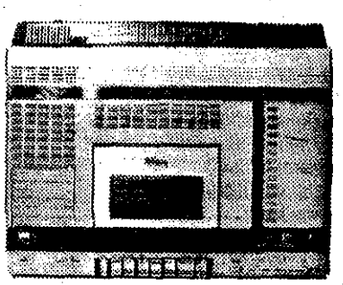
Lessons of the VCR Revolution

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

See COMPETE, A10, Col. 1

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.

Japan, by contrast, has increased its spending faster. In 1970 it invested 1.9 percent in R&D, but climbed steadily to match the United States' 2.8 percent by 1985, the last year for which figures are available. West Germany spent 2.1 percent in 1970 and grew to 2.6 by 1985. France went from 1.9 percent in 1970 to 2.4 percent in 1986.

Many analysts say, however, that the U.S. figures are misleadingly high because this country spends nearly one-third of its R&D money on military research, a far greater proportion than is spent by Japan or West Germany. If military spending is subtracted for the most current figures, the United States spends only 1.9 percent of its GNP on research and development, while Japan spends 2.6 percent and West Germany 2.5 percent.

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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Britain and the jet engine offer an older illustration. Although widely cited as an example of a major industrial power that has slid into global economic impotence and, in some ways, a declining standard of living, Britain continues to be one of the world's leading scientific innovators—second only to the United States as an originator of important fundamental technological advances.

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"To a far greater degree than we once believed," Rosenberg said, "a first-rate, domestic scientific research capability is neither sufficient nor even necessary for economic growth." More critical is the sophistication of the nation's manufacturing ability.

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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Under the Japanese system, experts in manufacturing technology

are free to complete the design in accordance with their knowledge of sophisticated manufacturing methods. They may modify the product design to ensure more reliable quality after manufacture. They may even invent new methods to make the product. As a result, the Japanese product can be made more easily, more cheaply and with much lower risk of defects.

The study was done by D. Eleanor Westney of the Massachusetts Institute of Technology's Sloan School of Management and Kiyonori Sakakibara of Hitotsubashi University in Tokyo.

Other key differences between the Japanese and American styles of managing engineering talent, according to Westney and Sakakibara, include:

- Japanese firms invest far more time and money in advanced training for their engineers than do American firms, partly because they have little fear that highly talented individuals will be hired away by rival firms. It is traditional for Japanese engineers to stay with an employer for life. One result is that hundreds are sent abroad to study for months or years—most often at American universities, which many Japanese regard as the best in high-technology fields. At MIT, for example, there are more than 100 Japanese engineers taking classes at any given time. Japan's much vaunted "fifth generation" computer project, in which the country hopes to leapfrog American computer technology, is based largely on innovations borrowed from U.S. computer scientists at MIT.
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- Although engineers everywhere often engage in "bootleg research," using company resources to pursue personal projects on the side, American firms try to discourage such activities because the engineers may then leave to exploit their ideas in new, spinoff entrepreneurial firms. Japanese companies encourage such sideline research, confident that the engineers will stay and turn the new ideas into valuable products for the company.

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.

Next Battle: Biotechnology

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.

The once unquestioned dynamism of the United States in the world marketplace is being tested as never before, forcing Americans to confront dramatic changes in standard of living, expectations and values. This is the second of six articles exploring these changes and their causes.

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"Monsanto, du Pont and Eli Lilly cannot cooperate in biotechnology," Schneiderman said. "We must be competitive, at arm's length. Yet Monsanto must be able to compete scientifically and commercially in biotechnology with MITI's consortium of 14 great companies in biotechnology and must compete with Japan's national commitment to biotechnology."

Monsanto's answer, and that of many other firms, is to seek collaboration with U.S. science-oriented universities.

"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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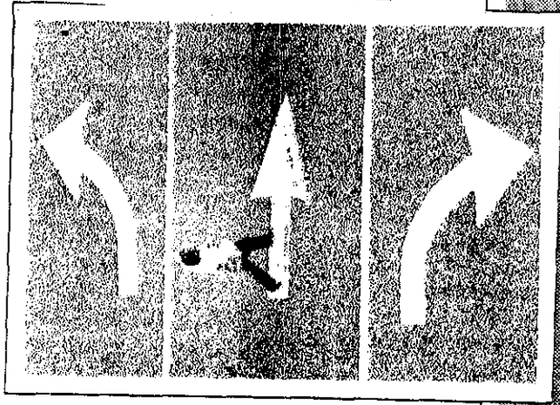

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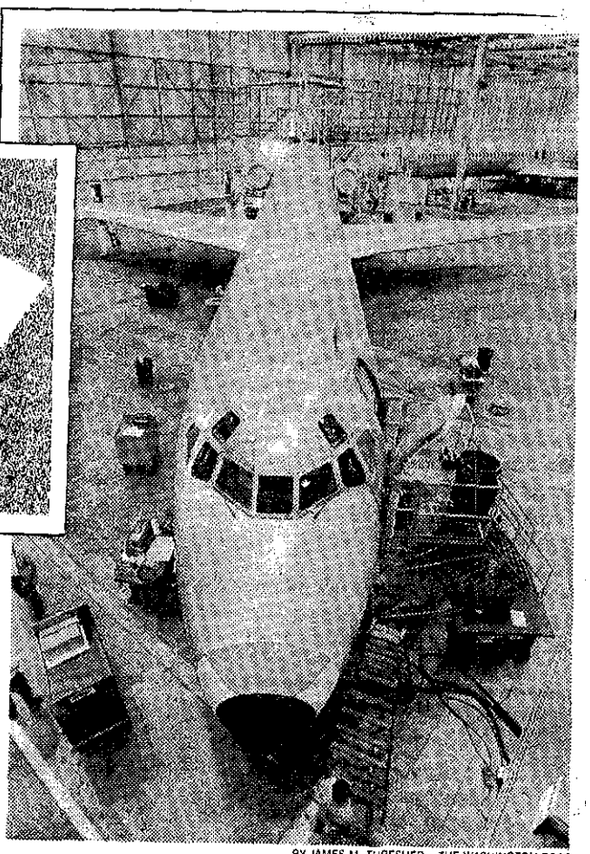

BY JAMES M. THRESHER—THE WASHINGTON POST

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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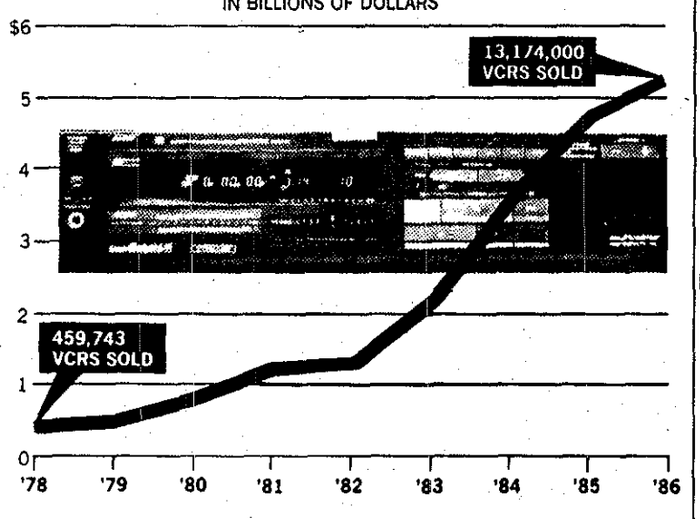
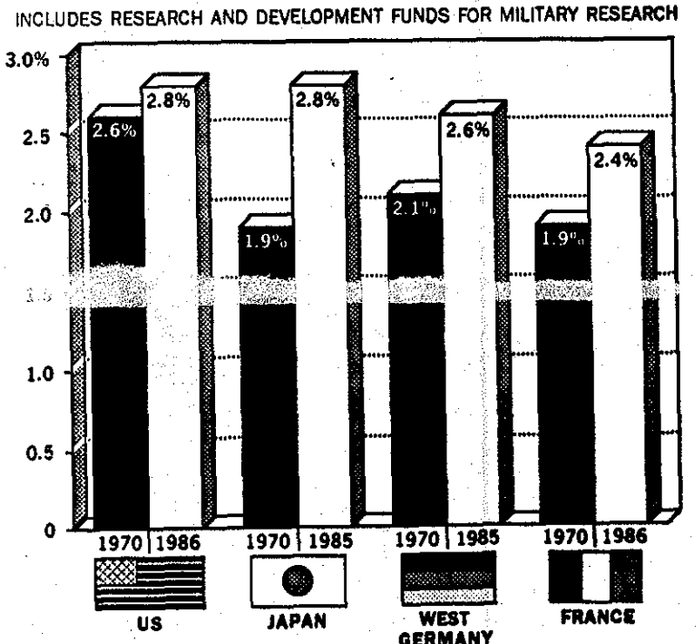


OURCE: Electronic Industries Association

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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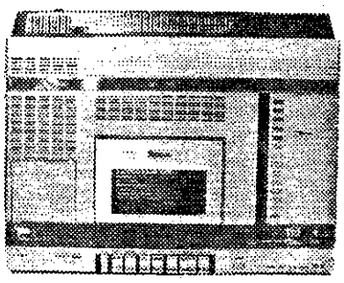

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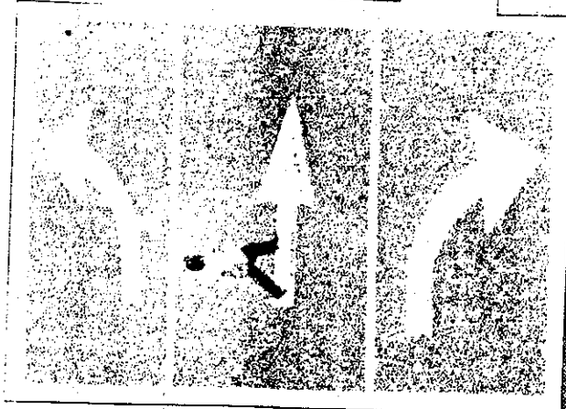
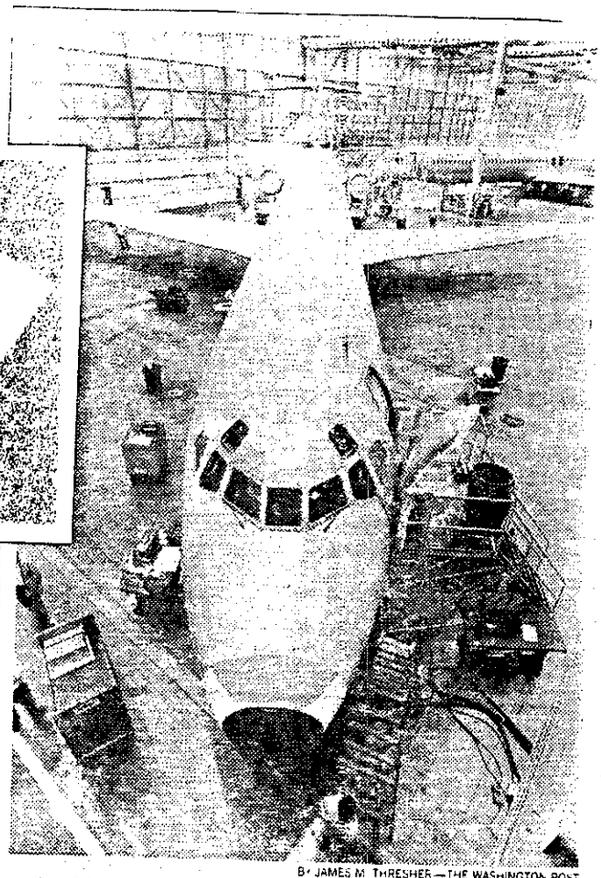
NEXT: The role of education

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.

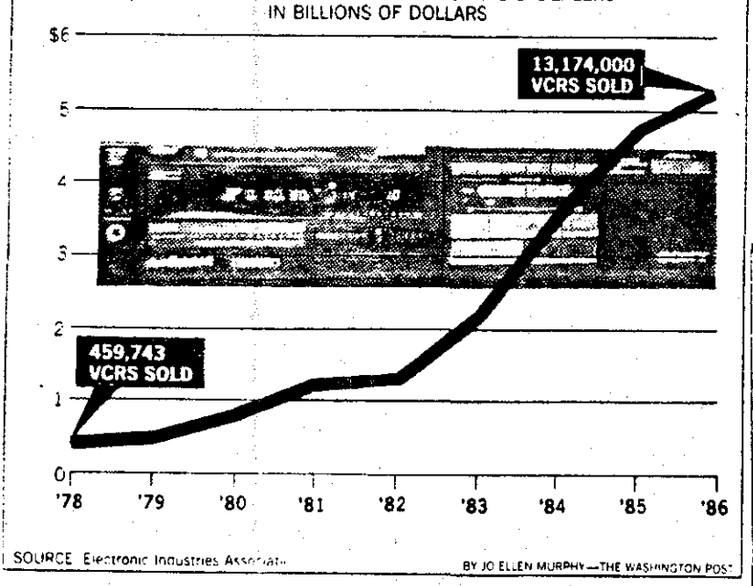


BY JAMES M. THRESHER—THE WASHINGTON POST

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

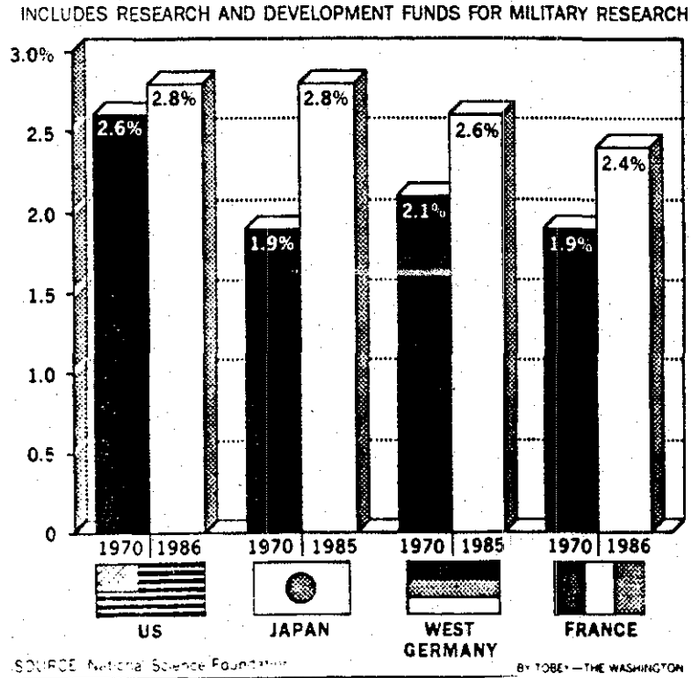


SOURCE Electronic Industries Associat...

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

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"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."

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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."

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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.

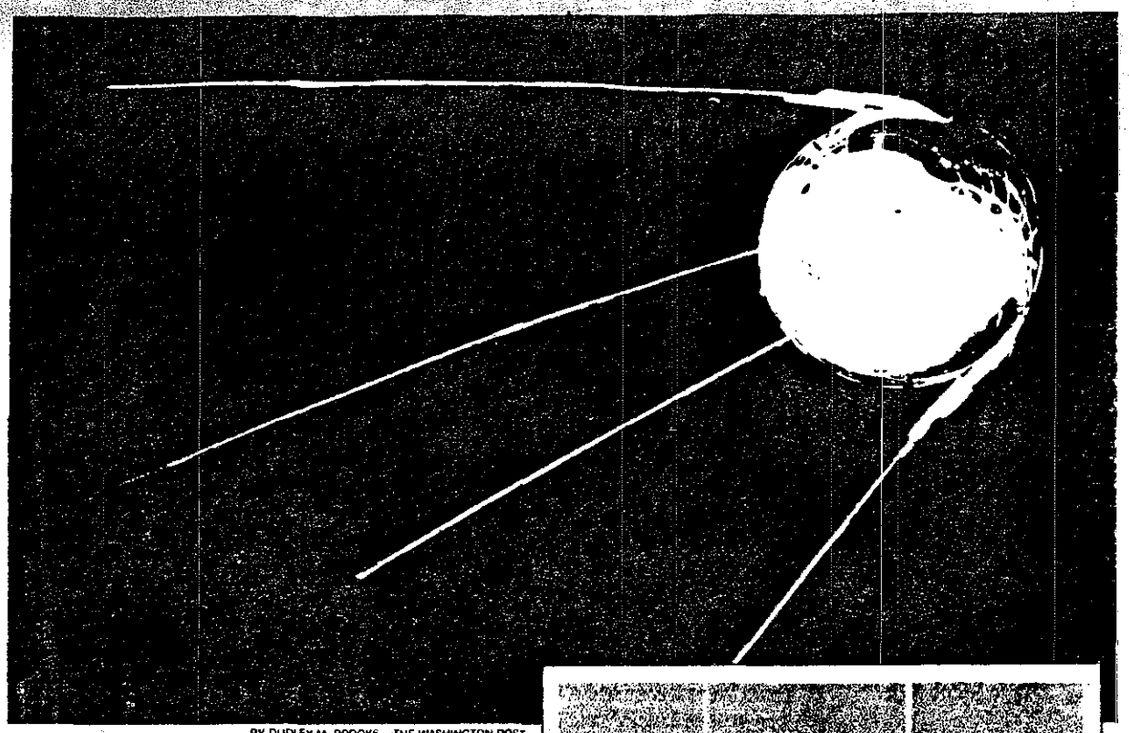
The University of Alabama has become known for aggressively helping to lure foreign investments and joint ventures. The Port Authority of New York and New Jersey has begun a government trading company called XPORT; it helps companies with the design, packaging, pricing, marketing and other needs of selling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

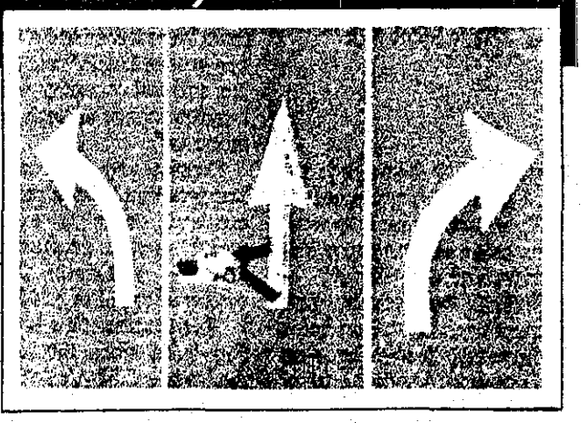
In a study issued last summer, for example, the National Governors' Association found that "hard data documenting job generation results is scant . . . and the result is that currently it is difficult to assess what works best."

