department. Defense is to act in an advisory capacity.

Richard N. Perle, who was the assistant secretary of defense responsible for the Pentagon's export control policy until he resigned this spring, denies that the Defense Department has encroached on Commerce's authority in this area. He points to a presidential directive, implemented by Defense Secretary Caspar W. Weinberger in 1984, that calls for defense-related technology to be treated as a "valuable limited national security resource, to be husbanded and invested in pursuit of national security objectives."

Jurisdictional issues aside, however, there is little doubt that the effect of Pentagon involvement is to make controls much stricter and the licensing process more complicated than would otherwise be the case. Commerce Secretary Malcolm Baldrige has consistently called for a 30 percent to 40 percent reduction in the number of items on the Pentagon's export control blacklist, which is currently about the size of the Los Angeles phone book. "The whole list needs an overhaul," Baldrige said in March. "It's very easy to add things to that list, but it's very hard to take them off."

The Pentagon's response at the time was firm. "Any loosening at this point would be extremely harmful to national security," explained Stephen D. Bryen, then Perle's deputy. Perle himself has said that the list's comprehensiveness is its strength, not its weakness. As he told Congress in 1984: "We have sought, and believe it makes sense to seek, the greatest possible precision. And precision is attained by having a list that is sometimes excruciating in its detail, because it enables people who have to make judgments on licenses to reference the precise commodity or technology in question. . . . The size of the list, which has frequently been the subject of criticism, is not the relevant measure of effectiveness."

Does the Pentagon really understand the rapidly changing face of American high technology? Boyd McKelvain, who is chairman of the export control blacklist advisory committee, likens the process of defining military criticality to the problem faced by "a Supreme Court justice in defining pornography: 'I can't define it, but I know it when I see it.' "

Commerce and Defense are agreed on basic principles. When former White House science adviser George A. Keyworth III complained that "the Soviets are robbing us blind" on high tech, he spoke for the entire administration. The argument is simply over procedure, and in many ways those problems are being addressed. President Reagan recently directed the National Security Council to study the entire export control system with an eye toward reform. Reform came up again in January's State of the Union address, and the current House omnibus trade bill contains a number of provisions that would liberalize the Export Administration Act. The Pentagon has tried to streamline the licensing process as well. During his tenure at Defense, Perle eliminated the backlog of applications that had piled up in 1981 and beefed up equipment and support staff.

There is no way around the fact that the heightened awareness of national security needs leaves U.S. high technology at a significant disadvantage, however, with respect to Europe and Japan.

Almost all Western nations are supposed to abide by the rules of the Coordinating Committee on Multilateral Export Controls, which governs exports to the Soviet bloc; but, perhaps unsurprisingly, levels of compliance vary widely. The United States takes longer to process licenses, requires more red tape and checks up far more closely than any other major industrialized country.

Says Daryl Hatano, an official at the Semiconductor Industry Association, "Companies are saying, 'Why should we buy controlled American chips that come with all kinds of strings attached, about how they can be used or where the end product can be sold, when we can buy uncontrolled Japanese chips?' " Of the U.S. firms surveyed by the National Academy of Sciences panel, 52 percent reported lost sales because of export controls, 26 percent said they had had deals turned down because of them and 38 percent said existing customers had actually expressed a preference for shifting to non-U.S. sources to avoid controls.

Controls have not been the only sticky wicket in government-industry relations. The government directly funds some 775 research laboratories across the country, employing some 80,000 people (about one-sixth of the nation's scientists and engineers) and gobbling up about half of the annual $123 billion that goes to pure and applied research nationwide. These are the labs that do research on the Strategic Defense Initiative, missile systems, nuclear energy, synthetic fuels or the space program. They lay the scientific groundwork for much of the U.S. public sector's use of advanced technology. But the work they do — publicly funded, much of it unclassified and easily accessible — does almost nothing for the country's broader economic competitiveness. Since the 1950s, only 5

GLEN STUBBE / INSIGHT

Pentagon's Perle kept firm grip on exports, despite objections from Commerce.

Says one observer, "The notion that what government labs do is just all-out wonderful stuff for industry to commercialize on is a pipe dream."

percent of the government's 28,000 patented inventions have been licensed for commercial use.

In recent years, in Congress and the executive branch, this underutilization of federal technology has been ascribed to a lack of coordination between private industry and public labs. In 1980, Congress passed the Stevenson-Wydler Technology Act, which requires the government's larger labs to set up special offices to promote technology transfer. Last year, Congress beefed up the act, making special allowances for cooperative research and development efforts between government and private industry, strengthening individual labs' technology transfer offices, formalizing the creation of a federal laboratory transfer consortium and, most critical, providing government inventors with incentives — including royalties and patent rights, which are unheard-of in most corporate laboratories — to make commercial use of their research.