—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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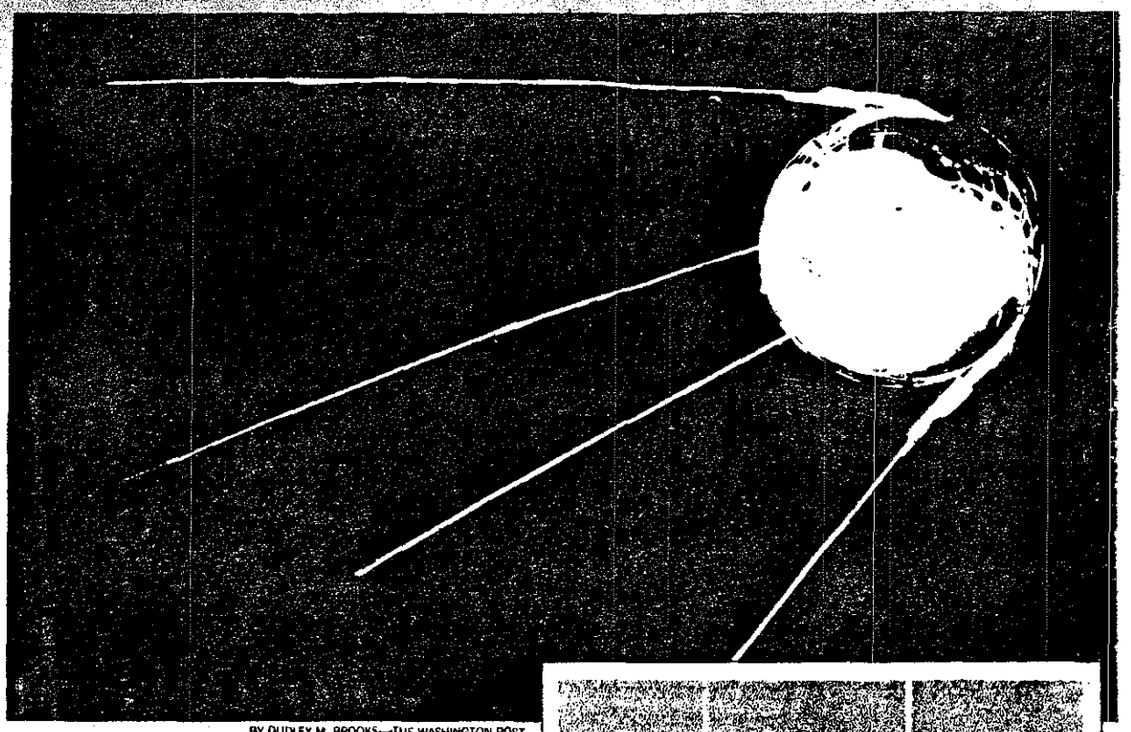

BY DUDLEY M. BROOKS—THE WASHINGTON POST

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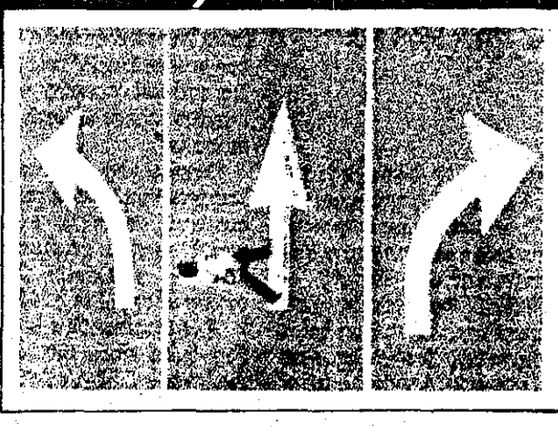

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U.S. Competitiveness: A Campaign Code Word

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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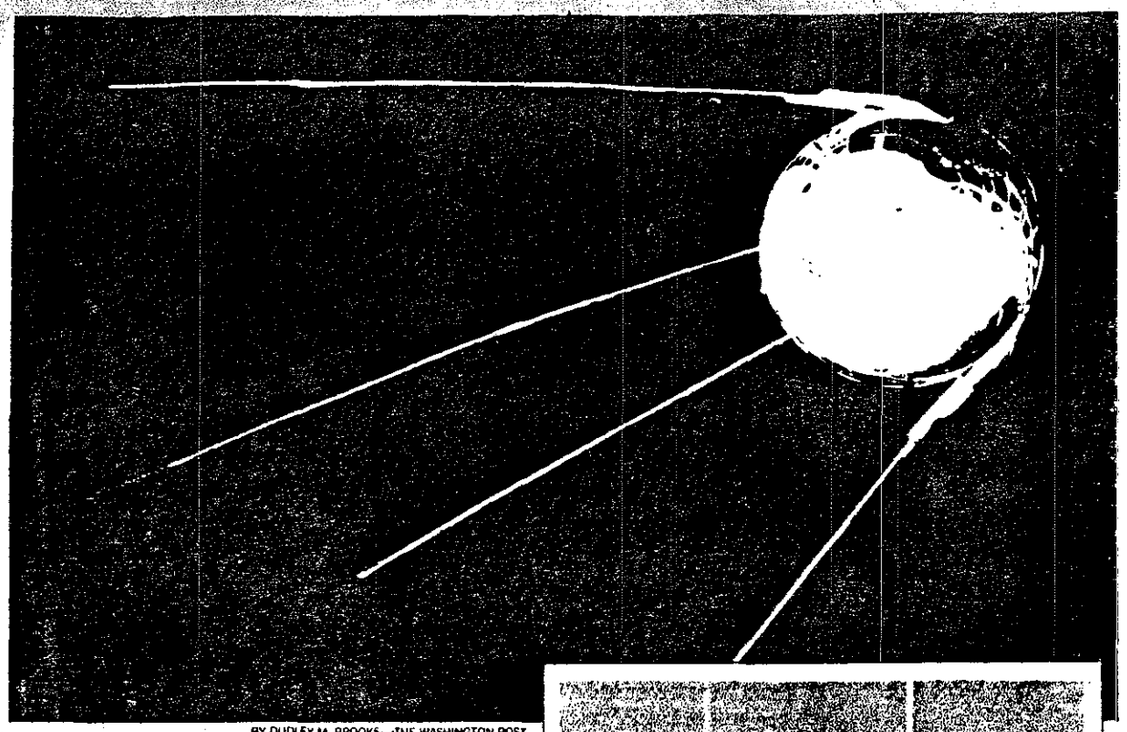

BY DUDLEY M. BROOKS—THE WASHINGTON POST

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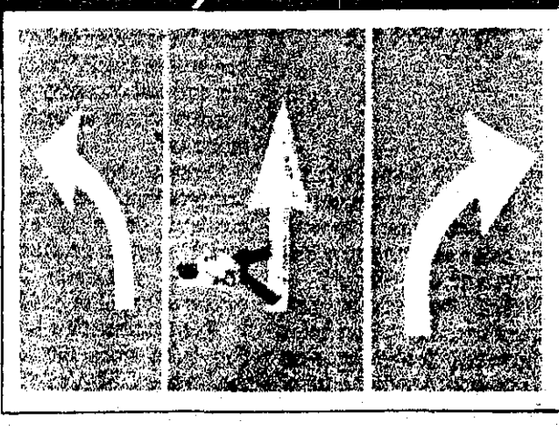

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America, the 'Diminished Giant'

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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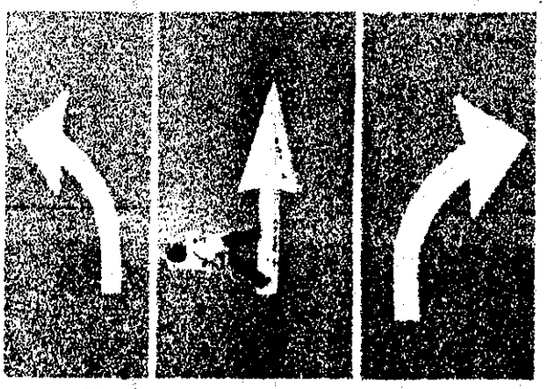

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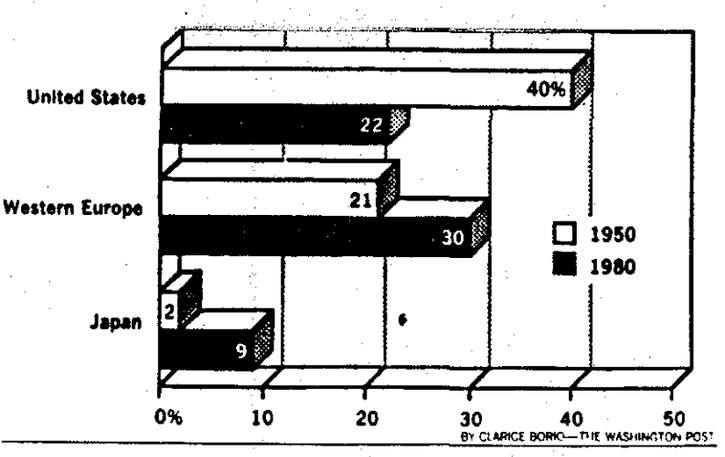

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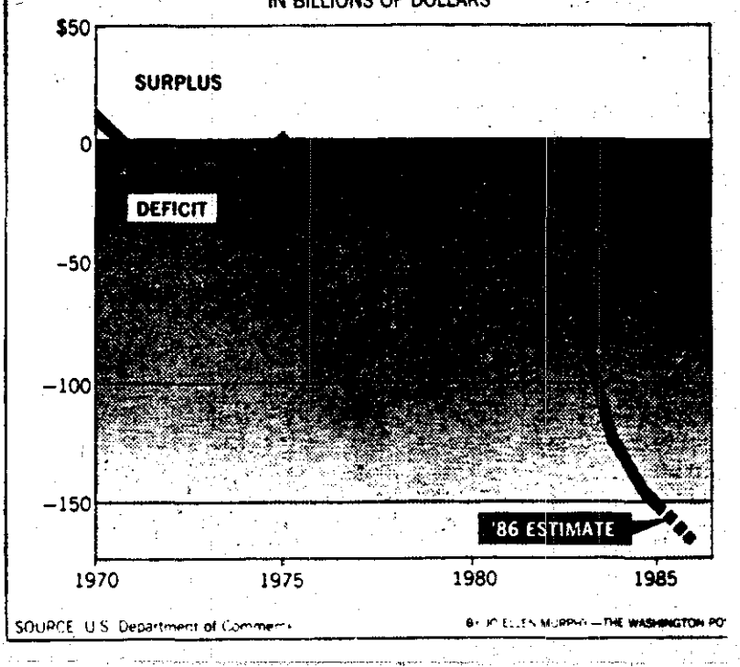

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But virtually all the experts agree that the era of overwhelming U.S. dominance of the international economy—an era that began after World War II when much of the rest of the world was devastated—is over.

"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.

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.

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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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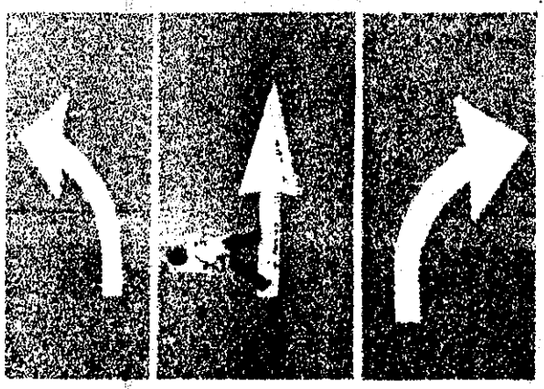

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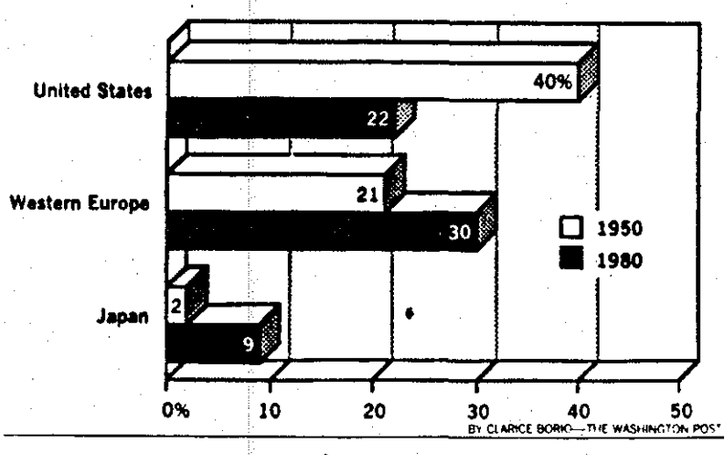

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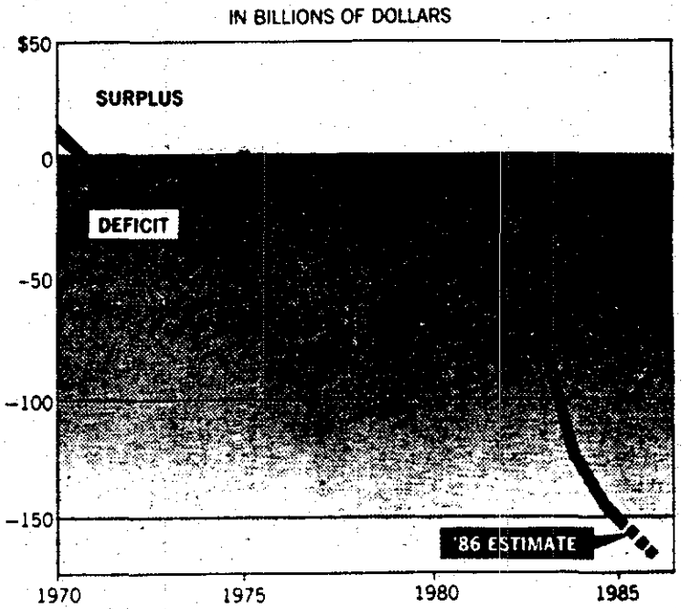

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"Can a small island nation [Japan] that is now militarily insignificant and far removed from the traditional power centers provide at least some of the needed global leadership? Can the United States continue to lead its alliance systems as it goes 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.

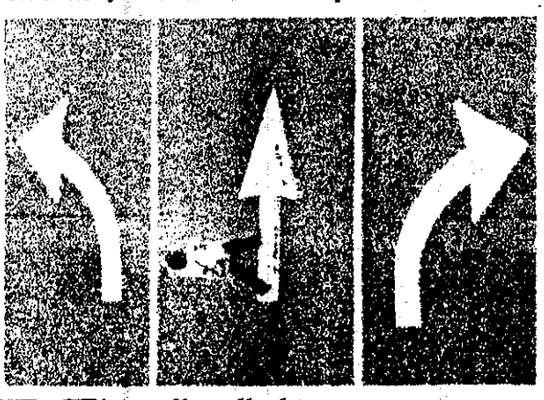
Now, Aho said, "we will see how much vibrancy this economy has."

NEXT: Politics of "competitiveness"

RUDE AWAKENINGS

BY JAMES M. THRESHER—THE WASHINGTON POST

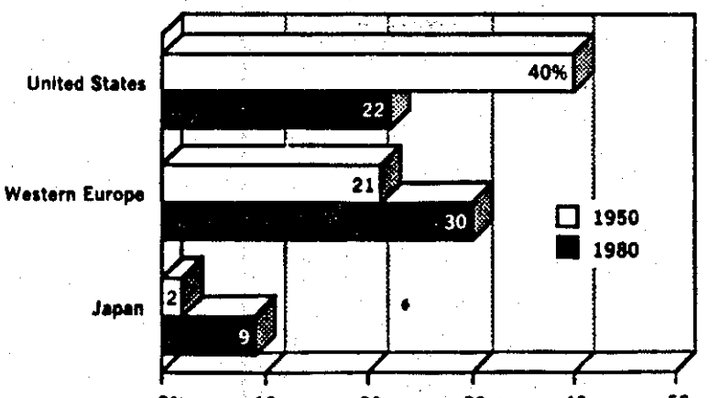
Korean workers prepare Hyundais for export to the United States and Canada. In the United States, the car set a first-year sales record for imports.



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

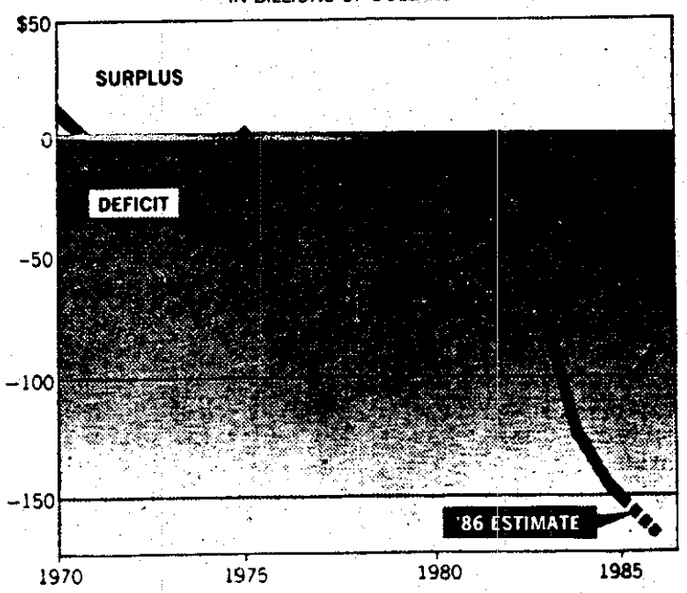
IN PERCENT



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

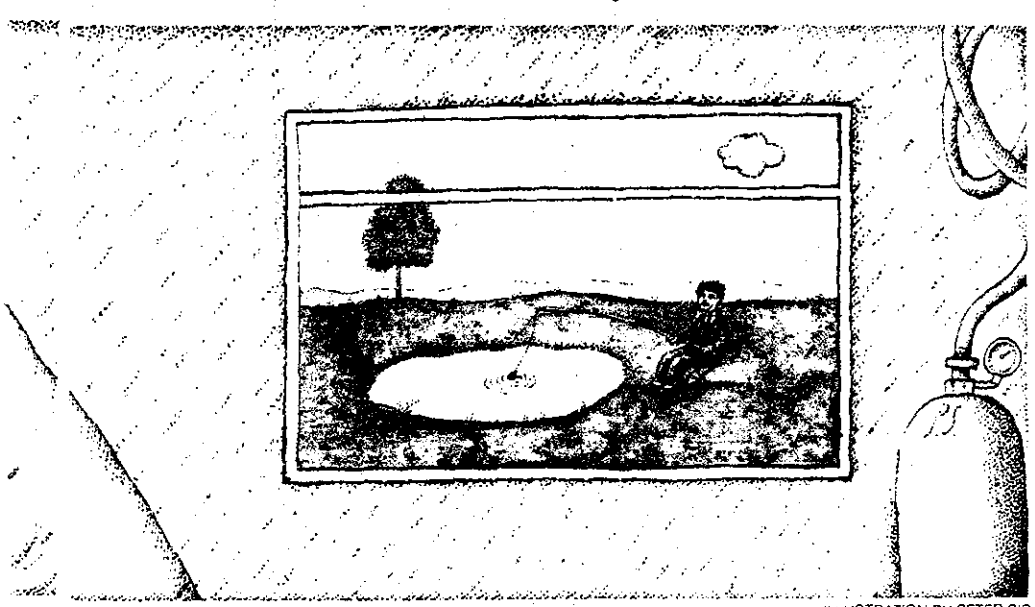

ILLUSTRATION BY PETER SIS

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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2. For USDA agencies, laboratories 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 proposal's author to obtain all required clearances before the proposal is sent to OICD.

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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Program Assistant	VACANT	(202)653-7860
Asia/Oceania		
International Affairs Specialist	Jean Curran (Asia)	(202)653-7860
International Affairs Specialist	Stephen Hawkins (Oceania)	(202)653-7860
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Latin America/Africa/Middle East		
International Affairs Specialist	Richard Hughes** (Latin Amer.)	(202)653-7860
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2121 K. Street N.W.
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.

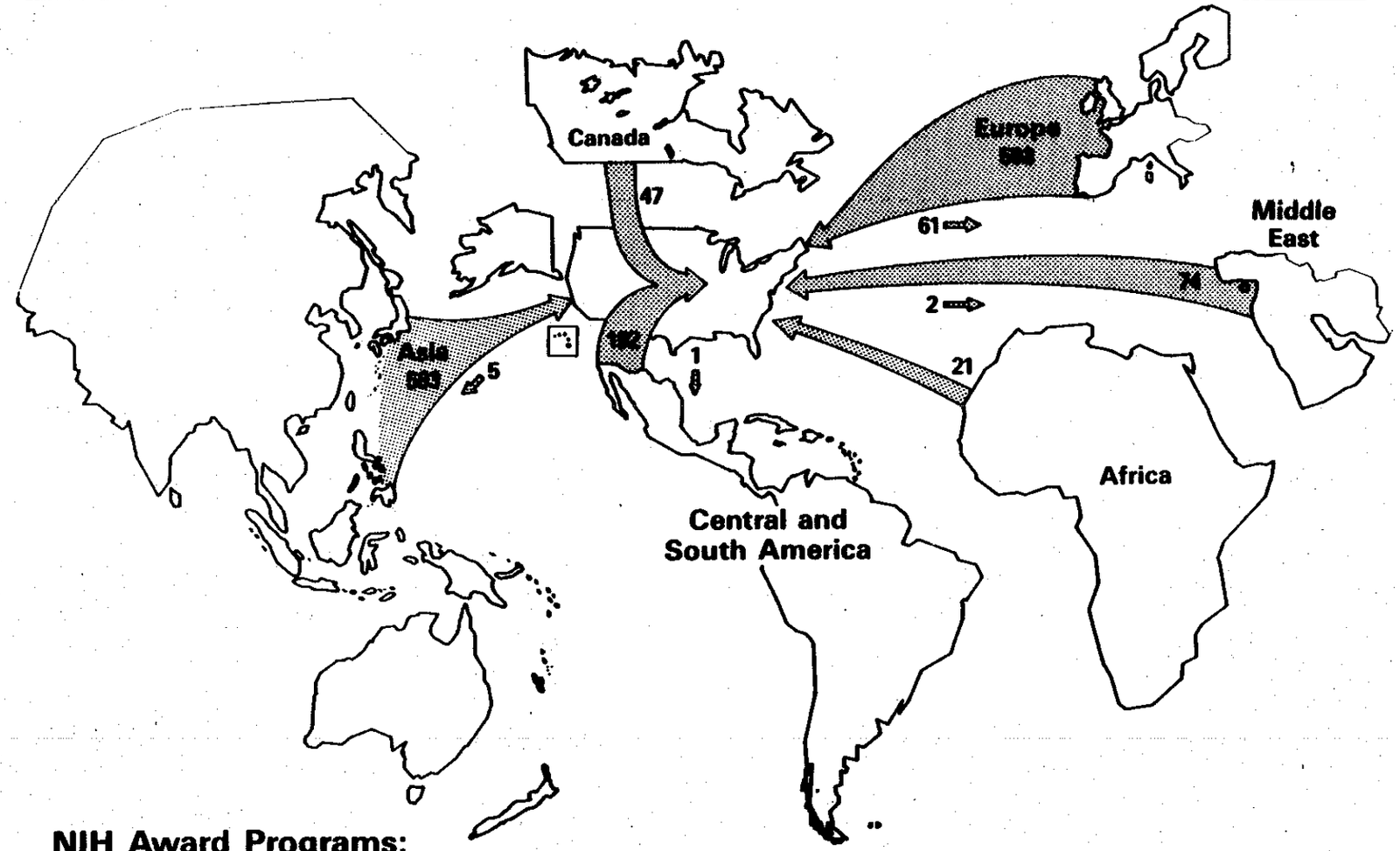
Aside from possible problems in forming brittle ceramic into wire, the new superconductor still can't handle enough current to be used in heavy applications such as power plants. Superconductors also don't work well with alternating current, the type of electricity used in most of the world's power equipment.

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.

Please contact:

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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
Total	2,081	119	2,200

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

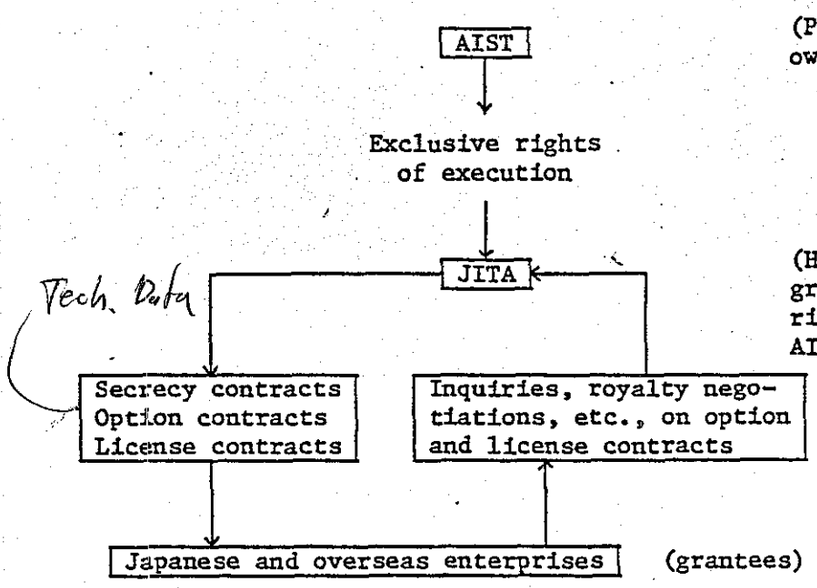

Figure 1. Technical Transfer System of AIST's State-Owned Patents

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.

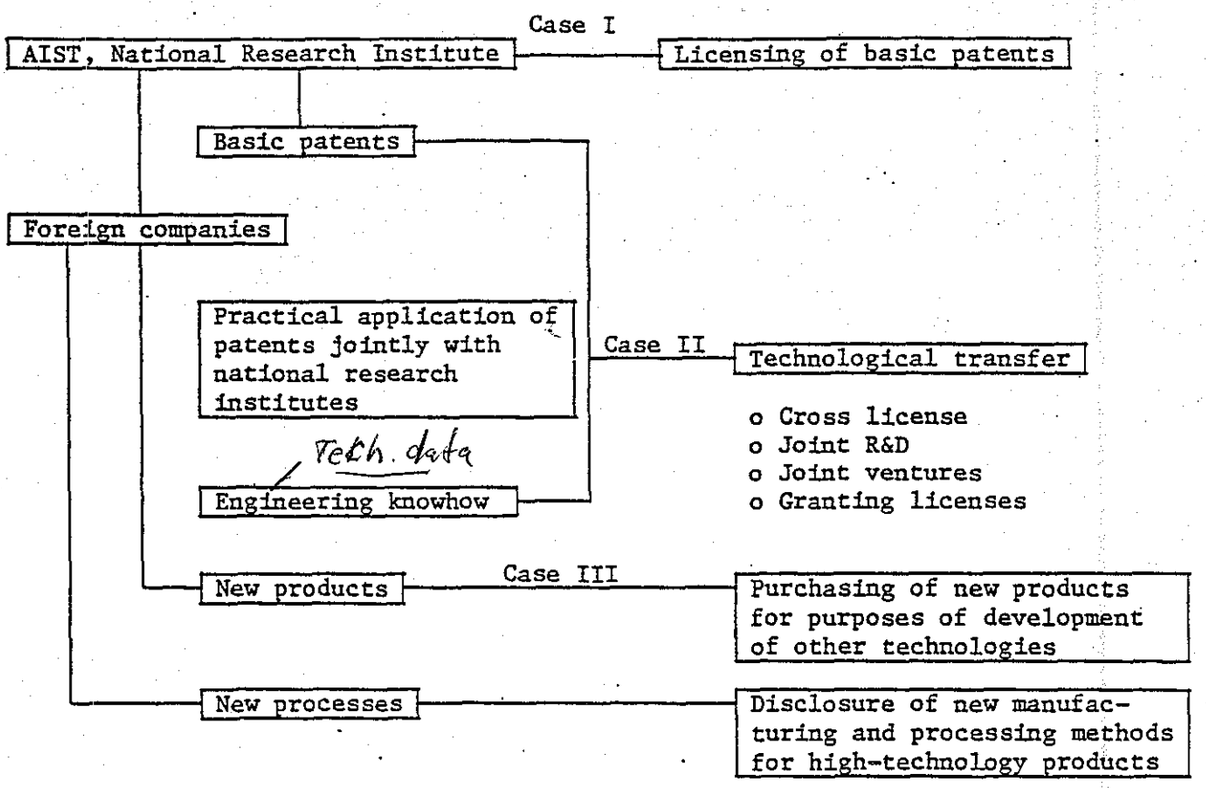

Figure 2. Technology Transfer of State-Owned Patents Abroad

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

EIJI MIYAZAWA / BLACK STAR

COVER STORY

PART 1

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.

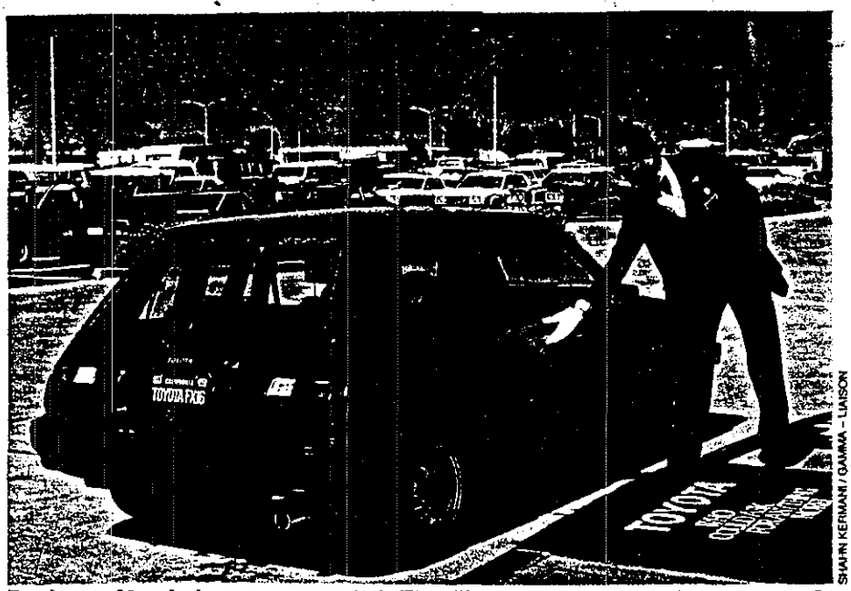
The first shot in the superconductor revolution was fired by two European scientists working for a U.S.-owned multinational firm in Switzerland. Sometime, somewhere, someone might sort out the tangled genealogy of that first discovery — and the dozens of breakthroughs all over the world that have followed 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

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



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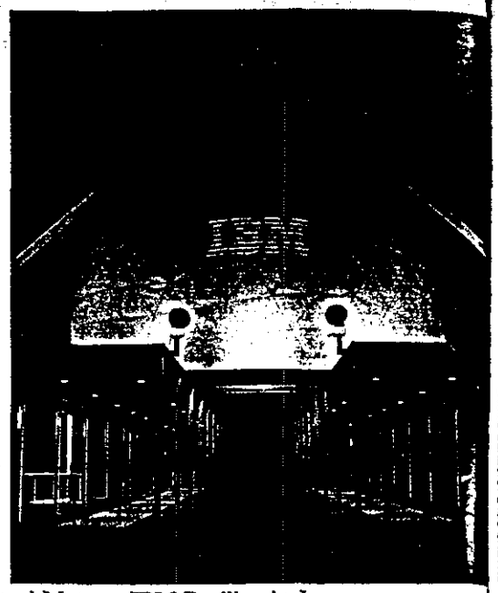


CHARLIE COLE / PICTURE GROUP

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.

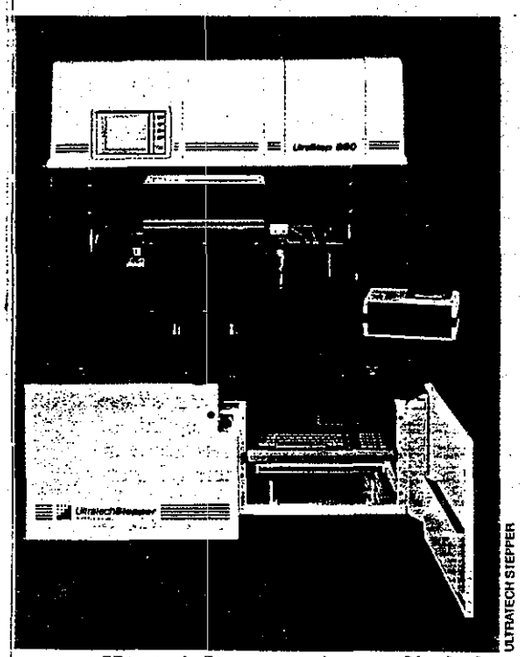
Insiders paint a picture of a Pentagon that talks tough on research controls but shies away from implementing regulations as aggressively as the language would allow. That may represent a victory for the scientists, but its impermanence leaves some of them nervous. And in the meantime the gap between 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.

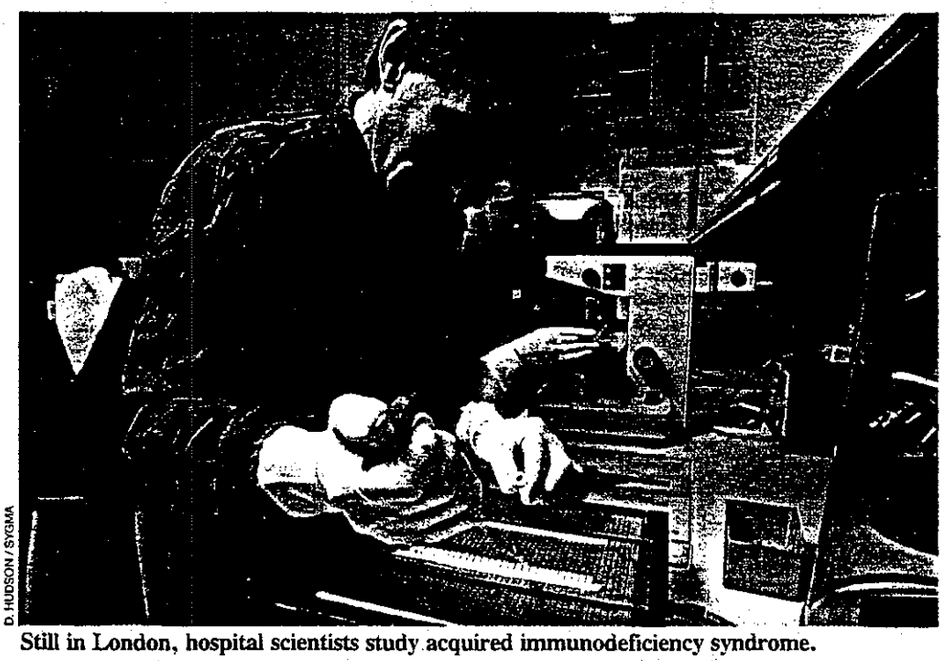
More scientists leave the United Kingdom every year than leave the rest of Europe combined, and the brain drain has never been worse. The golden age of British science, between 1950 and 1975, when the Nobel Prizes won for England were legion, is but a memory. In comparison to the rest of the world — 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.

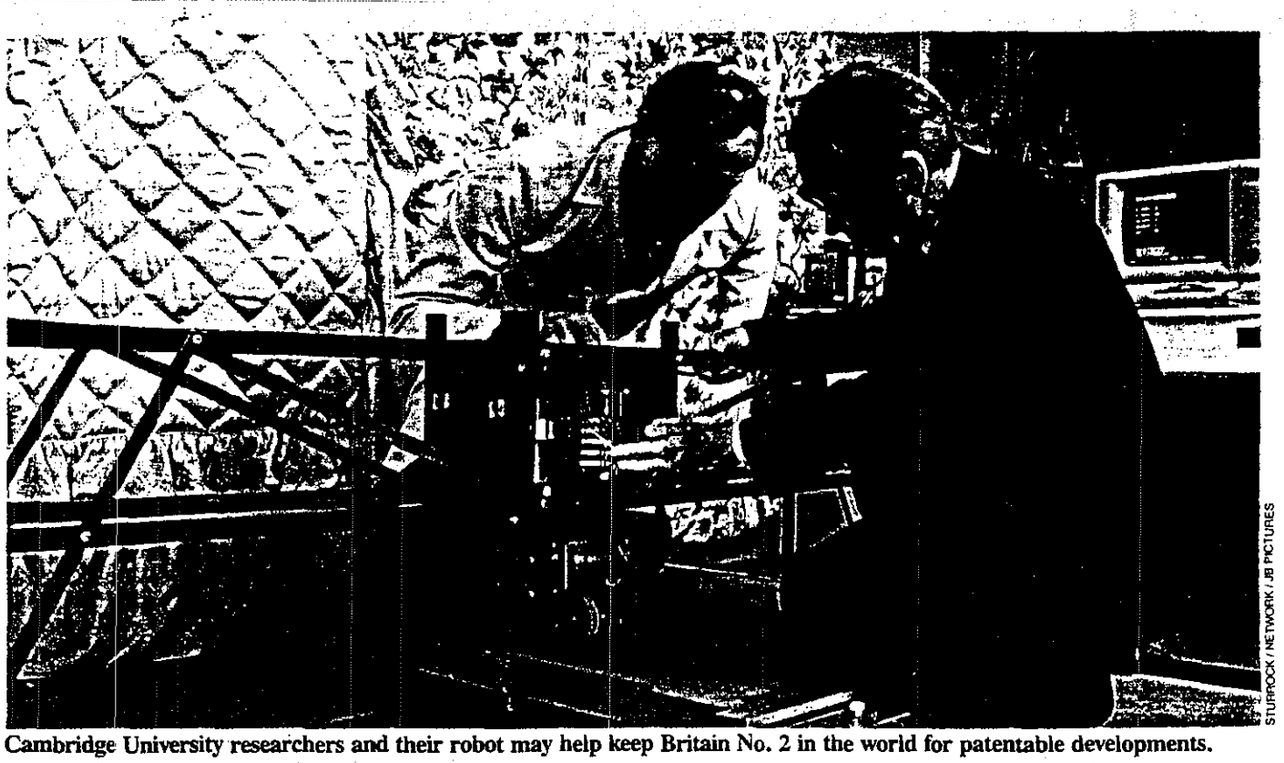
Faced with these frustrations, and salaries that have fallen 12 percent relative to average income since 1980, some of Britain's best are simply going elsewhere. "I don't think I've ever seen the morale of British science so low," says Professor John Ziman, chairman of the recently created Science Policy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

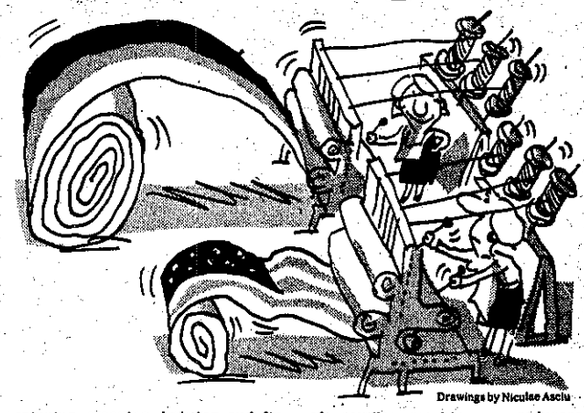
In time, mill owners grew dissatisfied with the standard products and modified them — but kept the results of their tinkering to themselves for competitive reasons. This cut the machine makers off from an invaluable source of new ideas.

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. ■

Charles F. Sabel is associate professor of social science at the Massachusetts Institute of Technology. Gary B. Herrigel is a graduate student at M.I.T.

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

See BEHR, E2, Col. 4

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.

Special Report

MARK PENBERTHY

CAN AMERICA COMPETE?

ITS OPTIONS ARE A SURGE IN PRODUCTIVITY—OR A LASTING DECLINE

Take this statistical portrait of a 45-year-old worker, adjust it for age and sex, and see if you can relate. There are millions like him, and his story says a lot about what is happening to the U. S. and why its economy is so troubled.

When he started working in the 1960s, our worker's income was climbing more than 4% a year. After inflation, his hourly wages rose close to 2% a year. Real raises came easily, because the economy was booming and productivity gains were consistently strong. The U. S. was virtually unchallenged as industrial leader. Americans could make anything, and because their products were the best, they could sell whatever they made, both at home and abroad.

But somewhere around 1973, the gravy train was derailed—and it has never really gotten back on track. It may have been a combination of things: Vietnam, the OPEC price shock, the inflation spiral. U. S. producers met fierce competition from foreign industries that churned out high-quality goods made by low-wage workers. And, the experts now say, the great wave of innovation that began after World War II peaked.

Whatever the causes, productivity sagged. The U. S. economy grew more slowly. Our typical worker's raises soared to 7%, but it was all inflation. In real terms he took a pay cut. By the end of 1986 his real wages were back to their 1969 level.

Another funny thing happened in the 1970s. Perhaps it was what economists call "money illusion," but our worker kept spending as if he were still getting the kind of real raises that he won in the 1960s. His thinking was "buy now, before the price goes up again." With a little luck, he figured, his next raise would keep the credit-card bills and the mortgage covered.

But the real raises didn't get any better in the 1980s. Our worker heard horror stories about declining U. S. productivity and competitiveness, givebacks, and widespread layoffs in manufacturing. But he couldn't lower his sights, so he started borrowing. He now owns a house, a big Japanese color TV and VCR, an American car, and a Korean personal computer—all bought on credit. He is making ends meet, but only because his wife went back to work two years ago. Her income covers the children's orthodontist bills and family entertainment, but it falls short of what they'll need to send the kids to college. He feels as though he's on a treadmill. One of these days, he keeps saying, he and his family have got to tighten their belts.

This, in microcosm, is what has happened to the U. S. over the past two decades. The nation is in a growth crisis, the kind that sneaks up on people so that it takes months or even years before they know what's hit them. Long-term growth has slowed to a crawl, and without a rapidly growing economic pie, America just isn't the same. Both personal and national agendas that were once unquestioned suddenly seem too expensive. For individuals, that might mean a delay in buying a home or even getting married. For the nation, the list includes the programs that burgeoned in the 1960s and 1970s to care for the poor and the elderly, the projection of U. S. power overseas, and the pushes for safer workplaces and a cleaner environment. Which do we give up?

The U. S. has not stopped growing. But the decades of breakneck expansion after World War II conditioned Americans to expect more from their economy, and the slowdown has opened a huge chasm between expectations and reality. In the 1950s and 1960s, real gross national product rose by 4% or more in 11 years, and that 4% came to be considered the norm. Real GNP growth averaged 3.8% in the 1960s (chart, page 46), and the nation spent right up to its income. When growth slid to 2.8% in the 1970s, that barely fazed Americans. They simply made up the difference by borrowing—at first from each other and then, increasingly, from over-

JAVIER ROMERO

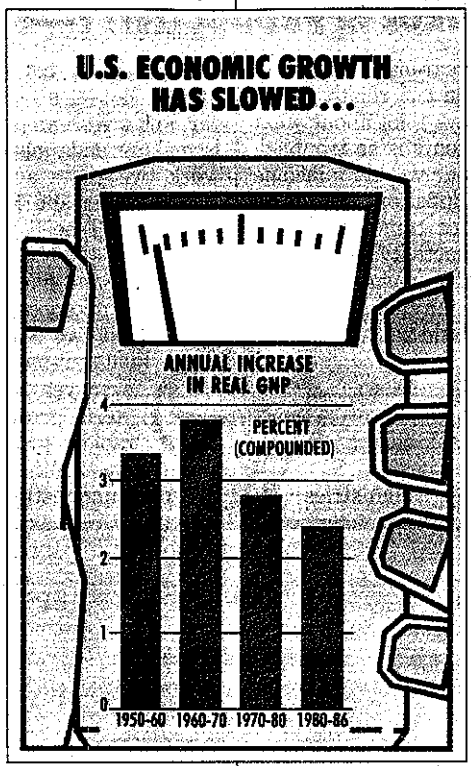
seas. Since 1980 growth has averaged only 2.4%. Spending has grown so much faster, especially for imports, that by 1986 the U. S. was consuming almost $150 billion more a year than it produced (chart, page 47).

As a result, the ratio of personal debt to income is now 30% above normal for this stage of an expansion, according to economist John H. Makin of the American Enterprise Institute, and the national debt exceeds $2 trillion. Even more worrisome, the U. S. has become a debtor nation on a scale undreamed of by any developing country. U. S. debt to foreigners could exceed $750 billion by 1990 even if the trade deficit starts to shrink this year. And, says Makin, "all this debt reflects America's failed expectations for growth."