HERMAN KOKOJAN / BLACK STAR

SDI research: A good deal of funding but few commercially exploited patents

The key word in the new technology transfer vocabulary is communication. Officials at federal labs around the country speak of the importance of networking. Argonne National Laboratory in Illinois uses an electronic mail system to relay information and assistance around the country. Critics of practices from the old days have cited the fact that only the United States among the world's leading industrial nations has no centralized government office to coordinate public sector research with private sector needs. Their views struck a nerve: The past six years have seen the creation and refurbishment of, among other organizations, the Commerce Department's Center for the Utilization of Federal Technology; the National Industrial Technology Board; the private Technology Transfer Society; and two directories, the Guide to Federal Technology Resources and the Directory of Federal Technology Transfer Personnel; not to mention technology transfer operations sponsored by the National Bureau of Standards.

At congressional hearings on technology transfer, the air was thick with definitions, explanations, caveats and analogies, all in the new language of competitiveness. A.T. Brix, president of Battelle Technology International Exchange, warned Congress: "Technology isn't like Campbell's soup. It doesn't come in a nice container, properly bar-coded for easy pricing. It cannot be rendered delicious by merely adding two cans of water and simmering it on the stove." What is it then? "Technology transfer can be more realistically likened to going into a supermarket and finding ingredients for soup interspersed with detergents, bakery goods and pots and pans. In short, here are some herbs, potatoes and onions; now make your own soup."

That culinary challenge is intended primarily for U.S. companies. Indeed, the 1986 law makes it clear that, whenever possible, domestic industry should be given preference in licensing agreements. But, one Senate staffer concedes, there is no way to guarantee that Yankee know-how will go to Yankee companies, and the fact is that the Japanese and West Germans have historically been far more interested in the fruits of U.S. government research than have U.S. companies. "There's nothing illegal in what they're doing," the staffer says. "They're just more aggressive. They appreciate the values of tapping into these resources. What we're doing as a Congress is taking a gamble that by trying to speed up the transfer of technology we'll benefit this country. Whether this will work remains to be seen."

A more serious question, however, is whether improved networking and communications is actually the answer to the technology transfer at all. "The notion that what government labs do is just all-out wonderful stuff for industry to commercialize on is a pipe dream," says Richard Nelson, a professor of international political economy at Columbia University. "A lot of folks in Congress have misconceptions about the way technical change proceeds." Commercial labs and federal labs, the argument goes, do different kinds of research for very good reasons: because commercial labs have tested similar waters and found them wanting, or because government research priorities — especially those having to do with defense — are so specialized as to have little commercial use at all. One of the pioneers of Silicon Valley, Robert Noyce, founder and now vice chairman of Intel Corp., has put it bluntly: "There is no work of interest to commercial industry going on in government laboratories."

If he is right, then the enormous resources devoted to federal research — important as that research is, and however much it contributes to the welfare and security of the country — nevertheless represent a net drain on the economy's productive capacity. The efforts of the recent technology transfer brigade to bring considerations of the national interest into step with the demands of the world economy may, ultimately, prove fruitless. The same is true for export controls. It may be possible to ease the economic burden that restricting Soviet access to Western technology places on American high technology, but as long as U.S. foreign policy objectives coexist with economic considerations, there must be some sacrifice. What is good for General Motors is not always what is good for America. That is truer now than it has ever been. The challenge of the modern world economy is to strike the proper balance.

— Malcolm Gladwell

The British Elite in Exodus: 'We're Losing Our Captains'

SUMMARY: Brain drain, the loss of a nation's elite, is usually a problem for developing countries. But in Britain, it is epidemic. Scientists there face relative salary declines, harsh budget cuts and a government that has been ill-disposed to university research. Public funding is rising finally, and scientific special interest and support groups are springing up. But Britain's brain drain is not likely to end.

Some of the best minds in the world come from Britain, and the better they are the faster they come. Over the past few years, the cream of the nation's academia, thousands of its top scientists and engineers, have left to take high-paying jobs in the United States. Twenty-five percent of the fellows of the Royal Society, the United Kingdom's most prestigious scientific organization, work abroad. All of the Royal Society of Chemistry medals for research last year went to British scientists working in America. "We're losing the top four or five in every field," says one professor at Oxford University. "We're losing our captains."