One way or another, if slow growth is not reversed, Americans will become poorer and their standard of living will sink. By some measures it's already happening (page 48). Burton Zwick and Susan Lakatos of Kidder, Peabody & Co. figure that the U. S. must fork over 1% of GNP a year to foreigners for the next five years just to service this debt. In effect, says Paul R. Krugman of Massachusetts Institute of Technology, "the U. S. will have to give back all of the standard-of-living increases we've borrowed from foreigners."

To put this another way, servicing foreign debt will consume about one percentage point a year of U. S. production. If output grows only by 2.5%, Americans will be left with just a 1.5% gain for themselves. To make up the difference, they will have to consume less.

This is the inexorable arithmetic of the balance-of-payments account. Ultimately foreigners will want to be paid back, chiefly in goods. To meet this demand, U. S. manufacturing must revive and rebuild its share of world trade. Services are simply too small a part of U. S. exports to push the trade balance into surplus. If U. S. producers can't compete on quality and productivity (page 54), the currency markets will keep knocking the dollar down until American wares are cheap enough to market overseas. The resultant inflation would reduce real wages and profits further. If foreigners sharply curtail their lending, interest rates would then soar, and the next stop would be recession.



RUNAWAY DRAIN. Obviously, trade is a critical element of U. S. growth, although economics textbooks never made much fuss about it until recently, considering it a marginal part of total production. Today, exports and imports together amount to 24% of real GNP, compared with 16% in 1970. The 1986 trade deficit, $170 billion, equaled 4% of GNP—roughly the excess of U. S. consumption over production.

Of course, foreign creditors don't have to take U. S. goods in payment: They can buy America instead. With the dollar declining, U. S. assets, both real estate and corporate, become a bargain, and the cash-rich Japanese and other foreigners already are seizing the chance to invest here. Foreign investment should spur U. S. output and save American jobs. But the nation still could lose, since a growing portion of U. S. income must wind up overseas.

Is there any alternative? Yes: Grow faster. Says Nobel laureate Lawrence R. Klein of the University of Pennsylvania: "If we got our priorities reoriented, the U. S. could achieve a growth rate of 3% to 4%. That's what we should be aiming for." But some economists are skeptical: "It's whistling in the dark to think we can grow our way out of this," says Krugman. "Raising real growth is a very long-term proposition."

When it comes to growth, many economists start to sound like old-time Calvinists discussing predestination. The sinning economy may outrun its destiny for a while—and many forecasters think that a turnaround in the trade deficit will boost growth to 3% or so this year. But no amount of good acts in the near term will guarantee a lasting improvement. Economic growth is simply the sum of the growth rates of the labor force and productivity. Unless the U. S. eases its restrictions on immigration, which it may have to do by the end of this century, labor-force growth is a given, and it's settling down near 1.5% a year. Productivity growth seems to be stuck around 1%. Add these numbers, says Charles F. Stone of the Urban Institute, and "that upper limit of 2.5% doesn't change."

But is 2.5% growth really predestined? Not if the U. S. starts to compete again. That would require a strong, sustained surge in productivity—and there are no quick fixes. Americans would have to work harder and manage smarter, especially in manufacturing. Service industries would have to figure out why their productivity is still feeble after two decades of computerization. Washington must realign its economic policies to foster saving and investment instead of runaway consumption. And, most important, U. S. business and labor need the flexibility to operate in a rapidly changing world economy where the newest technology and trillions of dollars flow across borders almost at the speed of light.

Watch out for "flexibility." It may soon be a hotter buzzword than "competitiveness" is today. In a sense, many of the actions taken by business and Washington since the early 1970s can now be seen as ad hoc attempts to achieve economic flexibility and position U. S. industry to respond to foreign competition. Whether each made sense is arguable, but all were driven by the need to keep American companies in the game. Here are some of the recent moves in this direction:

- Deregulation was aimed at freeing business from excessive government intervention. It's working.
- Product diversification strove at keeping up with swift changes in markets, but it was a flop for many companies.
- The development of the service-oriented "hollow corporation" (BW—Mar. 3, 1986) is a strategy to escape high U. S. wages and rigid work rules by buying most components and entire products overseas. It may maximize profits in the short run, but it can cost companies and the country the ability to manufacture and innovate.
- Corporate restructuring—the razzle-dazzle game of mergers, acquisitions, and leveraged buyouts—has attacked the hierarchical rigidity of some old-line, mass-production companies that resisted change. Many needed shaking up, but it is not clear whether the benefits have been worth the carnage.
- The rise of high-tech entrepreneurs recalls the freewheeling, frontier-breaking style of the 19th century (page 64). Overall, it has been worth every dollar of venture capital spent.

Each of these approaches has its positive side. But collec-

CHARTS BY ROGER GORMAN

tively they miss the mark. To the extent that such strategies have relied on reducing real U. S. wages, eliminating or downgrading jobs, and simply propping up short-term profits, they defeat the major purpose of competitiveness: to be able to sell a country's wares at prices that give its investors a fair return and its population a rising standard of living.

The burden rests largely on U. S. industry. John Zysman, a political scientist at the University of California at Berkeley, warns that companies that "become expert at making or marketing cheap-labor goods will lose their technological edge sooner or later and wind up making nothing but low-value-added goods." Adds Stephen S. Cohen, co-author with Zysman of the forthcoming *Manufacturing Matters: The Myth of the Post-Industrial Economy*: "The U. S. and its companies must keep their mastery over manufacturing. You can't control what you can't produce."

HARD CHOICES. Cohen and Zysman argue that in a world of open markets, rapid technology transfer, and ever-shortening product life cycles, full competitiveness requires a lot more flexibility than shuffling financial assets or moving jobs, production, and technology overseas can achieve (page 56). Companies and their stockholders must choose between playing the short-term maximization game and making money by investing for growth and appreciation. Industry must step up its tentative moves toward programmable automation and flexible manufacturing systems, techniques that emphasize shorter production runs and response times over economies of scale.

Specifically, flexible manufacturing would let manufacturers customize one product line or shift quickly from product to product with virtually the same equipment. If it works, it should permit makers of specialized high-value products to match the cost-efficiency of mass production. It departs sharply from conventional commodity production and assembly-line techniques that permit little variability in the product.

Skeptics argue that a major move toward flexible manufacturing would turn the U. S. into a "boutique economy," too fragmented to be efficient. Proponents reply that flexible production is enabling West Germany and Italy to overtake the U. S. in productivity and capture increasing market shares in such products as machine tools and textiles.

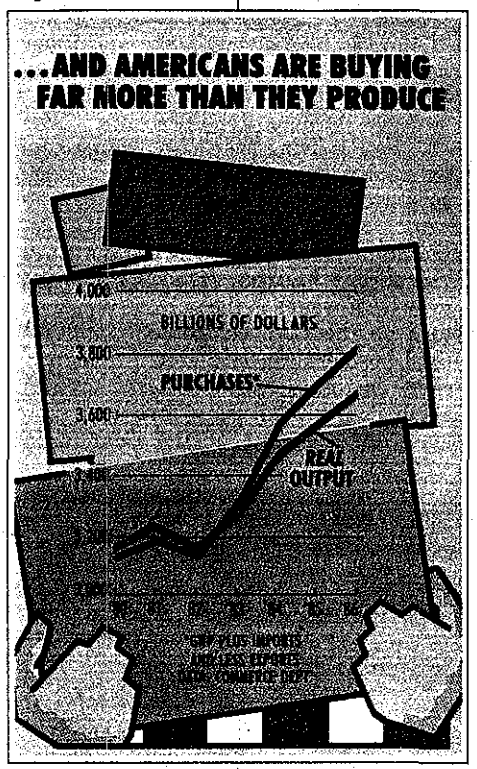
Differences over flexible manufacturing are causing sometimes-bitter debates in U. S. companies, where many executives see it as too radical a departure. Economist Michael J. Piore, who has been studying manufacturing organization in the U. S. and abroad as part of a "Management in the 1990s" project at MIT, notes that "every major American company is examining or even trying new approaches to manufacturing. And labor is working on this, too."

But while many companies are willing to make some big changes, says Piore, "they still want to go only partway. They think they can simply apply the techniques of flexible specialization to mass production."

It is not surprising that many U. S. executives are reluctant to risk a full commitment to flexible manufacturing. The investment is costly, and mistakes can be disastrous. What's more, success requires cooperation with labor and reliance on government to maintain a steady policy environment, and business isn't used to trusting in either. "The overvaluation of the dollar came just when people had to make fundamental changes," says Piore. "It created vast uncertainty about whether business could still build or maintain mass markets. It caused a loss of confidence and direction."

The Reagan Administration's reversal on tax policy has added to business uncertainty. Although last year's Tax Reform Act ultimately should make allocation of capital more efficient, industries that have lost the investment tax credit and other breaks argue that they've also lost an incentive to manufacture in the U. S.

But if capital spending is critical to productivity, it's only part of the story. To foster growth, capital must be deployed efficiently, and that is up to management. In the Reagan era, notes economist Everett M. Ehrlich of the Congressional Budget Office, "we've achieved price stability, shaken down the tax laws, stabilized regulation, and driven down unit labor costs. Yet the economy has been unable to fire a second stage." Ehrlich attributes much of the economy's sluggishness to the huge budget deficit, but beyond that, "it comes down to management."



WASTED BOUNTY. To make capital work well, business also needs an educated, skilled work force that cares about what it's producing. This will become clearer to managers as new production technologies are introduced. Getting the kind of labor force needed to make flexible automation work will require management and unions to abandon the old adversarial attitudes and strive for cooperation (page 61). If unions resist such change, they will guarantee a continuing loss of jobs and production to foreigners. Manufacturers, for their part, can flee the U. S. or make their domestic operations pay better by investing more in training and encouraging worker participation.

Finally, there is the little item that shows up at the end of every economist's productivity equation: technological progress. It is the hardest component of growth to measure, yet no one doubts that it often is the most powerful. The U. S. has never wanted for inventiveness and creativity, yet it has managed in recent years to squander this bounty.

For a while in the 1970s, U. S. business scaled back research and development spending just as it was becoming most critical for meeting foreign competition (page 59). Both federal and private spending on basic research became skimpy. For want of capital, inventors and high-tech startups sold their richest ideas to foreigners before they could flourish as innovative new industries in the U. S. Manufacturers repeatedly failed to move from the R&D stage to full production. Strategic alliances between U. S. and foreign producers often wound up with the American producers giving their technology away (page 62). Such miscues put the U. S. behind in fiber optics, for example, and kept it out of VCRs entirely.

Getting more Americans to realize that it pays to make things in the U. S. is the heart of the competitiveness issue. This is no small order. But the task can start with a hard look at the sources of U. S. growth, its prospects, and the cost of letting it languish.

By Norman Jonas in New York

WARNING: THE STANDARD OF LIVING IS SLIPPING

Adjusted for inflation, paychecks are declining for many people

Is the American dream about to end? For the first time since the Depression, millions of Americans face the growing likelihood that they will not be able to live as well as their parents. Caught in a vise between slowing productivity and fierce competition from low-wage foreign producers, many workers are being forced to accept pay cuts to save their jobs. Manufacturing continues to decline as a source of high-paying jobs, while services boom. But the service jobs offer mobility only to a well-educated top tier of the work force.

Other workers who might have gone into the same plant that employed their fathers find those jobs disappearing. And they may lack the education and skills needed on Wall Street or Route 128. Corporate restructuring, too, is driving hoards of middle managers and white-collar workers onto unemployment lines or into lower-paying jobs.

What's happening is painfully simple: The U.S. standard of living, long the envy of the rest of the world, has hit the wall. In fact, there is overwhelming evidence it's already slipping for many people and may drop even more unless the U.S. can reverse its productivity decline of the last 15 years or so. Says former Labor Dept. Under Secretary Malcolm R. Lovell Jr., who now teaches at George Washington University: "The standard of living hasn't been going anywhere for a decade." For nonsupervisory workers—some four-fifths of the work force—wages adjusted for inflation have fallen since their peak in 1972.

THE SWEAT FACTOR. If cooling off the growth of wages is the only current way to keep the U.S. competitive—at least until business can make itself more efficient in other ways—what's so bad about it? After all, says Richard S. Belous, an economist at the Conference Board, "we still have a tremendously stable society, and the proletariat isn't about to storm Bloomingdale's."

Right, but Belous raises some more serious issues: "If we don't start growing again, a dropping standard of living will bring more inequality and could cut off some of the traditional roads to advancement." That could shake the nation's governability, he adds, by "making it harder for politicians to form broad, lasting coalitions." For business, it could mean a resurgence of unionization, even among professionals, and a further erosion of worker loyalty.

The standard of living is a difficult concept to define, much less measure. To see how the average person has fared, some economists take the real gross domestic product—the total output of goods and services in the country—and divide it by the population. That yardstick shows that GNP per person increased at a brisk annual pace of 2.6% a year from 1960 to 1970. But since then

ROGER GORMAN

the rate has fallen to a 1.6% annual rate (chart). Other economists prefer to look at what has happened to the income of the typical household. And that tells a more dismal story. In 1973, median household income, after adjusting for the effects of inflation, was actually almost 8% higher than it was in 1985.

The stagnation in income is even more disturbing because more people than ever are working to produce that same income. What economists call the sweat factor has risen. The number of people employed has jumped from 40% of the population in 1970 to 46% today, as the baby boom has swelled the number of working-age people and more women have gone to work. The overall labor force has grown by nearly 28% since 1973, to more than 115 million, and two-thirds of the 33 million new workers are women, who now account for 44% of all employees. Since hourly wages in real terms have fallen 8.7% since 1973, it is these added workers who have helped families keep their heads above water.

NO HONEYMOON. Look at what would have happened to living standards if men had remained the sole breadwinners. According to a study last year by the Joint Economic Committee of Congress, a 30-year-old male earned—in 1986 dollars—an average of $25,253 in 1973. Ten years later, the average 30-year-old man earned only $18,763 after adjustment for inflation—one-fourth less. "Clearly, if only the father worked in an average young two-parent family in the 1980s, there would be a drastic decline in family income as compared to 1973," states the Committee's report. Even with more wives working, the report finds that the average income of two-parent families fell by 3.1% from 1973 to 1984. The decline would have been three times as large if more mothers had not gone to work.

The conclusion is unsettling: Many American families now must put two people to work to match the living standard that one person could have provided in previous decades. Some economists argue that many women are working not out of necessity but because they want to. Nonetheless, their extra income should make their families better off. Instead, the average family is working harder just to stand still. "Today, you need two people working to make what is considered a middle-class standard of living," says Frank Levy of the University of Maryland.

To keep spending as their income falls, U.S. families have gone deeper and deeper into debt. Consumer installment debt rose from 13% of personal income in 1973 to more than 16% last year. And that doesn't include all the home-equity loans that are being used to buy cars and other products.

Slow economic growth has had its most dramatic effect on those born during the baby boom. Many baby boomers have delayed marriage, in part because of the sexual revolution but also because of the decline in their ability to earn a decent living. The data show that instead of getting married at 22, as their fathers did 30 year ago, men on average today hold off until they're 26. Women whose mothers married at about 20, now wait until they're 23. When they do marry, these young couples put off having children. And the number they choose to have is down as well: The birth rate has dropped from 24 children per 1,000 women in 1960 to 15 per 1,000 today.

The baby boomers also have had to settle for less in other ways. Many live in smaller houses than those of their parents: Less than half of new housing units today are single-family detached units, compared with more than 60% as late as the 1970s. They also get by with fewer necessities. The typical family headed by someone aged 25 to 34 spent 14% less on furniture in 1981 than a similar family did in 1973, according to a

ALAN LEVENSON

NOW, EVEN THE DAILY PAPER IS A LUXURY

Most Americans today expect at least to match the lifestyle they enjoyed growing up in their parents' house. But Curtis and Cynthia Paltza are finding that modest goal out of reach.

When the couple married two years ago, they planned on a house and children and maybe even a second car. Now they have a seven-month-old daughter, Breanna. But they still live in a rented apartment, though Curtis' office job with the Los Angeles School District pays $27,000 a year—close to the $27,735 median annual family income in the U.S. in 1985. Even buying the daily newspaper has become a luxury the family can no longer afford.

Since Cynthia quit her $10,000-a-year job as a florist to raise Breanna, the comfortable life their parents had has become even more elusive for the Paltzas, both 30. Half the $1,246 a month that Curtis brings home goes for rent. To pick up an extra $30 a month, he monitors college entrance exams at California State University at Long Beach.

Meanwhile, the Paltza's indebtedness keeps climbing. The car recently broke down, swelling their Visa bill to $800. And they still have not repaid the $1,300 they borrowed for the security deposit and the first month's rent on their apartment in the south Los Angeles community of Lomita.

STILL HOPING. Even so, the rough times haven't dampened the Paltzas' hope of finding a home of their own. Somehow they manage to put $55 a month into a savings account. But it will be tough to match what their parents had. Curtis' parents lived nicely on the combined income they earned from his father's job as a produce worker at Safeway Stores Inc. and his mother's job as a secretary. In 1949, when his parents were both 25, they could afford to buy a $7,500 house.

"By comparison to us our parents were self-sufficient," laments Curtis. Adds Cynthia: "It was much easier to make ends meet back then. Our parents feel sorry for young people today—they know how hard it is for us."

Joint Economic Committee study. They spent 15% less on personal care, 38% less on charity, and only $47 more a year on food outside the home, despite the fact that the woman most likely worked. "The young middle class has experienced a dramatic decline in its ability to pursue the conventional American dream: a home, financial security, and education for their children," says Richard C. Michel, an economist at the Urban Institute and an author of the study.

The stagnant economy has hit those at the bottom of the heap hardest. Families without two earners have suffered the most, especially those headed by women. Single women now head 16% of all households vs. 12% in 1973. With a median income of $13,660 a year, many of these households are below the poverty line. Indeed, they have been a big reason why the overall poverty rolls have jumped from 11% to 14% of the population since 1973. The gap between rich and poor is at a postwar high: The poorest one-fifth of the country's households now receive less than 5% of all income, while the wealthiest one-fifth receive more than 40%. "Inequality grows as the standard of living falls," says the Conference Board's Belous. "Since the early 1970s inequality has been increasing, and the trend has become more pronounced in the 1980s."

PETER YATES

'I HOPE THINGS WILL BE EASIER IN THE FUTURE'

Ronald W. and Judith P. Bateman face a problem that's all too typical of their generation: How to raise a family on what they earn. Despite the neatly printed ledger pages that detail each dollar of the couple's monthly budget, they laughingly lament their weekly "deficit spending." Without the $4,000 a year in overtime pay that Ronald earns as a dispatcher for Michigan Bell Telephone Co., they figure his $25,000 base income would leave them with a $70 shortfall every month. "We don't have anything in our budget for clothes or car and house repairs," says Judy, 32.

The Batemans, the parents of a six-month-old daughter and a 2½-year-old son, are hardly big spenders. Even their so-called splurges are lessons in frugality. By choosing the right restaurants and doing some savvy meal-sharing, boasts the 27-year-old dispatcher, who helps coordinate telephone installation orders for Michigan Bell, the family manages to eat out once a week for less than $10—tip included.

The couple is fortunate in one sense: Cheap housing can still be found in Detroit's suburbs. But their $29,000 home is in a fairly rundown section of Hazel Park. The Batemans managed to save enough for that purchase only by living with one of Judy's brothers for a year. And the couple still had to take a loan from Ronald's parents to complete the downpayment.

STAYING HOME. Last year, Judy added about $2,500 to the family's income by working sporadically as a secretary. The late-night schedule left her little time with her husband, but it spared them baby-sitting expenses. Now she intends to stay home with Erica and Aaron. But without her paychecks, she admits that "we're not going to be able to do the things we wanted to do."

Ronald says his mother worked as a secretary and spent the money on extras. In contrast, Judy's earnings always go toward bills. "I hope things will be easier in the future," says Judy. "I know we're sure working towards it." Until then, she laughs, "we enter a lot of sweepstakes."

Even the majority of Americans who have maintained their living standards may not be able to do so much longer. The rush of women into jobs has begun to slow. Baby boomers are reaching the age where children must be borne or put off altogether. And there are limits as well as economic costs to the debt levels the economy can bear. "We can't keep [living above our means] forever, but while we're doing it, it's like having a great party on borrowed money," says Lester C. Thurow of Massachusetts Institute of Technology. "At some point, we're going to have to pay the bill."

TALL ORDER. Most economists agree that a return to fast economic growth is the only long-term way to keep the standard of living from declining further. But even a healthy economy doesn't necessarily mean well-off consumers. Since the recession of the early 1980s, much of Corporate America has been trying to boost productivity. But while productivity has rebounded in many manufacturing industries, the gains often have come from cutting wages, dumping inefficient plants, and exporting jobs overseas. Such measures may help individual companies return to health, but they also slash at overall living standards.

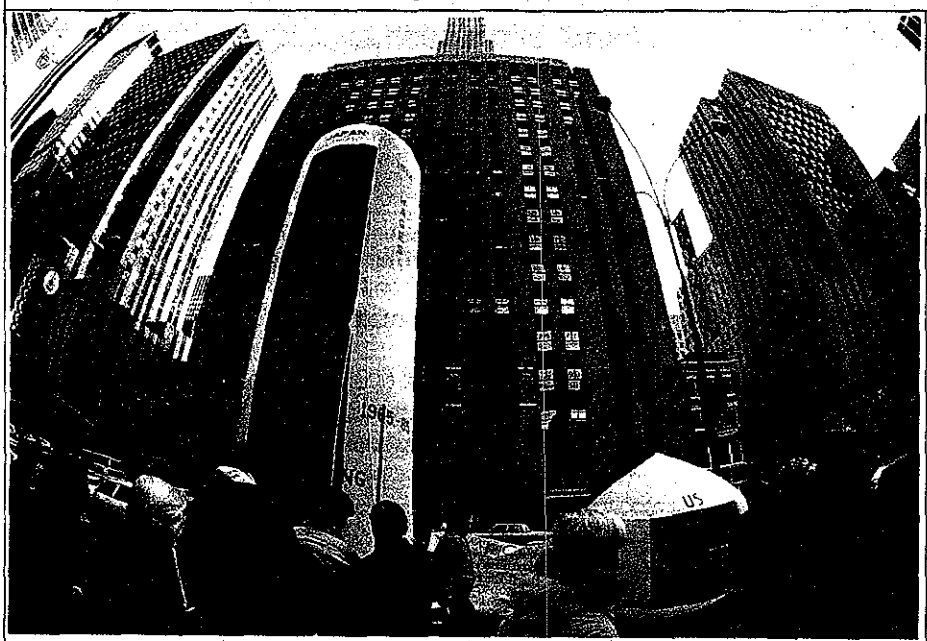
And the new jobs being created by the recovery may not offset this decline. A controversial study by the Joint Economic Committee last year concluded that while some 9 million new jobs were created from 1979 to 1985, 44% of them pay $7,000 a year or less. If it's true and the pattern continues, the U.S. could find itself in a peculiar situation: Companies could begin making record profits and the economy could surge ahead, while incomes decline for the vast reaches of the middle class and for lower classes.

If the economy is to grow in a fashion that augments living standards, companies have a tall order in front of them: They must boost wages and output as well as productivity. This has been the traditional way that economic growth has occurred. But if it doesn't begin to happen again soon, an increasing number of people will find the American dream is just a dream after all.

By Aaron Bernstein in New York

PRODUCTIVITY: WHY IT'S THE NO. 1 UNDERACHIEVER

Growth is stalled by an aging capital stock and a poky service sector



A DEMONSTRATION IN NEW YORK POINTS UP JAPAN'S GAINS IN EMPLOYMENT PRODUCTIVITY

KEN KERBS

Although there's no free lunch, one thing comes awfully close: productivity. When it's growing, business can do the impossible. Companies can hand out raises, slash prices, and increase profits—sometimes all at once. Productivity transforms luxuries once reserved for society's elite into ordinary household items. Malthusian prophecies of worldwide starvation and scarcity turn into archaic curiosities. Even warnings that workers won't be able to support the next generation of retirees sound less ominous, if productivity can be counted on.

But for all its potential, productivity has not been living up to its promise lately. Output per worker has been growing, on average, less than 1% a year since 1973, compared with a rate of more than 2% in the 1960s. If the higher rate had been sustained, a worker's output would double in 32 years. At the slower rate it takes more than 70 years. Wages follow productivity almost in lockstep, and the cumulative effect of the shortfall on incomes is huge: "It's as if every worker were leaving $10,000 a year on the table," says Carl G. Thor, senior vice-president of the American Productivity Center in Houston.

Business depends on productivity as much as workers do. Manufacturers in 1986 were able to offset wage inflation and hold unit labor costs flat. For most companies outside of manufacturing, however, productivity was stagnant, and higher wages simply flowed through to higher prices.

THE CULPRIT. The lag in productivity is clearly a culprit in America's declining competitiveness. U. S. trade rivals are scoring faster productivity growth, and America now ranks near the bottom among industrialized countries (chart).

Economists have come up with some reasons for the productivity slump that started in the late 1960s and turned into a rout in the 1970s. The slowdown began with the arrival of the baby boomers in the job market. The flood of young workers dampened the postwar productivity surge by reducing the overall level of experience and skills. Business also had to absorb the shock of soaring energy prices, a tidal wave of government regulation, and accelerating inflation. Managers steered investment almost single-mindedly to projects that conserved energy, not capital or labor. Faced with lower inflation-adjusted rates of return, business cut back on capital spending.

The result is an aging capital stock. The average age of a manufacturing plant was about 15 years at the end of 1986, vs. 13.8 years in 1980. For equipment, the average age is up by half a year.

Yet, the greatest drag on productivity growth has come from the ever-expanding service sector. Many service firms, from far-flung bank holding companies to the boutique on the corner, have been frustrated trying to squeeze more output from less input. Since 1979, output per hour in service-related industries has risen less than half a percent a year.

The official figures may be understated, economists suspect, because the volume of services is difficult to measure. Tons of steel are counted more easily than the output of attorneys. Government statisticians have resorted to plugging in workers' earnings as a proxy for the value of output for 20% of services. "Instead of output, they measure labor input," says John W. Kendrick of George Washington University. "For some industries, they compute zero productivity growth just by definition."

BUYING BINGE. It's more than a measurement problem, however. While factories typically use capital equipment to economize on labor or to increase volume, the same cannot always be said for service firms (nor the white-collar divisions of manufacturers). More than $160 billion invested in high-tech equipment—computers, communications gear, and the like—since 1985 has not produced broad-based savings, reports Morgan Stanley & Co. economist Stephen S. Roach. Data-processing divisions went on buying binges, says Roach, believing that "productivity paybacks would be automatic."

Instead, corporations have mined data more intensively. Management nurtures a "let's-calculate-it" mentality, says economist Lester C. Thurow of Massachusetts Institute of Technology. "Reports we used to do every three months we now demand every day," says Thurow. "Nobody asks if this added knowledge generates new output."

Manufacturers, too, are less able to

demonstrate productivity gains in their offices than their factories. Minicomputer maker Tandem Computers Inc., of Cupertino, Calif., for example, has cut the average design time for its semiconductors to just 4 weeks from 14, after installing several million dollars worth of computer-aided design equipment. But Tandem cannot identify similar savings for its largest white-collar investment, an information network that links marketing, engineering, and manufacturing divisions at 200 locations in 35 countries. Tandem has poured tens of millions into the network, according to Stephen C. Schmidt, vice-president for operations. "We all think it makes us a lot more productive," says Schmidt. "But I'd be damned if I know how to quantify it."

BACK ON TRACK. Basic manufacturing operations, though, have managed an impressive comeback. Forced by foreign competition to slash its labor force and close obsolete plants, the U. S. manufacturing sector has essentially recovered from its 1970s slowdown and is back on a 3% growth track. If not for the sluggishness in services, total U. S. productivity would have grown by a respectable 2.2% since 1979. But the service sector can boast a crop of winners: Communications and rail transportation have turned out sizable productivity gains.

Many economists warn that broader efficiency gains will be hard to come by unless workers have the levels of education and skill required to handle advanced technologies. This means that the U. S. will have to make greater investments in its "human capital." The economy may not be able to abide a 13% illiteracy rate much longer.

Whatever shortcomings the U. S. may have in human and physical capital, the nation has long enjoyed a clear advantage in what experts consider the most important, though least controllable, component of productivity growth: technological progress. It may appear as an unexpected breakthrough, such as the latest discoveries in superconductive materials (BW—Apr. 6), or as incremental follow-up advances. Despite decades of debate, the uneven pace at which technology advances remains a mystery to economists. But most agree that the rate can be influenced by spending on research and development.

Here the U. S. could be doing more to help itself: Outlays by business and government for civilian R&D are a smaller share of the economy in the U. S. than in other countries.

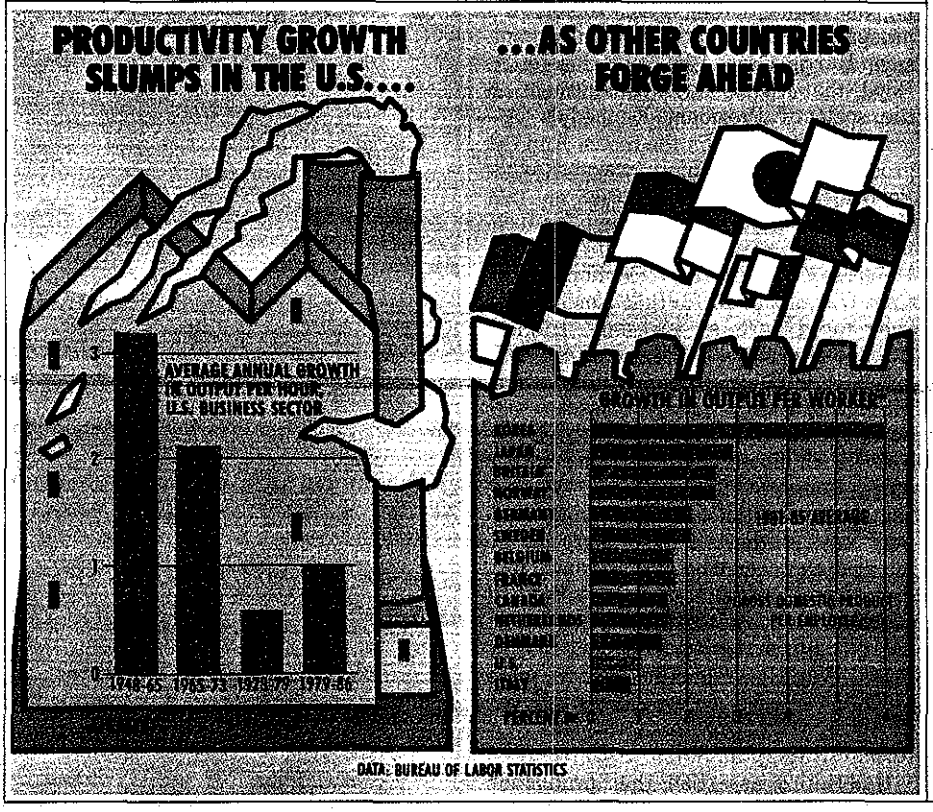
The record of the last 15 years or so gives the U. S. the edge for initial product inventions. But it is Japan that wins the accolades for bringing down costs in the commercialization stage. "In the kind of research that wins Nobel prizes, we've done extraordinarily well," says technology expert Nathan Rosenberg of Stanford University. "But basic science is now an international commodity—you can pick up a lot in other countries just by reading scientific journals."

The next competition: superconductivity. Commercial use of the low-resistance conductors of electricity, though still years away, is likely to provide more conventional cost-cutting and output-expanding technology than computers have. Scientists believe superconductors will help revolutionize operations in service industries, such as transportation, utilities, and even health care.

TURNAROUND TIME. Does it matter which country capitalizes on a new technology first? Absolutely, if the country is running a huge payments deficit with the rest of the world. True, economists expect other countries to adopt U. S. technology and their productivity growth to outpace America's—that's what happens when nations play catch-up with the leader. But they do worry that turning around the massive U. S. trade deficit, which climbed to $170 billion last year, will be much more painful without a productivity revival.

Otherwise, "the exchange rate will bear the brunt of the adjustment," says Richard O'Brien, chief economist of the American Express Bank in London. He calculates that with swifter productivity growth, a dollar-yen exchange rate from 180 to 200 yen would have been low enough to have restored America's competitive position. "Factoring in relatively low productivity growth, however, takes the dollar to 150 yen or lower," O'Brien says. Continuing downward pressure on the dollar has already flashed ominous signs of higher inflation and interest rates—both enemies of faster economic growth. Productivity remains the best escape from the dismal arithmetic.

Joan Berger in New York, with bureau reports



TOP AND BOTTOM BY ROGER GORMAN

MAKING BRAWN WORK WITH BRAINS

U.S. factories must innovate as fast as labs invent

Back when most homes had black-and-white TVs and dial phones, before U. S. inventors had dreamed up microwave ovens, quartz wristwatches, and videorecorders, this country thought it had a lock on the good life. After all, U. S. factories were spewing out a steady stream of low-cost consumer goods that the whole world was lapping up. In his 1958 classic, *The Affluent Society*, John Kenneth Galbraith could confidently boast: "We have solved the problem of production."

Not quite 30 years later, things couldn't be more different. The American standard of living is slipping. Even the country's once-unassailable lead in high technology is narrowing: Japan produces and uses more computer chips than does the U. S. And it is coming on strong in biotechnology and gearing up for a massive assault on what could be the next major new technology—superconductivity (BW—Apr. 6).

Meanwhile, U. S. factories are producing a rapidly dwindling share of the products that made this country an industrial powerhouse. Starting with steel and machine tools, then consumer electronics and automobiles, the U. S. share of world exports has ebbed in one industry after another. Imports, meanwhile, are flooding U. S. shores. Buy a quartz watch or a VCR and odds are it will be made by a foreign company. In just the past six years, America's trade balance in manufactured goods has plummeted sharply into the red, from a surplus of $18.1 billion to a deficit of $151 billion. Even high-tech electronics products have been running a negative balance since 1984. Last year they posted a $13.1 billion deficit—49% bigger than in 1986.

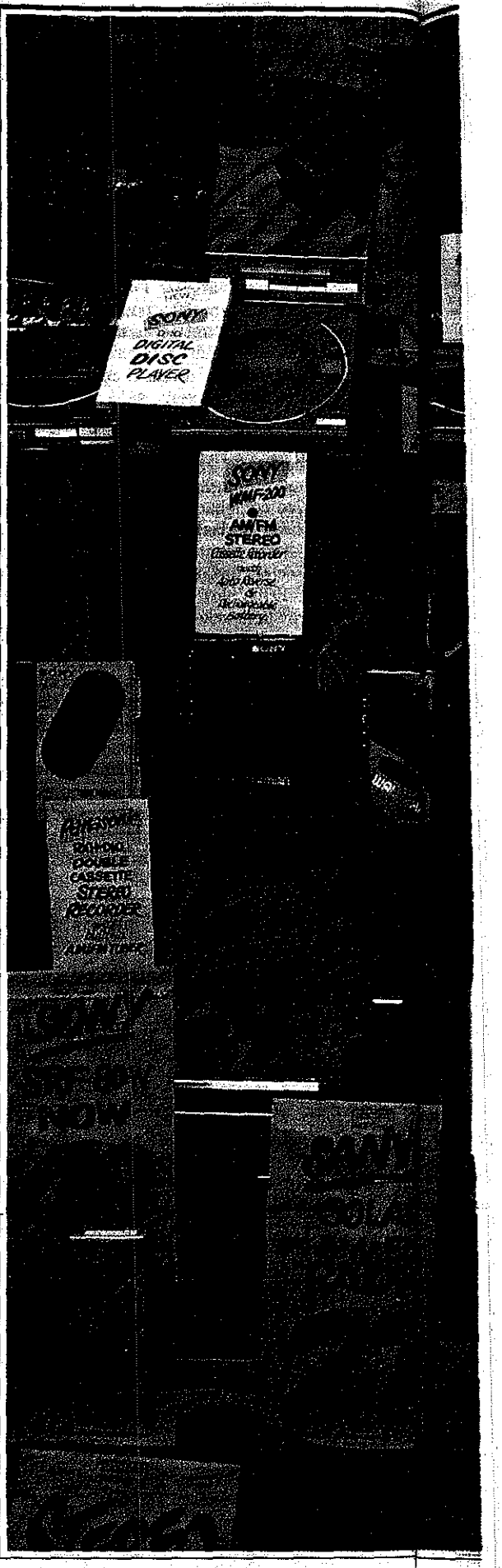
The crisis in U. S. competitiveness has sparked a spate of studies by federal agencies, academia, and industry—no fewer than 17 major ones in the past few years. Their recommendations are familiar: Spur technological innovation by pumping up research and development, forge bonds between industry and academia, and turn out more scientists and engineers. These areas can bear improvement, and some positive steps are being taken (page 68).

But such actions beg the question. The fact remains that the U. S. is still a creative hothouse. Its laboratories churn out important advances and whole new technologies, from biotechnology and fiber optics to superconductivity. And foreign students flock to U. S. universities, where they now account for 20% of all students and a staggering 55% of those studying engineering. So the failure is not American technology—it is American manufacturing. U. S. industry has big trouble when it comes to transforming ideas into products that can be sold on world markets. That's the missing link in the innovation process.

Unless the U. S. gets its manufacturing operations back in shape—and fast—it could lose any hope of maintaining the foundation on which tomorrow's prosperity rests. That task is so urgent, says Harris Corp. Chairman Joseph A. Boyd, that it calls for a commitment on the scale of President Kennedy's program to put a man on the moon. And the process won't be painless, warns Roy H. Pollock, who recently retired as RCA Corp.'s executive vice-president for technology and now lectures at Fordham University. "With the exception of the Civil War, it's doubtful that America has ever faced such an awesome trauma. But the alternative," Pollock says, "is to accept continuing economic decline and the end of America's greatness."

DEAD ENDS. What happened to U. S. factories? All fingers point to the corner office. For most of the 1900s, "we were the quintessential manufacturing society," says Herbert W. Nidenberg, an industrial engineer who is now senior program manager for manufacturing at Battelle Memorial Institute. And that evolved into arrogance. "Coming out of World War II, we got the idea we were much better than we were," says Steven C. Wheelwright, professor of manufacturing strategy at Stanford University.

Galbraith's assertion that production



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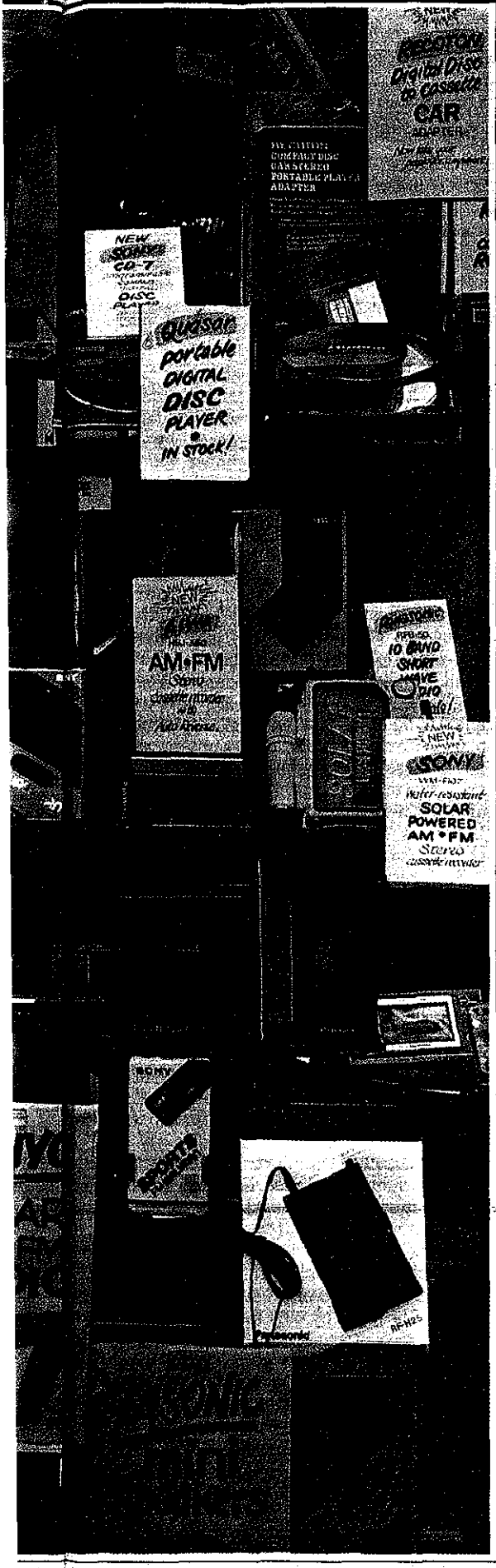


had been mastered reflected the prevailing view of top executives in the 1950s. By then, manufacturing had ceased to be a factor in strategic planning. Factories had been handed over to caretaker managers in dead-end jobs. Their assignment was simple: Don't do anything risky, just keep the production line humming. More and more factory jobs were reduced to boring, repetitive chores that anyone could do, and the pool of skilled machinists withered.

The upshot: By the time Japan emerged as a serious challenger in the late 1960s, the U. S. was saddled with an alienated work force and moribund factory managers. They didn't have a prayer against Japan's dedicated workers and energetic engineers. Twenty years later the situation isn't much better, because few senior managers have yet come to grips with the enormity of the feat that Japan has pulled off.

STUNNING SPEED. Even after Japanese auto makers had knocked Detroit for a loop in the late 1970s, General Motors Corp. was totally unprepared for the miracle of NUMMI. In setting up New United Motor Mfg. Inc., managers from Toyota Motor Corp., GM's partner in the joint venture, took a mothballed California assembly plant with outmoded equipment and transformed it into GM's most efficient factory. GM executives, who have long patted themselves on the back for being America's most progressive managers, were staggered. "Productivity there is twice the average level in GM," says David J. Teece, director of the Center for Research in Management at the University of California at Berkeley. "Yet here is a plant where nothing special is going on in terms of technology." The difference is the way that the Toyota managers organized and operate the NUMMI plant.