This is far from the first time brain drain has become an international issue. From the time of the biblical exodus to the group of Jewish scientists and intellectuals (including Albert Einstein, Sigmund Freud and a young Henry A. Kissinger) who fled Nazi Germany in the 1930s, the talented have always been the first to migrate in search of better opportunities. But since the end of World War II, brain drain has primarily been an issue between the developed and the developing worlds, wherever the differences of economic climate and personal opportunity have been greatest. In the industrialized world, the pressure to compete internationally and the push toward high technology have made countries more aware than ever of the importance of keeping the best and the brightest at home. Brain drain, in the West, is a nonissue.

Except in Britain.

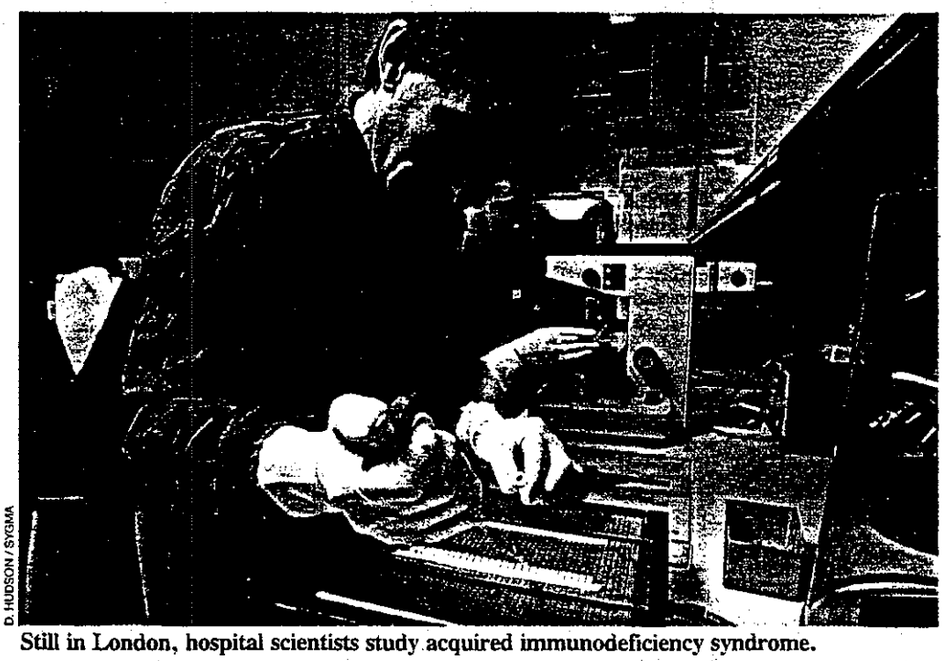
More scientists leave the United Kingdom every year than leave the rest of Europe combined, and the brain drain has never been worse. The golden age of British science, between 1950 and 1975, when the Nobel Prizes won for England were legion, is but a memory. In comparison to the rest of the world — from the United States, where fostering high-tech research and promoting competitiveness is all the rage; to West Germany, which spends nearly twice as much per capita on civil research and development as Britain; to France, which coddles its scientific community — Great Britain has been markedly less concerned about the fate of its intellectual resources. In the long term, that may mean trouble for the country in an increasingly competitive and technologically dependent world economy.

In 1981, the Conservative government of Prime Minister Margaret Thatcher cut back government funding for university research. "I think that that first round actually did us some good," says Dick Bishop, president of Brunel University in London. "It made us think more seriously about the research that we were doing. But we thought things would level off by 1984, and they didn't. It's been a slow squeeze. The cuts have begun to hurt."

The percentage of gross national income that Britain spends on research and development has remained virtually unchanged over the past 25 years, even as technological needs have intensified and the cost of research has skyrocketed. Last year the government's Science and Engineering Council, which doles out research money, closed up shop for six months because it ran out of funds. The horror stories of what budget cuts have done to British universities are legion: libraries that cannot afford scientific journals, laboratories that cannot afford to hire technicians. The University of Southampton is so strapped for cash it cannot afford to buy a Macintosh computer for the dean of its mathematics department. Right now he is ninth on the school's waiting list.