Indeed, that's the secret to how the Japanese pulled the rug out from under U. S. manufacturing. They figured they could break America's stronghold in many markets only by offering customers a broader choice of goods. That would attack the key weakness of mass manufacturing: It depends on long, stable production runs. By totally revamping the factory and finding methods that could rapidly inject a stream of new products into the market, the U. S. would be unable to keep pace.

It was a stunning strategic coup that marked the end of an era. The Japanese created a manufacturing infrastructure that can respond with blazing speed to market demands and changing opportunities. Products are designed from scratch not only for ease of assembly—with an emphasis on simplicity and the fewest parts possible—but also for easy modification. Factories are organized by product, not by function, so that raw materials enter a manufacturing "cell" and exit as a finished product or component. Unlike U. S. operations, there is no so-called work-in-progress waiting for a drilling machine, then moving into another queue until it can be processed on a grinding machine. And the whole soup-to-nuts production is orchestrated with such precision that it runs with virtually no inventories of purchased parts and materials or of partly finished products—all of which tie up money.

NEW CYCLE. Moreover, the Japanese put the craft back in manufacturing by making quality the responsibility of each worker, not after-the-fact inspectors. Jobs that need only mindless hands are delegated to mindless machines: robots. And while it seems unbelievable to many Americans, this approach yields products that are both higher-quality and less expensive. Almost overnight the precepts of decades of manufacturing science were turned upside-down.

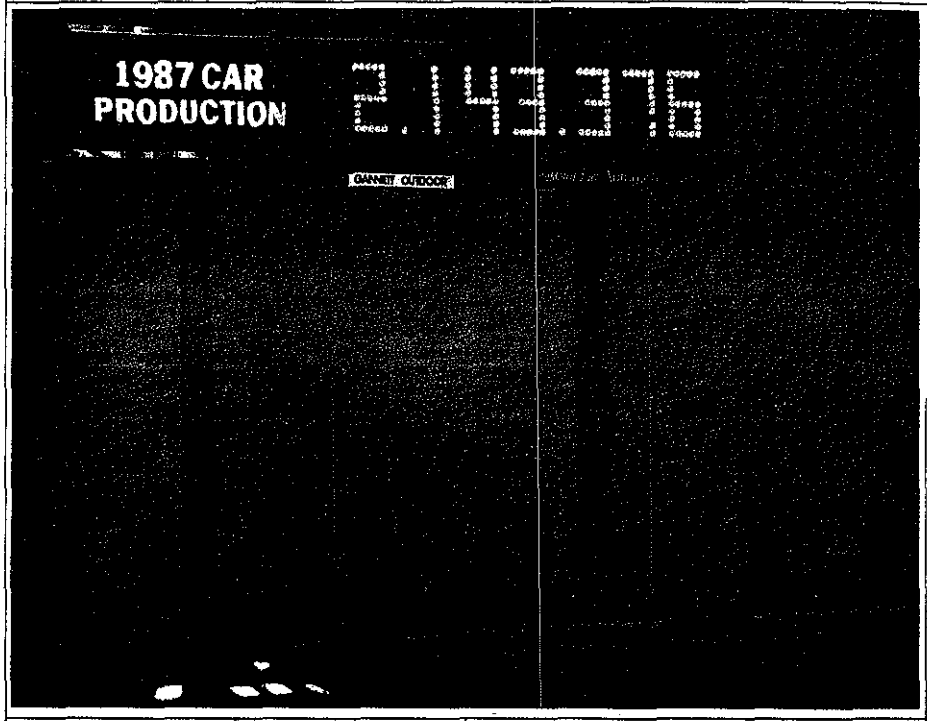
The full dimensions of Japan's achievement are finally beginning to sink in. But few U. S. companies have the manufacturing talent necessary to mount an effective response. The experts can tick off only 30 or so major corporations that are clearly serious about manufacturing: Allen-Bradley, GM, and IBM usually head the lists. Close behind are such names as Apple Computer, Caterpillar, Deere, Hewlett-Packard, Honeywell, Johnson's Wax, 3M, Xerox, and the major aerospace companies.

General Electric Co.'s $11.6 billion investment over the past six years to

CONSUMER ELECTRONICS

TRADE BALANCE: -$11 BILLION

In the early 1960s, the U. S. produced nearly 90% of the color TVs made in the world. Now, more than half are made in Japan. That country also controls more than 90% of the world video-recorder market. Last year, domestic producers supplied just 38% of consumer electronics sales in the U. S., down seven points from 1984—and several are Japanese-owned. Philips of Holland teamed up with Sony Corp. when it rolled out the hot-selling compact disk only because there was no suitable U. S. partner.



AUTOMOBILES

TRADE BALANCE: -$31 BILLION

U. S. factories turned out nearly half of the world's cars in 1960. Today, Japan is close to claiming that distinction. Last year, imports accounted for almost 30% of U. S. auto sales, and the Commerce Dept. predicts foreign cars will grab 37% of domestic sales by 1990.

boost competitiveness wins it a place on that list. But more telling than the money, says Fred W. Garry, vice-president for manufacturing, is a change in managerial mindset: "the idea of looking at things from a total-cost point of view," not each manager's narrow specialty. In GE's major appliance business, people from design, marketing, and manufacturing now huddle at the start of a development cycle to coordinate the project. The payoff: Japanese competitors that had been planning to go after the U. S. market for refrigerators and washers and dryers have been spooked. Better products, Garry believes, "delayed their decision and maybe aborted it."

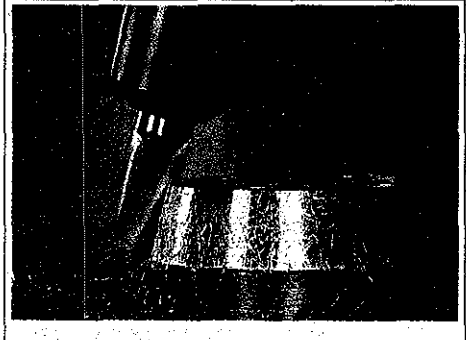
PROWLING ENGINEERS. Black & Decker Corp. pioneered exercises in product simplification a decade ago. By trimming the number of components in its power hand tools to increase productivity and reliability, B&D multiplied sales sixfold during the 1970s while cutting prices in half. The concept works just as well with huge locomotives. At GE's Erie (Pa.) factory, engineers prowl the plant, asking workers for ideas to improve productivity. Case in point: Shop workers thought a complicated door, which took sophisticated equipment to produce, could be simplified. The door is now built with simple tooling, using 40% fewer parts and costing 25% to 30% less.

Since 1980, Westinghouse Electric Corp. has been stressing greater flexibility, defect prevention instead of defect detection, and "bottom-up" management in production. It created a 300-person Productivity & Quality Center to carry the message to every plant, and several thousand hourly employees are now organized in work teams that are responsible for their own supervision. Westinghouse has also invested more than $2.4 billion to improve manufacturing. That helped boost net income to $671 million last year, nearly 50% above the 1983 mark, on a 13% sales rise to $10.7 billion.

The programs were triggered by a 1979 internal study. Westinghouse wanted to know why it was getting its pants beaten off in quality by the Japanese. The answer quickly became apparent. The Japanese measure quality in terms of "composite yield," or the percentage of work done right the first time by each worker. Westinghouse sampled quality at the end of the production line, often oblivious to the rework before that point. Applying Japan's standards, Westinghouse was shocked to learn that its quality was as low as 15% in some plants. "As incredible as it sounds, we never measured our output in this manner," wrote Thomas J. Murrin, president of the Energy & Advanced Technology Div., in 1979. Quality has since jumped sharply, to as much as 90%.

Such results are typical when enlightened managers apply new technology—even without climbing the automation ladder all the way to computer-integrated manufacturing (CIM). That involves creating a single shared data base from which plans for operating not only the factory but all other departments are drawn (BW—June 6). The hangup with CIM, says Henry J. Johansson, head of manufacturing consulting at Coopers & Lybrand, "is that it crosses all functional lines, so there's a turf battle."

RESCUE MISSION. On the rung below CIM, companies have installed either flexible manufacturing systems (FMS) or direct links between computer-aided design (CAD) and manufacturing (CAM) systems. Such moves typically trim production time, scrap and rework, inventories, and direct-labor costs by 50% to 85%, according to a recent study by Booz, Allen & Hamilton Inc. An FMS is a cluster of computer-controlled machines that can be quickly programmed to turn out any one of a family of parts—for example, anything that can be machined from a block of steel up to a certain size. CAM systems are similar but can integrate more types of production equipment. With both FMS and CAM setups, produc-



MACHINE TOOLS

TRADE BALANCE: -$1.7 BILLION

America's share of world machine-tool exports has plunged from 23% in 1964 to about 4% today. Over the same period, imports soared to 47% of the domestic market, up from 4%. The Administration acted in 1986 to halt the slippage: It won five-year voluntary restraint agreements from exporters in Europe and Asia. The industry hopes that signals the start of the long march back.

PHOTOGRAPHS BY (TOP) PETER YATES; (BOTTOM) GARY KESSLER

AMERICA'S R&D PERFORMANCE: A MIXED REVIEW

The key to the future ability of U.S. industry to innovate may well be the factory, but the research and development efforts that fuel the industrial engine could also use some fine-tuning. Although the U.S. still leads the world in R&D spending, competitors are closing the gap. So here, too, the U.S. would be well advised to make changes. Below are snapshots of the health of the U.S. research enterprise.

INDUSTRIAL R&D

WHAT'S RIGHT After the doldrums of the 1970s, research and development spending by industrial companies sprang back. During the past decade, companies have stepped up the amount of money they spend on new products and processes by nearly 13% a year—almost twice the rate of inflation. In 1987 they will spend close to $60 billion. They are also forming group efforts to tackle problems too large for any single company. Such consortiums as Microelectronics & Computer Technology Corp. are going head-to-head with the organized efforts of Japan's Ministry of International Trade & Industry. The Defense Dept. has proposed to help fund Sematech, a consortium to develop manufacturing technology for computer chips.

WHAT'S WRONG The growth rate of industrial R&D spending may be tapering off. Estimates of company spending collected by the National Science Foundation indicate that industrial R&D may move up only 5.9% in 1987. That's even worse in real terms, because the cost of research is increasing rapidly. The share of U.S. patents granted to foreign inventors is rising. In 1960 fewer than 8,000 of the 47,000 U.S. patents issued were granted to citizens of foreign countries. In 1986 they accounted for almost half of all U.S. patents—nearly 85,000 to foreigners compared with 42,000 to U.S. inventors. In addition, the recent spate of mergers and acquisitions is consolidating many R&D budgets. Decreases have been reported at Phillips Petroleum, Crown Zellerbach, AMF, Uniroyal, Gulf, and RCA.

BASIC SCIENCE

WHAT'S RIGHT The Reagan Administration has championed basic science that leads to new technology. Over the past six years, federal support of such research, largely at universities, has jumped by 61% to $9.7 billion. The Administration is backing proposals to double the budget of the National Science Foundation, to $3.2 billion, over the next five years. U.S. industry has increased its support of research on campus, to $375 million last year.

The government is also encouraging tighter links between academic and industrial researchers. The NSF has set up 39 collaborative industry-university centers aimed at solving problems for industry. With $3 million in seed money from the NSF, the centers raised a total of $15 million from industry and $15 million from the states in 1986. In a similar program, the NSF has also established 13 Engineering Research Centers since 1985, with plans to add 12 more during the next two years. In addition, it expects to set up as many as 10 Basic Science & Technology Centers at universities by 1989.

INDUSTRIAL R&D SPENDING IS RISING—BUT EXPENSES ARE CLIMBING EVEN FASTER

WHAT'S WRONG The Pentagon's share of the U.S. R&D budget has soared—reaching $44 billion for fiscal 1987, or 55% of the total, compared with $17 billion and 24% in 1981. And the proportion it devotes to basic research has ebbed from more than 5% in the mid-1960s to only 2% this year.

At the same time, laboratories at universities, which conduct more than 60% of the nation's basic research, are aging. The Association of American Universities in Washington, D.C., estimates that U.S. universities are now able to fill only about half of their accumulated research-facility needs. There has been almost no new construction at engineering schools for the past five years.

Moreover, foreigners are taking greater advantage of U.S. basic research facilities than are U.S. companies. Foreign companies, for example, are sponsoring some 400 visiting scientists at the National Institutes of Health, while American industry supports only 15.

EDUCATION

WHAT'S RIGHT The U.S. has a unique system of higher education that encourages the kind of creative thinking that leads to scientific breakthroughs. That's why U.S. universities are jammed with foreign students, who now make up 20% of all PhD candidates, up from only 12% in 1960.

Steps are being taken to ensure a supply of technical students for the future. The NSF has earmarked $68 million in fiscal 1988 for educational programs to train teachers and revise science and technology curriculums. In addition, the American Association for the Advancement of Science has mounted Project 2061, a program to develop an innovative curriculum for science and technology by 1990.

WHAT'S WRONG The technical education system, however, urgently needs all the help it can get. Over the next 20 years the pool of 18- and 19-year-olds will decline by 25%, making it increasingly difficult to attract the numbers and caliber of scientific personnel that the country needs. Even so, by 1992, more than a million new teachers will be needed in public secondary schools. And the National Science Teachers Assn. estimates that 50% of U.S. science and math teachers are not qualified to teach these subjects. U.S. students lag behind those from other countries on comparative achievement tests. On the Second International Mathematics Study, U.S. 12th graders ranked 12th or below out of 20 countries in geometry, advanced algebra, and calculus. Students from Hong Kong and Japan ranked first and second, respectively, in each subject.

At the college level, more than 25% of current science and engineering faculties will retire in the next decade, creating an acute shortage. In 1985, U.S. schools graduated some 18,000 PhDs in science and engineering, but this is less than needed. Even more ominous, the number of U.S. students choosing to pursue PhDs in science and technical fields is declining. And there is little prospect of an immediate turnaround. A 1986 survey found that only one-third of the nation's high school students take a science course in any given year.

KEN KERBS

tion runs of one part become feasible.

Stanford's Wheelwright takes heart from these signs. "Fundamental changes are beginning to happen," he says. "But there have to be many more companies involved if we are going to bring manufacturing back." The major stumbling block is persuading management to invest in new technology—especially at the country's 150,000 small to medium-size job shops. Many of these companies face problems "that can put them out of business in months," warns Thomas G. Byrer, manager of Battelle's manufacturing and materials processing department. "They don't have five years to wait for help."

So Battelle has refocused its Manufacturing Modernization Project specifically on smaller manufacturers. To get the word out, Battelle is enlisting the aid of local utilities—26 so far—that include small manufacturers among their customers. And it has established a toll-free number, 800-824-0516, that shop managers can call with problems.

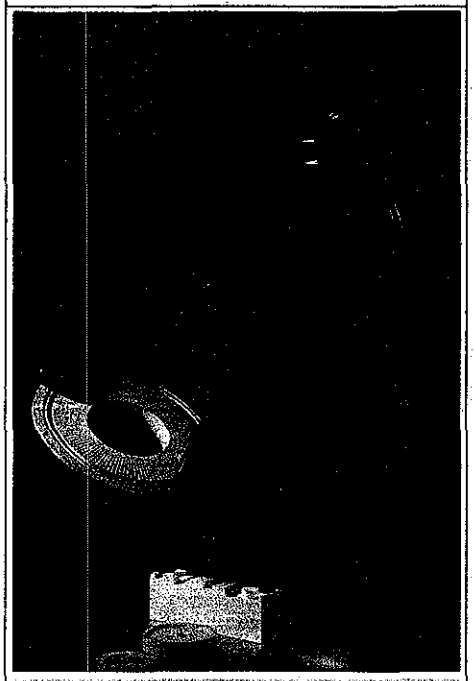
The Navy has launched a rescue mission, too. It's called RAMP, for Rapid Acquisition of Manufactured Parts. The Navy wants to be able to request bids for replacement parts and get delivery 30 days later. Today that process takes 300 days. Trimming the cycle by 90% is attainable—and it can be done with existing, proven technology, according to a study presented to the Navy late last year by the South Carolina Research Authority, based in Charleston.

GOING FOR BROKE. So the Navy has decided to steam ahead and apply that technology to an "ultimate job shop"—and make the technology available to all comers, not just Defense contractors. Scheduled to be up and running in 1990, the plant will automatically make anything that can be carved from a 12-in. metal cube or a cylinder 6 in. in diameter and 24 in. long. The shop is designed for a work load of 86,000 metal parts per year, in batch sizes as small as one.

A comparable prototype job-shop-of-the-future has already been demonstrated by a consortium called Impact, headed by Big Eight accountant Arthur Andersen & Co. And the National Bureau of Standards last December dedicated its Automated Manufacturing Research Facility, a factory-automation laboratory where companies can test production concepts. Even so, the scope of modernizing smaller plants is so vast that Stephen S. Cohen, co-director of the Berkeley Roundtable on the International Economy at UC Berkeley, believes Washington should establish an industrial extension service similar to the agricultural Cooperative Extension Service.

Justifying the cost of new technology is probably the main sticking point at most companies. Cost-accounting schemes rely chiefly on savings from direct labor to recover capital investments. But in most industries, labor has already been trimmed to the bone and represents only about 10% of production costs. Even squeezing out all remaining labor expenses wouldn't be sufficient to justify the investments needed.

'HAVE FAITH.' "Tying everything to just direct labor is no longer valid," argues J. Tracy O'Rourke, president of Allen-Bradley Co. "The nondirect cost areas—inventory requirements, product flow-through, and quality—have to be considered more closely," he says. "The normal capital-budgeting process, using discounted cash flow based on hard savings, has gotten in the way" of efforts to modernize, agrees John J. Clancy, president of McDonnell Douglas Manufacturing & Engineering Systems Co. It's difficult to forecast tangible benefits based on better quality and faster product introductions. Yet such intangibles can often affect a company's market share more than its prices do. Until now, O'Rourke quips, there was only one answer to this dilemma: "As the preacher says, you've got to have faith."



HIGH-TECH CERAMICS

TRADE BALANCE: TOO SOON TO CALL

Stronger than steel, as heat-resistant as refractory bricks, and diamond-hard, ceramics might be the plastics of the 1990s. As engines for cars, planes, and power generators, they would be lighter than metal and nearly indestructible. A race is on to develop the processing technology that will turn the promise into reality. The U. S. had the lead in the early 1980s; now experts give Japan the edge.

Not many companies are willing to make multimillion-dollar investments on those terms, largely because top management doesn't really understand manufacturing. "You don't find too many manufacturing types in top jobs in U. S. corporations," notes Mark Shepherd Jr., chairman of Texas Instruments Inc., who is one of the rare top executives from the "dirty fingernails" school—and proud of it. Managers who lack a feel for the shop floor cannot expect to dictate results and cooperation, he adds. "The boss can't be just the boss today; he has to be a leader."

For conservative executives, the outlines of a whole new approach to cost management and capital budgeting will shortly be released by Computer Aided Manufacturing-International Inc., a factory-automation research co-op in Arlington, Tex. The CAM-I plan was more than a year in the making by a task force composed of all the Big Eight accounting firms, 30 industrial companies, and the three armed services. "It's the first time I've seen the Big Eight working together on anything," says Johansson of Coopers & Lybrand.

IDEA FACTORY. The initial report will sketch the framework for evaluating such intangibles as how higher quality or faster delivery can translate into improved market share and fatter revenues. This year the task force will develop specific policies and procedures. "Even the bean counters are excited," says Richard B. Troxel, head of financial management practices for Peat Marwick Mitchell & Co., "because it means the financial people will be more involved in formulating strategic decisions." Hanging a dollar sign on the factors that enhance strategic competitiveness, adds Johansson, is vital: "Otherwise, you're not going to get off the dime in manufacturing modernization."

The U. S. cannot afford to let that happen, especially now that Japan is also starting to undercut America's role as the world's idea factory. In the past, says H. Kent Bowen, director of Massachusetts Institute of Technology's Manufacturing Systems Engineering & Management Program, the U. S. was dominant in technology and Japan had the advantage in manufacturing. "But if they get both, where does that leave us?" It's time management took to heart the old saw: People are a company's most valuable asset. And a factory's.

By Otis Port in New York, with John W. Wilson in San Francisco and bureau reports

JIM JUDKIS

GETTING MAN AND MACHINE TO LIVE HAPPILY EVER AFTER

Management and labor must rewrite the rule book to make flexible manufacturing pay off

Only people, says Japanese labor expert Haruo Shimada, can "give wisdom to the machines." It's a lesson that leading-edge U. S. companies are beginning to learn. By integrating multiskilled, highly trained workers and computer-driven technology, these companies are seeing remarkable gains. They could represent the wave of the future in manufacturing—but only if management and labor discard obsolete practices and collaborate on innovative production systems.

A startling concept is starting to take hold in the workplace: Capital and labor are no longer competing inputs in production. The mechanization of musclepower in the first Industrial Revolution led to simpler and simpler tasks that demanded little of workers except the use of their hands. Management neither expected nor wanted broader worker involvement. In the new Industrial Revolution now under way, capital consists of information technologies that require workers' mental commitment and responsibility for entire systems rather than for narrow tasks.