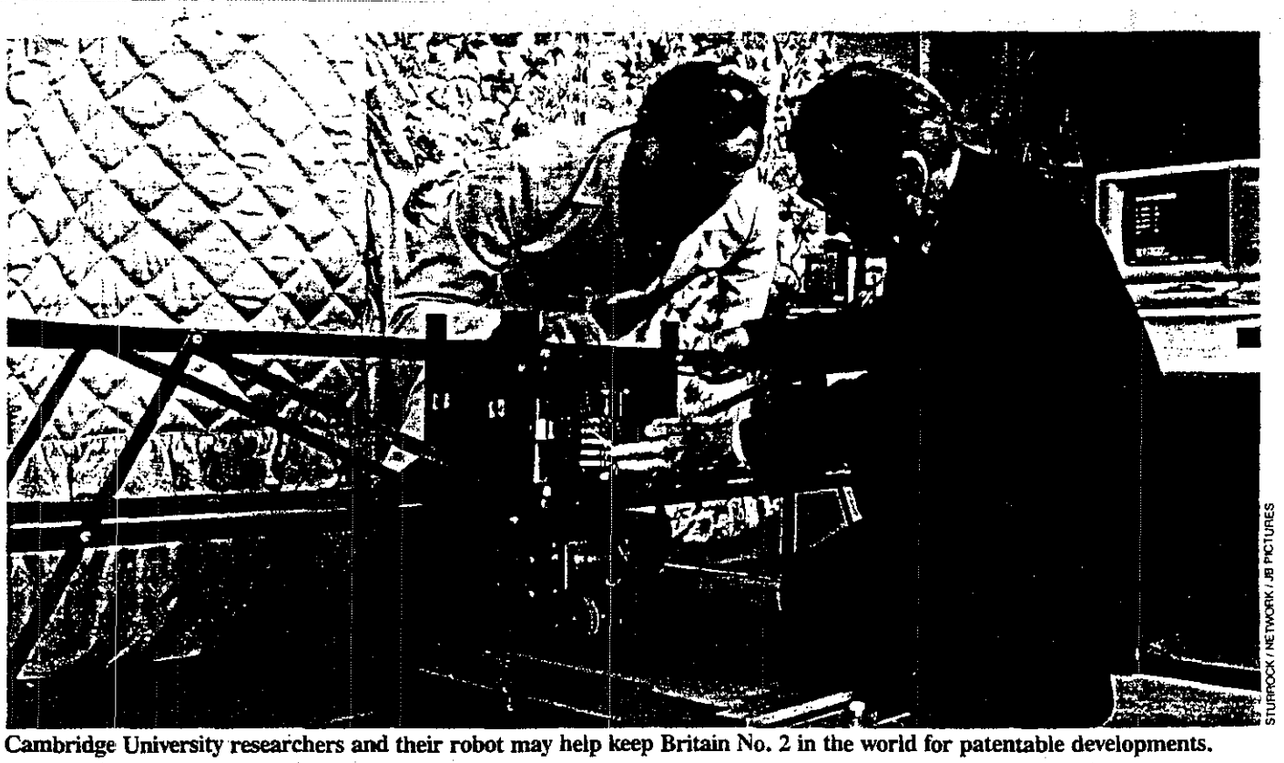
Faced with these frustrations, and salaries that have fallen 12 percent relative to average income since 1980, some of Britain's best are simply going elsewhere. "I don't think I've ever seen the morale of British science so low," says Professor John Ziman, chairman of the recently created Science Policy Support Group.

Those scientists who do not leave face a research climate of increasing uncertainty. Oxford Professor Denis Noble, who heads Save British Science, a recently formed lobby of distinguished scientists and Royal Society fellows, says that what



D. HUDSON / SYGMA

Still in London, hospital scientists study acquired immunodeficiency syndrome.



STUFFROCK / NETWORK / JB PICTURES

Cambridge University researchers and their robot may help keep Britain No. 2 in the world for patentable developments.

he calls internal brain drain is as bad as the external kind. He compared U.S. and British grant requests and found that, as a rule, researchers in the United States receive three times as much money from their science council as their British counterparts. "Those that stay have their own intellectual resources drained by a continual process of keeping their research going. In the U.S. the top people are far better-off. It's inconceivable that the equivalent of a Royal Society fellow would find himself in the position of scrambling for money. Yet that's the case in England."

Much first-class work is still being done. The Royal Society recently compared Britain's performance in basic scientific research with that of the rest of the world and found that while the country had slipped from second to fourth in theoretical and experimental physics over the past 10 years, it still led everyone outside the United States in biomedical research and genetics. And the Thatcher government has not been been deaf to the pleas of the scientific community. In February the government agreed to raise academic salaries 24 percent over the next few years. Also, as part of the Tories' preelection promise to raise public spending 1.5 percent this year, the Department of Education and Science is slated to get a 7 percent budget increase and universities an additional $80 million.

But some wonder if these measures will actually solve Britain's problems. The salary increases still leave the nation's universities at a substantial disadvantage when it comes to competing with the $70,000 to $100,000 positions often offered by U.S. schools, and Save British Science estimates that nothing short of a flat-out $180 million research increase will ensure that all worthy projects are adequately funded. Indeed, even if the government has loosened the purse strings somewhat, it continues to defend the original premise behind the spending freeze of the last six years.