BREAKING BARRIERS. Integrating the work of robots and other computer-controlled machines in networks requires "a collection of people to manage a segment of technology and perform as a team," says Richard E. Walton of Harvard business school. Capital and labor interact in a different way, calling for new arrangements that aim especially at involving workers in decisions to a far greater degree.

The people-machine symbiosis is especially powerful in American plants that are operated under "sociotechnical" principles. These innovations mesh workers' social and psychological needs with technological requirements. Semiautonomous work teams and other innovations enable some plants to be 30% to 50% more productive than conventional ones. Many leading companies have adopted the work-team approach, including Procter & Gamble, Cummins Engine, GM, GE, Westinghouse, IBM, Xerox, and Polaroid.

WESTINGHOUSE'S FURNITURE PLANT: CUSTOMERS REGULARLY VISIT TO TALK WITH WORKERS

MICHAEL L. ABRAMSON

This burst in productivity is happening mainly in new plants, outfitted with advanced machinery and designed specifically with sociotechnical methods in mind. The semiautonomous team concept needs nurturing; quick-fix, cookie-cutter methods won't do. Nor is it applicable to all situations. But the use of teams and other work reforms in conjunction with technology can speed productivity growth in manufacturing.

Still, barriers must be broken to make the work climate hospitable to innovation. The old-style "control" methods of managing people impedes the growth of worker commitment. Companies must adopt participatory management, eliminate bureaucratic layers of supervisors, listen to employees, and develop job-security and retraining programs. Workers generally want to do a good job and will suggest work efficiencies if they feel that their jobs are secure. Furthermore, "gain-sharing" and "pay-for-knowledge" compensation systems encourage workers to learn new skills and raise productivity.

LOOSENED CONTROL. Unions, meanwhile, must move from a slavish dedication to narrow job classifications and other work rules that restrict shop-floor flexibility. Every manufacturing industry has some local unions that have loosened their control over the shop floor in return for more participation in departmental and plantwide decisions. National leaders of the Auto Workers, Steelworkers, and Electronic Workers support these and other changes in traditional union policies, although they still face internal criticism for doing so. Examples of highly participative, flexible plants are growing in basic industries such as autos, electrical equipment, tires, aluminum, and steel.

What makes this manufacturing flexibility possible is a high degree of worker involvement in decision-making. About 65% of the 830 employees at the Grand Rapids (Mich.) plant of Westinghouse Furniture Systems, a unit of Westinghouse Electric Corp., are involved in an elaborate system of committees and ad hoc task forces that discuss issues ranging from business strategy to the constant redesign of work areas for product innovation. Using computer-aided design and computer-controlled production, the plant can switch rapidly from one special order to another, combining standard parts in unlimited permutations. From 1983 to 1986, productivity—defined as constant sales dollars per employee—increased by 74%, according to general manager Russell A. Nagel.

Although the Westinghouse plant has

machines, blue-collar workers, and even a union—the United Brotherhood of Carpenters—it functions more like a service-type industry than an old-fashioned factory. Shop-floor workers consult frequently with customers who phone or visit the factory to check on the progress of their orders. As in a top-quality French restaurant, everything is aimed at pleasing the customer, including high product quality and short delivery time. Michael Maccoby, a pioneer consultant on work reform, says the Westinghouse plant is a leading example of a "techno-service" mode of production that is replacing the old "industrial bureaucracy" systems that crank out unvarying, mass-produced items. To become competitive, Maccoby says, companies must "get away from the bureaucratic industrial mentality which is oriented to output, not to quality or the customer."

The most comprehensive outline of a "strategy of permanent innovation" appears in *The Second Industrial Divide*, a book by Michael J. Piore and Charles F. Sabel. Under their concept of "flexible specialization," manufacturing would be performed in small companies or decentralized units of large ones, based on the organization of work along craft lines. Skilled workers, using automated machinery, could change quickly from one product line to another without the restrictions of union shop rules. Piore and Sabel concede that the U. S. may be unlikely to adopt such a system nationally, but they note increasing evidence of changes in that direction.

RETAILORED TEXTILES. A good example of flexible specialization involves the Amalgamated Clothing & Textile Workers Union and its centralizing role in helping the U. S. textile and garment industries compete with low-wage foreign labor. The ACTWU and manufacturers in both industries have formed a joint venture, Textile Clothing Technology Corp., to develop new technology for clothing factories. A prototype automatic sewing machine, now being tested in several plants, speeds up the difficult task of sewing sleeves in all kinds of clothing. "The quicker it takes to turn around from order to delivery, the better we'll compete with offshore production," says ACTWU Secretary-Treasurer Jack Sheinkman. "We don't intend to reduce our wages to the lowest common denominator."

Warren Bennis, an expert on organizational behavior, explained years ago why worker involvement is essential in an innovative plant. "Democracy," he wrote, "is the only system of organization which is compatible with perpetual change."

By John Hoerr in New York

FOREIGN ALLIANCES

MAKING DEALS THAT WON'T GIVE TECHNOLOGY AWAY

Companies try for new kinds of international collaborations

To skeptics, the forming of high-technology partnerships with the Japanese is tantamount to making a pact with the devil. But with Japan collecting an ever-growing share of world chip sales—40% last year, up from 35% in 1985—more and more U. S. chipmakers are deciding to chance a little fire and brimstone. Even the leading American companies feel that the gamble for a bigger slice of Japan's silicon pie, now the world's largest chip market, is worth the risk.

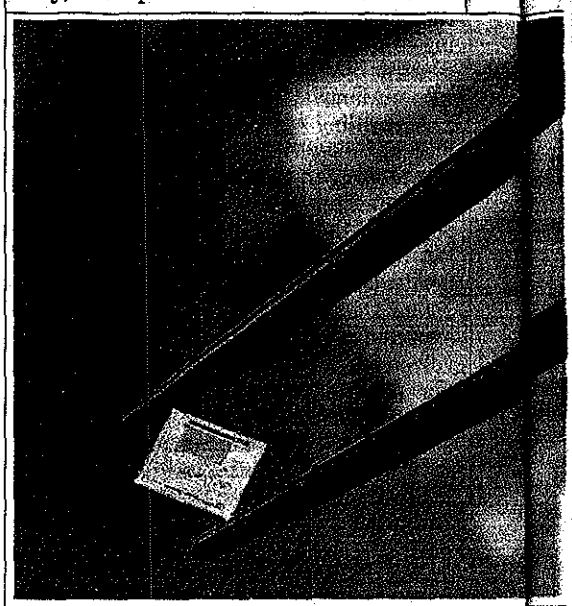
Take Motorola Inc., the No. 2 U. S. chipmaker after Texas Instruments Inc. Its global market share is a respectable 6% or more. But sales in Japan are microscopic, despite 20 years of trying. So Motorola has cozied up to Toshiba Corp., Japan's No. 2 producer, in a precedent-shattering deal—the closest, most sweeping, and possibly riskiest collaboration ever between the two camps. Over the next five years, Motorola will swap its most precious and sensitive technology for some of Toshiba's, plus help in penetrating the Japanese market.

Other recent examples include Fujitsu Ltd.'s ill-fated attempt to buy Fairchild Semiconductor Corp. and a mysterious deal between Advanced Micro Devices Inc. (AMD) and Sony Corp. that neither will talk about. Market researcher Dataquest Inc. counts at least 27 alliances formed last year between Western and Japanese companies. "Strategic partnerships are becoming an irrevocable piece of every company's strategy," says Ralph J. Thomson, a senior vice-president at American Electronics Assn.

MORE COMPLEX. Such pair-ups have been proliferating for several years in industries as diverse as automobiles, office automation, and robots (BW—July 21). Consultants such as Kenichi Ohmae of McKinsey & Co. argue that the alliances are essential as business grows more complex and global.

But semiconductors are a particularly vital business, arguably more fundamental to the commercial and strategic well-being of the U. S. than any other technology. That's why Thomson and others worry that teaming up with foreign competitors, especially the Japanese, will only accelerate the drain of technology from America.

The critics have history on their side. For 25 years, U. S. companies have been licensing technology to overseas rivals. Arrangements that looked at first like the deal of a lifetime often wound up seeming Mephistophelian. Lionel H. Olmer, former Commerce Under Secretary, calls past alliances "a fire sale of



the first order—the technology has gone for a fraction of what it cost to develop." Now pessimists fear that history is repeating itself in chips—in spades. Says Charles H. Ferguson, a fellow at Massachusetts Institute of Technology's Center for Technology Policy & Industrial Development: "If nothing substantial changes, the U. S. semiconductor industry will be gone in five years."

A study of the industry's problems was released in mid-February by the Pentagon's Defense Science Board and instantly fueled the growing protectionist sentiment in Congress. It cites an "unacceptable" reliance by the Defense Dept. on imported chips and urges major government assistance—$2 billion over the next five years. The money would help underwrite a Semiconductor Manufacturing Technology cooperative (Sema-

tech) to develop new production methods. Last month, authorization to spend $100 million a year was tacked onto an omnibus trade bill by Representative Don Ritter (R-Pa.).

While the plight of the semiconductor industry has captured headlines of late, Administration officials are also uneasy about the growing trend to "internationalization" in general. George H. Kuper, executive director of the National Research Council's Manufacturing Studies Board, is drumming up funds for a close look at joint ventures with foreign companies, U.S. investment overseas, and direct foreign investment in America. Kuper has had informal requests for the study from the Commerce and Defense Depts. and other agencies.

Kuper believes the results might make American executives "a bit more wary of some of these arrangements." Not only do 7 out of 10 joint ventures fail to achieve their aims but also the Japanese seem much more able to exploit such ventures. The Japanese, he explains, do their homework. "They've had 20,000 people tramping through American factories in recent years; we visit the temples of Kyoto."

For U.S. chip producers, though, there are few options. W.J. Sanders III, chairman of AMD, explains that it is essential for American industry to improve its manufacturing and process technologies. "This means that we must enter into mutually beneficial strategic alliances with the best microelectronics producers, wherever they are in the world."

With the pace of development quickening and the costs of production soaring, it is increasingly difficult for U.S. chipmakers to go it alone. "There is a certain critical mass that has to be achieved," says Ronald J. Whittier, marketing vice-president at Intel Corp., "and no single company can do this by itself." That's why Motorola Executive Vice-President James A. Norling opted to team up with Toshiba. Norling and others are convinced they can cut deals that will guarantee value in return.

Unlike the routine second-sourcing and design-licensing deals of the past, the new arrangements can involve equity participation, joint ventures, technology sharing, and even coordination of marketing and product-development strategies. For example, Motorola can buy Toshiba memory chips stamped with Motorola's name. If Motorola wants to produce the chips, says Tsuyoshi Kawanishi, head of Toshiba's Semiconductor Group, the U.S. company will get Toshiba's design and production technology—"and they can use it worldwide." Toshiba also will help Motorola penetrate Japan's markets through a joint venture in Japan.

Still, Motorola is proceeding cautiously: Its prized microprocessor technology will be transferred only in lockstep with improved sales in Japan. If all goes well, Norling asserts, "we will create a significantly greater market opportunity for Motorola's microprocessor architecture." Sheridan Tatsuno, senior analyst for Dataquest's Japanese Semiconductor Service, believes the move is a smart one. "Toshiba probably has the best memory technology now," he explains.

Some experts fret, however, that advanced microprocessor technology, still a major bastion of U.S. companies, should not have been allowed to fall into Japanese hands. If the government had been smart and forced open Japan's semiconductor market, says MIT's Ferguson, "Motorola wouldn't have had to trade technology for market access." Robert S. Heikes, American co-chairman of startup European Silicon Structures, also has doubts. "I hold out the possibility there is something about the deal that I don't understand. But I don't think it's a good deal. Even if it's good for Motorola, it's not a good deal for the U.S."

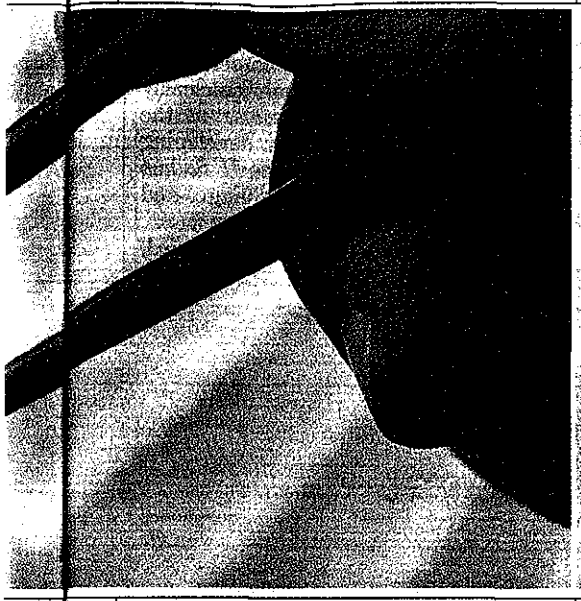
Although not as dramatic as the Motorola-Toshiba pact, other alliances have benefited American companies. LSI Logic Corp., for example, got started in the early 1980s largely by arranging for Toshiba to make its semicustom chips in exchange for the Milpitas (Calif.) company's design technology. More recently, it has lined up financing from Kawasaki Steel Corp. for a semiconductor plant in Japan. At current exchange rates, "an American company is facing a mountain of yen if it wants to invest in Japan," says Wilfred J. Corrigan, LSI's chairman.

In a tie-up with Japan's NMB Semiconductor Corp., National Semiconductor Corp. has avoided substantial capital costs by getting NMB to use an idle line to make static random-access memories for National. In return, NMB gains experience making state-of-the-art chips. Executive Vice-President James M. Smaha insists National is not giving away the store. "There is no question that NMB's goal is to be in the merchant business, but they would get there anyway."

CELL LIBRARY. Strategic alliances aren't limited to transpacific linkups, as the 1985 purchase of Mostek Corp.'s assets by France's Thomson attests. Now, Thomson is talking merger with Italy's SGS Semiconductor. Philips and West Germany's Siemens are spending more than $1 billion in their government-backed Mega Project, which is aimed at catching up with the Japanese in next-generation memory chips by 1990. Siemens, Toshiba, and General Electric are working together to develop a so-called standard cell library for semicustom chips. Siemens and Intel have cooperated closely for 11 years on microprocessor development and production.

Rather than barring U.S. companies from turning to offshore partners, some experts advocate easing America's antitrust laws to allow more domestic partnerships. That's happening, anyway. Late last month, giant Texas Instruments and Linear Technology Corp., a small California chipmaker with $30 million in sales, formed a long-term alliance to expand their business in analog chips. TI believes joint relationships are becoming so crucial that it has delegated Executive Vice-President William N. Sick Jr. to scour the country—that is, America—for potential partners. "We believe strongly in maintaining our core technology in the U.S.," says Sick. Customers, he adds, like it that way because "they see little difference between a U.S. company dependent on Japanese technology and a Far East supplier."

By Robert Neff in Los Angeles, with John W. Wilson in San Francisco, Michael Berger in Tokyo, and bureau reports



ROBERT HOLMGREN

U.S. LINKS WITH JAPAN

Some semiconductor deals cut in 1986

JOINT VENTURES	
Advanced Micro Devices	Sony
Chips & Technologies	Kyocera and Mitsui
LSI Logic	Toshiba
Motorola	Toshiba
Standard Microsystems	Sumitomo Metal
JOINT DEVELOPMENT	
Boeing	NEC
Catalyst Technologies	Oki Electric
General Electric	Toshiba
Vitelic	Tokyo Sanyo
EQUITY INVESTMENT	
Cambridge Instruments	Fuji Electric
Ion Beam Technologies	Marubeni Hytech
Perkin-Elmer	Citizen Watch

DATA: DATAQUEST INC.

IS THE U.S. GOING THE WAY OF BRITAIN?

What caused U.S. industrial power to fade, and how far the process might go

A decade or so of slowing growth, lagging productivity, and deteriorating competitiveness has gripped Americans with a fear that they are losing ground—and irreversibly at that. After all, cities grow and then shrink, nations advance and retreat, and empires rise and fall. Doesn't the ebb and flow of events tell us that the U. S., the world's greatest industrial power, will suffer Britain's fate and fall from grace? Will the mantle of economic leadership, having once passed from Britain to the U. S., soon pass from the U. S. to . . . Japan?

Not necessarily. History is not destiny, the U. S. is not Britain, and Japan is most definitely not the U. S. Still, historical patterns are an essential part of understanding how nations grow, and they give some insight into what lies in store for the U. S.

Economists and historians have developed varying frameworks for analyzing economic growth. Some have identified stages of growth, akin to the stages in human life. A related approach is to focus on industrial and technological advances as the impetus to change. Still others have attributed economic growth to the crossing of geographic frontiers. Recently, some experts have studied the role that government and institutions play in retarding or fostering growth.

SPICE MERCHANTS. These analyses deal mostly with modern history. That's because the pre-industrial age was characterized by far slower progress, and economic centers seemed to follow one surefire route to power: They traded their way to the top, or feasted on the spoils of war. From the 15th century city-states of Italy to the 17th century Dutch empire, gaining the upper hand with neighboring landowners or distant spice merchants was paramount.

Britain broke out of this pattern, and the U. S. broke the mold entirely. Most economists date the origin of the modern world's economy to the 18th century Industrial Revolution, which enabled Britain to grow through manufacturing. Yet the U. S. provides perhaps the richest and the biggest canvas, with an economy that has moved from farming to manufacturing and, finally, to services.

What has worked for America clearly does not work for everyone else, as the postwar experience of many developing countries has shown. But the U. S. has been a proving ground for change, and continues to serve as an example.

And that example has been very good,

THE STAGES OF GROWTH IN AMERICA

BATTLE OF CONCORD ▲
Revolution and independence free the colonists from British rule. A new nation throws off Old World restraints on liberty and growth.

WESTWARD HO! ▶
In 1803 the Louisiana Purchase opens the frontier to settlers and prospectors. The fertile plains and the mineral-rich mountains provide ample resources.

KING COTTON ▶
On Southern plantations, slave labor cultivates cotton, while factories spring up in the North.

THE RAILROAD ▼
The first transcontinental line, completed in 1869, symbolizes a new age, as nation-builders and robber barons alike promote industrial progress.

PHOTOGRAPHS BY BROWN BROS. (2); BETTMANN ARCHIVE (2)

even surprisingly so at times. The 1950s and the 1960s demonstrated spectacular growth in the U. S., on the order of 3.5% per annum, with many years coming in at 4% or more. "At the end of World War II," says economist Albert T. Sommers of the Conference Board, "the U. S. had the most powerful collection of economic stimuli ever available. There was a sense of rebirth, in the U. S. and in the world, that was unprecedented in economic history."

PENT-UP ENERGY. More than a decade of depression and five years of war had deferred consumer demand worldwide. The U. S. had printed money to finance the war effort, and the money was now there to finance all the deferred consumer demand. The U. S. had no real rivals because the industrial plant of much of Europe and Asia had been destroyed. Even technological progress had been suppressed. So the pent-up energy created a burst of growth. By contrast, recent growth in real output has averaged about 2.5% a year. That may seem a little low, says economic historian Walt Whitman Rostow, "but against the long sweep of American history, it's not a terrible figure."

Rostow is the father of the "stages of growth" theory of economic development. The first stage is a long period—a century or more—when the preconditions are established. Then comes a takeoff period lasting three decades or so, when growth is propelled forward. The final stage is a long period of sustained and "normal" growth. The rate of growth in a mature economy naturally slows down, while that of nations in the takeoff or early sustained-growth stages is still robust.

A glance at the average per-capita growth rates from 1973-86 tells the story. In the U. S., output per person grew 1.4% a year during the period, slightly ahead of Britain's 1.1%. West Germany and Japan, with more distance to make up after the war, show stronger gains. The newly industrialized nations show even faster growth (chart, page 66).

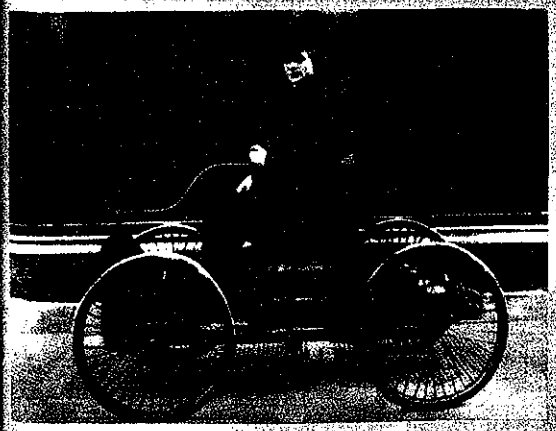
America is still waiting for the payoff from a surge in high-tech investment

The reason is simple, says Rostow. Technology has already been absorbed in the most mature nations, and only new technologies, well implemented, can affect the rate of growth. Other countries, however, are still absorbing old as well as new inventions and so are still "catching up."

Technology, in fact, has proved to be the key building block for growth, while resources, capital, and people are the raw materials. The best crop yields derive from new machinery and scientific advances. The most efficiently manufactured products are the result of careful design and up-to-the-minute production techniques. How far resources go, and how productive labor is, ultimately depends on technology. Without the first Industrial Revolution and the successive waves of innovation of the past two centuries, there would have been no growth as we know it.