Thatcher still says that much of university research is wasteful, supporting what one of her ministers calls scientific "white elephants." The government has long argued that scientific prowess is not necessarily related to economic success. In recent hearings in the House of Lords, Treasury officials cited the fact that Britain's postwar scientific brilliance coincided with the period of the country's greatest economic decline.

By the same token, with science in apparent decline, the economic outlook now is rosier than it has been in years. Economic growth is expected to reach 3 percent this year, higher than most industrialized nations. London's financial markets are the most important in Europe, drawing banks and investors from around the world. After the lean early years of Thatcher's economic program — which saw unemployment triple to 3 million and whole sectors of manufacturing, particularly traditional smokestack industries of northern England and Scotland, collapse — Britain has made impressive strides in developing new, internationally competitive high-tech industries. California has Silicon Valley; England has a silicon crown around London.

Does Britain really need a strong, publicly funded research base? And even if it does, does it matter that that base is moving overseas? "People who migrate from a country don't necessarily disappear from view," points out Jagdish Bhagwati, a trade economist and brain drain expert at the World Bank. "That was the tendency in early brain drain literature. Today we tend to look at a diaspora model. People keep their ethnicity. Communication and return to the home country is much easier now. Smart developing countries also have been facilitating increased participation in their own scientific work of people who have settled abroad." Losing scientists does not necessarily mean losing the fruits of their work.

Even so, commercial high tech in the developed world, and particularly in the United States, historically has tended to grow in clusters around such prominent universities as Stanford in California and the Massachusetts Institute of Technology and Harvard in Cambridge. The proximity of scientists and businesspeople seems to count for something in the chemistry of entrepreneurship. Nor does it follow from the apparent lack of correlation between British scientific achievement and economic success that science should be cut back. "It's a non sequitur," says Ziman. According to the National Science Foundation in Washington, British science trails only the United States in developing patentable technologies. British science isn't wasteful; it's wasted by a commercial industry that, as George Walden, minister responsible for science, readily admits, "is at the top of the league in pay raises and bottom in research."

So why use science as a scapegoat? "I think that our Treasury doesn't have any great sympathy for or understanding of science," says Ziman. "It's part of the two cultures in this country. There are no scientists in the Treasury."

"A top-ranking researcher might enthuse another 30. If you lose people like that you lose the stimulus that others get from interacting with him."

His theme is echoed by other academics, who insist that science has never been properly respected or represented in the United Kingdom. Noble recruited 2,000 prominent British academics for Save British Science because, he says, "there came a point when people began to wonder that what was wrong was that we didn't have what people in America have: a political lobby capable of putting political pressure on the government." The House of Commons has nothing like the U.S. Office of Technology Assessment to keep it abreast of developments in science nor even a standing committee dealing with science and technology. Scientists are conspicuous only by their absence on corporate boards and in positions of political responsibility.

To some extent this is the fault of scientists themselves.

"Bound up in their own self-congratulatory elitism and academic self-importance," says Ros Herman, a prominent British science writer, "scientists have largely lost touch with the rest of society." A recent Royal Society report worrying about the image of science in Britain prompted the formation of an ad hoc Committee on the Public Understanding of Science, drawing from all of Britain's major scientific organizations. Planned are a $750,000 investigation into the way science and technology are perceived by the public and a massive "scientific literacy" campaign in the media next year. Will it work? Nature, Britain's most influential scientific magazine, does not think so. The journal described the report's analysis as "overflattering to the scientific community everywhere" because it refused to address "the convention of self-certitude that has been taken up by academics."

Ultimately, though, the ball is in the government's court, and more support is now its stated goal. For example, Thatcher has said that she would like to see the portion of university research supported by industry rise from its present 2 percent to somewhere in the vicinity of 30 percent. But policies may be lagging behind proclamations. Corporate donations to universities are not tax deductible. Nor has the prime minister changed the tax code to encourage increased commercial research: There are no tax credits for industrial research and development, which most of the country's competitors allow. Even on the critical question of encouraging companies to exploit new technologies, Thatcher's policy has been indifferent. Technology transfer may be a big issue in the United States, but in the United Kingdom the Technology Exchange Center just went bankrupt.

Brain drain is the price that Britain is paying for this. One thousand of its finest leave every year, and although that figure is small compared with the 50,000-odd new scientists and engineers who join the work force in that time, it is the quality of those leaving that counts. "A top-ranking researcher might enthuse another 30," says one professor. "And they in turn might enthuse a few hundred of their students. If you lose people like that you lose the stimulus that others get from interacting with him."

"We are moving from economies that basically deal with materials — iron, steel, coal — to economies driven by information," says Carver A. Mead, one of the prime movers behind the modern microchip. For the U.S. scientist, the intellectual component in any product is increasingly becoming more important than the actual manufacturing process or materials involved. Brains count for more in the high-tech age. Last year Texas Instruments Inc. renegotiated all its patent agreements with Japanese electronics manufacturers, raising the cost of licenses by millions of dollars. "More important than the immediate financial impact of these settlements," company President Jerry R. Junkins said at the time, "may be the general recognition by our industry that intellectual property has considerably greater value than has been recognized in the past."

If he is right, that may mean trouble for Great Britain. "Somehow," says Brunel's Bishop, "the excitement seems to be gone from British science."

— Malcolm Gladwell in London

RICHARD KOZAK / INSIGHT

Edinburgh observatory: Britain slipped internationally in experimental physics.

NORM / JOE / DICK

TRIPPING ON OUR OWN SUCCESS

Losing a Market to a High-Wage Nation

By CHARLES F. SABEL and GARY B. HERRIGEL

ALL too often, the debate about American competitiveness is conducted in the sterile context of large, high-visibility industries such as steel, automobiles and semiconductors that seem to be losing out to low-wage competitors. Thus confined, the debate often obscures more than it reveals.

In fact, for decades now the United States has lost technologically sophisticated industries to foreign competitors with living standards comparable with our own. Only when we understand why this happens will we begin to appreciate what it will take to make industry competitive again.

The textile machinery industry provides a clear example of how high-wage foreign nations quietly innovate us out of industry after industry. The United States was once the world's leading producer of textile machinery. By 1982, according to the Commerce Department, domestic producers supplied only 48 percent of the $1.6 billion American market, and 92 percent of American sales were for spare parts. We lost this market not to Taiwan but to West Germany and other advanced nations.

The explanation for our manufacturers' failure is also the secret of their success. American manufacturers dominated world markets for 50 years with a system based on mass production. But the same system prevented them from learning enough from customers — the textile mills — to remain innovative.

As the textile industry expanded rapidly in the late 19th century, fast-growing machinery makers established a controlling grip on their customers. The mills depended on them for service, technical advice and sometimes for capital. A dependent mill seldom turned to a competing supplier. Thus, equipment makers could standardize their products, apply mass production to cut costs and tighten their hold on the mills.

But this strategy limited the companies' ability to respond to shifts in demand. In such a tightly integrated system, every change in production required many others. As a result, anything short of a sure-fire breakthrough was too costly to try.

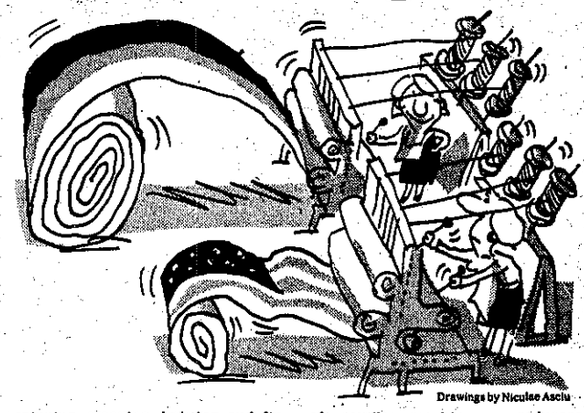
In time, mill owners grew dissatisfied with the standard products and modified them — but kept the results of their tinkering to themselves for competitive reasons. This cut the machine makers off from an invaluable source of new ideas.

By the 1950's, the machinery producers were rich but aimless. They earned enviable profits selling replacement machines and spare parts, but had no incentive to develop new technology or to modify their products for sale in new markets. Then, market conditions began to change.

Mergers created textile mills bigger than even the largest machine makers. Moreover, intense international competition in textiles led to rapid shifts in fabric production in the 1960's. The mills needed new kinds of machinery but American equipment makers reacted too slowly. They were soon displaced by foreign competitors, particularly the West Germans, who were quicker at developing new products and adapting current ones to customer needs.

Germany's Success

What accounted for the West Germans' success? The key was a tradition of specialization. Because 19th century German textile mills could not compete with the British in standard items, they turned to specialty weaves, creating a demand for new



Drawings by Nicolae Asciu

spinning, weaving, knitting and finishing technologies. Textile machinery makers came to view their industry as an association of specialists, each with unmatched expertise and flexibility in a particular phase or type of production.

Companies achieved economies of scale through joint marketing and research. These arrangements were called finishing associations, to distinguish them from price-fixing cartels. Each company was guaranteed protection against competition from other association members during downturns. Without such assurance, few would have committed their fortunes to specialization.

By the 1920's, the trade association of textile machinery producers pooled advertising expenses, established foreign marketing agencies, oversaw the setting of industrial standards and fostered cooperation between the industry and its customers. Groups of companies, regional textile mills and local governments sponsored research institutes that later were incorporated into a public technology-development and transfer system. Public vocational schools trained apprentices and offered engineering courses to craft workers.

Because companies could not diversify to reduce losses, they improved or customized their products. Progress by one company in one phase of production stimulated complementary innovations by other companies. The more individual companies saw that success depended on cooperation, the more they supported the institutions that made cooperation possible. The kinds of incremental innovations ruled out in the American system stimulated self-renewal in the German model.

New Subcontractors

In the 1980's, the German system prospers by perfecting its traditions. As development costs rose with rapid technological and product changes, companies began to share the additional expenses with subcontractors. The companies now concentrate their expertise in coordinating design, assembling the final product and advancing a few key technologies. Increasingly, they develop complementary technologies with subcontractors.

This leads to the creation of a production network that cuts across industries. When subcontractors work for different industries, companies are not so afraid that information passed to suppliers will wind up with competitors. On the contrary, they profit from the subcontractors' collaboration with customers in different industries. At the same time, diversified subcontractors are hedged against slumps in any one industry.

A consequence of this system is that West Germany is moving rapidly into high-technology areas although it lacks — in American eyes — two prerequisites: a distinct high-technology industry and a venture-capital sector. German flat-knitting machine manufacturers, for example, offer computer-controlled machines to make high-fashion knit goods.

There is nothing inevitable about American decline, just as there was nothing inevitable about West German success. Many of the institutions that promoted flexible production in Germany were established by regional governments. Unless we similarly encourage industry to reorganize in a manner that encourages innovative specialization, our economic successes will not offset our failures.

For that to happen, basic American convictions must change. The trade associations and cooperative banks that help institutionalize flexibility in West Germany strike us as collusive. The close relations between skilled workers and managers would discomfit many bosses and trade unionists here. Many Americans believe that the only way to encourage innovation is to remove obstacles to competition, including anything that smacks of cooperation.

Recently, however, economists, public officials and managers have begun to concede that competition can be a barrier to innovation. Through joint ventures and participation in collective research efforts, many companies are learning that cooperation can be crucial in developing profitable new ideas. Many states now have programs for revitalizing medium-tech industries, like automobile parts and cutting tools.

Moreover, what is now called "pre-competitive" cooperation has precedents in American tradition. Early in this century, for example, Justice Louis Brandeis sought to legalize just the sort of associations characteristic of West German industry. Many craft unions combined defense of workers' individual rights with efficiently flexible use of labor.

America is losing its industrial base because of its concepts of production efficiency and market competition. It is important to make sure that our trading partners don't cheat, that our business schools teach the right courses and that the exchange rate is stabilized at a level that encourages long-term domestic investment. But the debate about competitiveness should be first and foremost a collective discussion of how we can jump over the shadow of our success. ■

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Stirrings in the U.S.?

In the accompanying article, the authors suggest that the subcontracting of production now so popular among major corporations might provide the basis of an industrial revival. In the following discussion, Hannah Roditi, a research analyst with the Massachusetts Machine Action Project, in Springfield, assesses their theory from her perspective on the factory floor.

The Machine Action Project was established in 1986 to seek ways to revitalize the metalworking industry, which provides about one-third of the area's manufacturing jobs.

Q. Is there any hope for Springfield's metalworking industry?

A. Absolutely. We did a survey recently of what shops had closed and why. We found that most were larger shops. Many smaller companies are poised for growth. They do high-quality, precision work for customers around the country.

When we started this program, we assumed that skilled workers were abundant and the need was to revitalize industry to create jobs. Instead, we found that the industry was robust and the real problem was a shortage of skilled workers.

Q. Why are so many smaller shops prospering while so many big shops have closed?

A. Most of the larger shops are subsidiaries of conglomerates. They produce high-volume, standardized products that are facing a lot of foreign competition. In many cases management either has decided not to upgrade facilities or to relocate.

What's driving the smaller shops is the growing trend among large companies to outsource production. The small shops are specializing in narrow market niches.

Q. Has the groundwork has been laid for large companies to form subcontracting networks?

A. Yes. The small shops are beginning to work together. It depends on how innovative they are. If subcontractors do work together, then they can bid on a lot more contracts because they can each do a part of the job. But there is a tradition of competition, so whether they can get together on joint marketing efforts, we'll see.

Q. Why is there a shortage of skilled workers?

A. The larger shops were mainly production and high-volume oriented. A person was stuck operating one or two machines for 5, 10 or 20 years. When the plants closed, these workers hit the labor market without the skills that smaller shops need.

In the smaller, 5- or 30-person shops, people have to be flexible, know how to do different things. Small shops are contract-oriented; they don't know what they will get from month to month. They need skilled machinists who can operate, say, lathes, milling machines, automatic screw machines or com-

Small shops are sophisticated places to work that pay wages up to $15 an hour. But kids in school, who should be filling the jobs, aren't getting this information. All they hear about are plant closings. If they got the basic skills in geometry and trigonometry that they need to go into a shop, they would be set for life. ■

The Washington Post
Thursday, October 16, 1986

PETER BEHR

Plugging the U.S. Knowledge Leak

The United States has quarreled with its trading partners over autos, TV sets, oranges, steel bars and semiconductors. Next comes a battle over knowledge.

The protection of American inventions, laboratory research and intellectual property from unfair exploitation has moved to the top of the Reagan administration's agenda for the next round of international trade negotiations.

It also has become a prime issue for leaders of universities and government labs, who argue that the basic research at their institutions constitutes America's best remaining competitive edge in world trade.

There are now suggestions that some of that research be put off limits to foreigners or that access be limited, at least temporarily. Call it a "buy American" approach to government-funded research and development.

Richard M. Cyert, president of Carnegie-Mellon University—one of the nation's centers of research on advanced industrial processes—says the competitive importance of the U.S. research establishment must be recognized.

"The United States, in my view, is in an analogous position to being on the frontier in colonial times. We really are fighting for our economic life. Unless we are able to do some things in universities to help in this, I think our whole way of life, our whole standard of living in this country is going to go down the drain."

Cyert said he would be willing to consider a proposal that would boost federal research support for American universities—with the requirement that the research work be restricted to U.S. citizens.

"I'd be interested in it, if we limited the period . . . . I'd be willing to go along with that for a little while. I'm sure it would be unpopular, in the sense that we like to think of ourselves as world citizens.

"It's obviously something I'm uncomfortable with. . . . But we want to have America get some temporary advantage from the research that we can do. . . . The notion that somehow you want to do something for your country should not be something that a university president is ashamed of," said Cyert.

Congress is not considering such a proposal. But it has approved and sent to President Reagan

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BEHR, From E1

legislation called the Federal Technology Transfer Act of 1986.

The bill's main purpose is to help American companies, universities and other institutions tap research in the nation's 700 federal laboratories. The labs would be authorized to enter into cooperative joint research arrangements aimed at speeding their technology into commercial use.

Foreign companies aren't prohibited from joining in such cooperative ventures, but preference is to be given to American firms that agree to manufacture in the United States.

Senate Majority Leader Robert J. Dole (R-Kan.), and Sen. John D. Rockefeller IV (D-W.Va.) added a section that is aimed at assuring that American companies get reciprocal access to foreign labs. In reviewing proposals by foreign companies, federal lab directors "may examine the willingness of the foreign government to open its own laboratories to U.S. firms," the legislation says.

Although the bill has strong congressional backing, there is some question whether Reagan will sign it.

Access to American research facilities—government and university—will become even more important in a competitive sense as these laboratories try to push their discoveries into the marketplace more rapidly.

University of Michigan has set up an "intellectual properties" office to help inventors obtain patents and to offer advice and aid in turning the inventions into products or commercial services. Like Carnegie-Mellon and most other major universities, Michigan is expanding its connections with American manufacturing companies.

In all of these area, universities must walk the narrow line between advancing the U.S. national interest and maintaining a tradition of open access to all. It is a microcosm of the free-trade, fair-trade dilemma confronting Congress and the administration.

Gilbert R. Whitaker, dean of the University of Michigan's Graduate School of Business Administration, notes that the school still looks actively for non-American MBA candidates.

"The Japanese send 10 to 15 students a year. Now we're getting increasing numbers of Koreans. They're obviously here to learn something about American culture and American business to take back with them. We're trying to learn similar things about their culture," he said.

Whitaker believes that the United States has more to gain through a continuing exchange of ideas, technology and expertise. "We'd like to get technology from elsewhere to put together with our knowledge. . . . We don't have a monopoly on brains."

Cyert agrees, with one qualification. "One of the great accomplishments of the United States has been the dissemination of its knowledge and technology around the world. . . .

"We want the bucket to leak. We do want the stuff out there. To the extent we can hold back a little bit, say by some restrictions on licensing, or on access to the most up-to-date [research], it would give us a little bit of a comparative advantage."

The search for that advantage promises to transform the way universities, company managers and politicians think about the American research establishment.