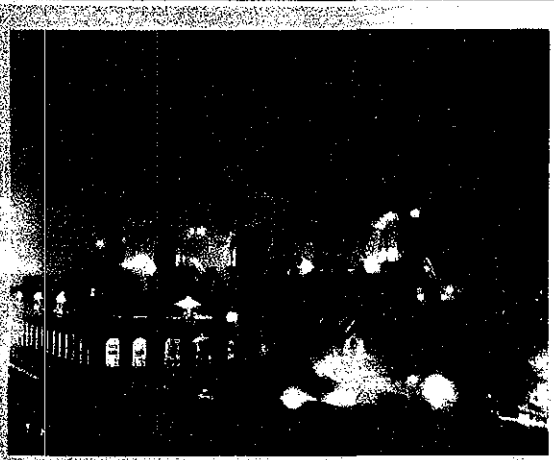
In its early years, America provided a vast region rich in resources to waves of settlers seeking freedom of expression and opportunity. It was a favorable set of circumstances: The raw materials of growth combined in a new nation with new ideals, untrammeled by stultifying laws and restrictions. The citizens themselves were diverse, educated, and motivated—characterized by a spirit that today would be dubbed entrepreneurial.

The fledgling nation began to exploit, in both the positive and the negative senses of the word, the resources and people at its disposal. The agrarian South grew as slave labor was forced to work the cotton fields. Even then, technology made a difference, as the widespread adoption of the cotton gin allowed for much swifter processing and great gains in output. In the North, textile mills and other light manufacturers

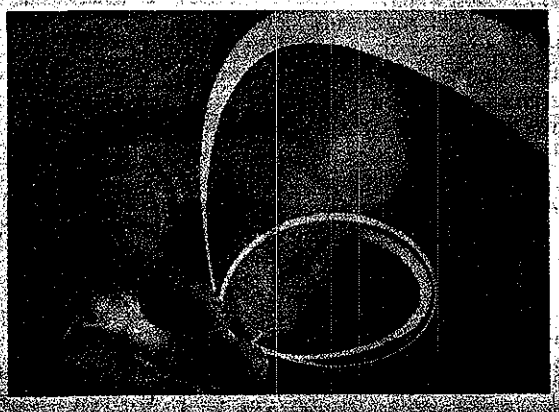


THE AUTOMOBILE ▲
Henry Ford introduces mass production for a mass market in 1908, as communications, electricity, and other advances sweep the nation.

J.P. MORGAN ▶
Wall Street grows with the economy. After World War I, the U.S. becomes a creditor to the world, but the 1929 crash brings on the 10-year Depression.



POSTWAR BOOM ▲
Its industrial plant undamaged, the U.S. emerges as a superpower after World War II. New technologies and pent-up consumer demand spur growth.



HIGH TECH ▶
Technology is now the big hope. A manufacturing economy built on superchips, fiber optics, and superconductors could give the U.S. a new competitive edge.

FOREIGN RIVALS ▼
Spoiled by success, the U.S. begins to lose its lead in the 1970s. As foreign competition builds in the 1980s, imports rocket and steel mills are shuttered.

CLOCKWISE FROM BOTTOM LEFT: BETTMANN ARCHIVE, BROWN BROS., BETTMANN, UPI, BETTMANN

were sprouting. But it was to the West that Americans looked to pursue and sustain dreams of freedom and economic opportunity.

So strong is the frontier notion that when the Superintendent of the Census reported in 1890 that the West had been so thoroughly settled that a frontier line could no longer be said to exist, the historian Frederick Jackson Turner was moved to write a paean to the significance of the frontier in American history. Turner mourned its passing and worried that its spirit would be lost.

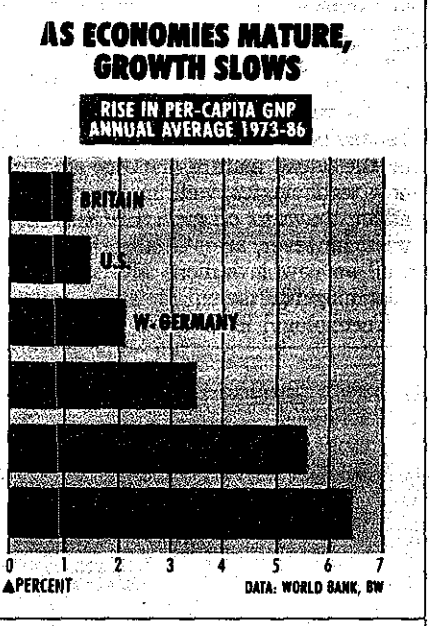
NEW FRONTIERS. He need not have worried. The Western frontier may have been exhausted, but technological frontiers were just opening up. By the late 19th century, inventions were coming fast and furiously, and by the turn of the century their application and acceptance was spreading across the nation. The telephone, the electric light, the automobile, and a host of time- and labor-saving machines became mainstays of daily life. Steel magnate Andrew Carnegie, at the onset of this period in 1889, wrote that "what were the luxuries have become the necessities of life."

That is, in one way, the essence of economic growth—the imperative that the standard of living should steadily be rising. Of course, this should be true for all citizens, not just a few. Carnegie would have abhorred the contemporary form of income redistribution by governments, but he welcomed the rise of individual progress that growth made possible. As nations grow, the distribution of income almost invariably improves, and so too, by definition, does the standard of living. Income distribution is far less equal in the developing countries than in industrialized nations.

Today the perception is growing that standards of living are slipping and the U. S. is following Britain into economic decline. The gloom is clearly exaggerated. The U. S. still ranks far and away as the largest industrial economy, while Britain is fifth. Britain's ranking, however, is being hotly challenged by Italy, in a tussle that highlights how important the direction of change is. Inevitably, an advancing nation appears more vital.

SETTING SUN. How did Britain lose its vitality? How did the birthplace of the steam engine, the cradle of industry, slide from preeminence? The Empire's defenders have long argued that Britain, as the pioneer, expended far more capital in breaking new ground than any successor did. What's more, they say, what Britain invented, the U. S. and others merely ran off with, eventually garnering the competitive advantage. This theft-of-technology argument is fashionable in Silicon Valley today, but it is largely beside the point. Few inventions remain secret for long; how they are utilized is what matters.

By and large, Britain simply ceded innovation to the U. S., and what it had, it used badly. It failed to reorganize its atomistic industrial structure into the corporate powerhouses needed earlier in this century to achieve the economies of scale demanded by mass markets. Economist William Lazonick of Barnard College argues in an analysis of Britain's cotton industry, which began to lose ground early in the early 1900s, that national supremacy over world markets had induced complacency. Across many industries, he says, too many producers simply operated within a comfortable status quo, without "engaging in innovative activity to alter constraints."



U. S. industry also has suffered from complacency. But this society has always made room for business pioneers who insist on doing things differently and, in recent years, created a Silicon Valley and a Route 128, while America's corporate giants struggled for survival. The U. S. has even managed to export a little of its entrepreneurial fervor to such nations as Britain and France. So what gives? Are we just waiting for the payoff? Will technology eventually be our salvation?

Quite possibly. But there may be something else at work, muting technology's impact. After all, the biggest surge in high-tech investment in the U. S. took place over the past decade, notes Stephen S. Roach, an economist at Morgan Stanley & Co., and by this time some results should be apparent. The problem, some economists believe, may be structural and institutional rigidity.

"Every long-stable society has shown signs of institutional sclerosis," says economist Mancur L. Olson Jr. of the University of Maryland. Special interests multiply as business cartels and labor unions gain power. Needless regulations and laws pile up to protect these interests, and the inevitable result is a misallocation of resources and slower growth, Olson argues. "We're dying a death by 1,000 cuts."

Institutional barriers can impede the adoption of new technology—at huge cost to entire nations. Argentina, a stellar economic performer early this century, now struggles as a developing nation. The worldwide depression of the 1930s was outside Argentina's control, but the long rule of Juan Peron may have done its economy even more harm, Olson argues. Fierce economic nationalism and rampant cartelization of business and labor replaced a relatively open, free-trading economy.

By the same token, the yoke of institutional restraints can be thrown off. Typically, wars or revolutions have done the trick, though there are better ways to cure slow growth. In the mid-1800s, as Britain's industrial revolution was taking off, steps were taken that opened up the economy and set the stage for truly sustained growth. The Corn Laws, which had imposed heavy tariffs on grain imports, and the Navigation Acts, which prohibited the use of foreign ships for trade, were repealed.

BIG JOLTS. In the U. S., Britain, and Western Europe today, a process of reevaluation is slowly beginning. The rigidities that Olson cites as impediments to growth are being questioned, and slowly some changes are being made. Whether they will be an unalloyed success in spurring growth is arguable. The pros and cons of deregulation, tax reform, and corporate restructuring in the U. S. are still being debated.

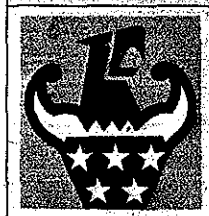
Perhaps the U. S., with so successful an overall economic history, may simply be unaccustomed to making the adjustments that changing circumstances warrant. Historically, it takes a big jolt to the system, such as the Great Crash of 1929 and the ensuing Depression, to create an upheaval and reorder economic priorities. The U. S. economy is being shaken up again—by the ever-growing trade deficits. If irreversible decline is to be avoided, the U. S. needs to create a new framework for growth. When it does, the still-vigorous inventiveness of America can be properly harnessed, and economic maturity need not be a euphemism for senescence.

By Karen Pennar in New York

PATRICE CAIRE

NO PAIN, NO GAIN: HOW AMERICA CAN GROW AGAIN

The steps the U.S. will have to take to regain its competitive edge



The U.S. isn't the only country that can't seem to grow as fast as it used to. Japan, West Germany, and other leading industrial nations also have slipped from their robust growth rates of past years. And their productivity gains have dropped, though they still exceed those of the U.S.

The result is that the so-called mature economies are now locked in a competitive struggle for each other's markets while the new trade tigers, such as South Korea and Taiwan, make increasing inroads on their old industrial mentors. Instead of seeking new sources of growth, the U.S. and its rivals are stumbling into the kind of rampant protectionism that deepened the Depression.

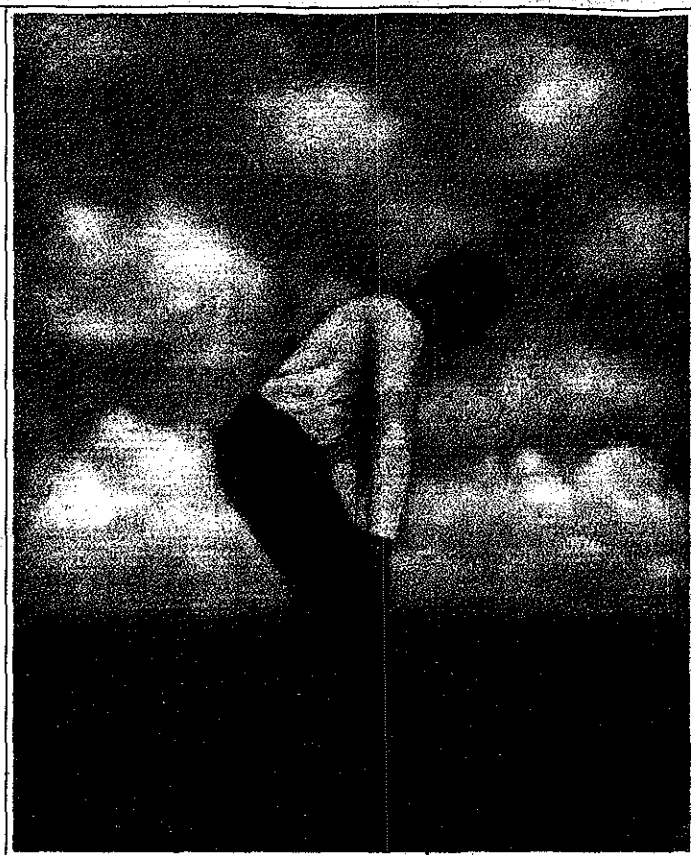
Today, entire regions of the U.S. have been blighted by plant closings, and profits everywhere have been battered by foreign competition. At different stages of the growth cycle, labor may fall behind as rising profits are used to build or modernize capital stock. The profit share may, in turn, be shorted when labor plays catch-up. But both sides are losing because U.S. competitiveness and growth have declined.

The first question is not how to distribute the fruits of growth but how to distribute the pain of not growing fast enough. The second question is how to start growing faster to minimize the cost of past mistakes. For Japan and Germany, the solutions are almost pleasant: What they have to do is grow faster and enjoy a better standard of living by stimulating their economies instead of relying so heavily on trade. For the U.S., however, pain will precede the gain.

MAKING SACRIFICES. To deal with its international debt, the U.S. will have to make some sacrifices. It will have to stop relying on foreigners' savings to finance federal and private deficit spending. If the U.S. had used the imported capital in recent years primarily for capital investment, as the nation did when it was a debtor in the 19th century, there would be little problem now. But it has been used instead to make up the gap between consumption and output, in effect paying for imported cars, VCRs, and the Strategic Defense Initiative.

This is the kind of spending that Washington would have to cut if the politicians were serious in proclaiming that America must again live within its means. There is not much more to be chopped from social programs. But whatever the choice, talk of competitiveness is nothing but talk if the U.S. doesn't move to reduce the deficit and increase national savings. If there is anything that everyone agrees on it is that the U.S. must invest more. To invest it must save. And to save it must consume less now. This gets back to the basics of growth theory. To Paul A. Samuelson of Massachusetts Institute of Technology, a pioneer in the field, "the primary way for a society to grow and improve its standard of living is capital formation and technological progress."

That, of course, is still the big picture. But the gods of growth dwell in the details. A new generation of economists and political scientists is now focusing on ways to bridge the gap between the macroeconomic issues of saving and investment and the microproblems of productivity. This requires a new emphasis on flexibility not only in management and manufacturing but also in how to think about growth.



BUSINESS WEEK's editors have compiled a list of proposals to revive growth and competitiveness reflecting this thinking:

- **Trade.** Democrats should dump proposals for automatic retaliation against foreign countries that run chronic surpluses with the U.S. and go back to John Maynard Keynes for an idea that could help the U.S. and other countries much more. Keynes once proposed having the International Monetary Fund tax countries that depress domestic consumption to keep pumping up exports. He urged that the revenues be used to finance loans to developing nations on the condition that they join in agreements to avoid world commodity gluts.
- **Third World debt.** It is, in any event, time for a new Marshall Plan, financed by the industrial nations, to help the developing nations out of their debt mess, conditional on sensible domestic policies. The U.S., Japan, and the other main players are writing off markets of more than a billion people who simply can't afford their goods. Open those markets and the demand side of the growth problem could be solved.
- **Reciprocity.** Retaliatory tariffs can lead to more of the same by U.S. trade partners and could further impede the U.S.

ILLUSTRATIONS BY MARK PENBERTHY

export sector. However, the U. S. must insist that the Japanese and others play fairly and drop their barriers to American goods and services. The U. S. also may have to treat high tech as an infant industry. American companies must learn to turn their ideas into products much faster to keep foreign concerns from skimming off all the cream of innovation. But the newest technology may need tariff protection at least to assure that research and development costs can be recovered.

■ **Tax policy.** Given the stubbornness of the budget problem, it may not be possible to leave the new tax code alone. But rate cuts for individuals could be preserved by expanding present excise taxes or tacking a consumption tax onto the system. A value-added tax, a levy collected at each stage of production and distribution, is a standby proposal whose time may yet come if it can be designed not to clobber low-income workers. Energy taxes are another good bet, with the same proviso.

With new revenue sources, the government would have the money to finance a better health care system, cut the deficit, or reduce corporate taxes to spur capital spending directly.

■ **Productivity.** Neither Washington nor any number of commissions can mandate a rise in output per hour—and its quality. That can only be done by companies that work with labor to develop such innovative production approaches as flexible manufacturing. Paper entrepreneurialism, the juggling of financial assets by legions of MBAs and lawyers, must be replaced by a new commitment to keeping manufacturing in America. To do that, business must invest in production methods that can respond to rapidly changing markets. Running away from high wages makes no sense when labor costs are being cut to less than 10% of the total production cost.

Business already spends billions of dollars a year on employee training, but it will have to shell out more to get workers with skills to match the new flexible production technology. Government must help by expanding its training and job-search services. Managers have to change their ideas about work organization to handle processes that are more like craft methods than mass production. Labor must become more adaptable to participate as shop-floor managers of machines rather than as cogs in the assembly line.

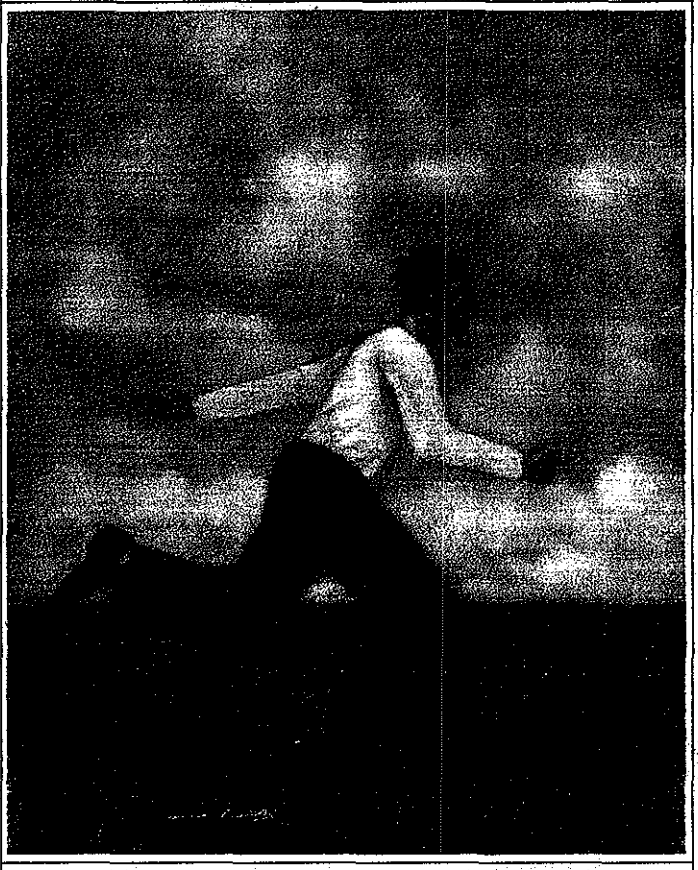
■ **Job security.** It may take federal or state legislation, but companies should give more advance notice of plant closings than they now do, and they should help in the retraining and relocation of displaced workers. If labor is to share in the risks of revamping the industrial system, it needs some insurance.

Economist Pat Choate of TRW Inc. proposes that the kind of workers needed in a "high-flex society" will also need the protection of "portable pension plans," administered by the government, so they can move from job to job without losing retirement benefits. Choate also calls for creation of individual training accounts, an IRA-like fund financed jointly by workers and employers, to pay for a voucher-based retraining and relocation system. Others have proposed new profit-sharing approaches to reinforce worker loyalty.

■ **Education.** The U. S. can boast that 50% of high school graduates go on to college, but only 70% of students complete high school, in contrast to 98% in Japan. The result, says MIT's Lester C. Thurow, is that "their bottom half is beating our bottom half" by being better prepared for the modern work world. Washington should be increasing support for education rather than trying to cut it.

On the college level, the U. S. is doing much better, but it's in danger of slipping. Universities are not turning out enough scientists and engineers to meet new demand in the leading-edge areas of high technology or advanced production systems, and soon may face a shortage of applicants to replace their aging generation of top-quality teachers in these fields. Nor are they encouraging the study of manufacturing. Behind the brain drain is the flight of top students into the more lucrative finance and legal professions. This is partly a matter of culture and values, but may also have something to do with the way business rewards and promotes its engineers and factory managers. Neal Orkin, a legal studies teacher at Drexel University, notes, for example, that U. S. companies "are years behind Japan and Germany in making sure employees share in earnings from patents they come up with."

■ **Technology.** Although collaboration by universities, business, and the government has worked well in the past to spur U. S. R&D efforts, an increasing share of that output is taken by the Pentagon and projects like the President's SDI. Experts insist that such tightly targeted research no longer has the much-acclaimed "spillover" benefits that advocates used to cite. Since the Japanese and other U. S. trade rivals do not have comparable defense burdens, their R&D spending is targeted more toward product and process development in such



high-potential areas as biotechnology and superconductivity.

Increasing National Science Foundation funding for basic research could help, but pulling back the Pentagon's claim on the R&D infrastructure might be even better. Failing that, retired Admiral Bobby R. Inman has suggested that Pentagon research contracts awarded to universities give them more freedom on how to allocate the dollars among basic and applied research and even educating scientists.

All of these proposals aim, in one way or another, at equipping the U. S. to attain the fullest possible flexibility in manufacturing and in helping other industries to respond to the foreign competitive challenge. But more important, they address the need to revitalize and encourage the nation's natural sources of economic growth: its vast pool of creative management talent and its historically productive work force. If Americans can form a consensus on these issues, it may not be too late to reach for new frontiers in growth, competitiveness, and the standard of living.

By Norman Jonas in New York

SEC. 3031. PROTECTION OF SENSITIVE TECHNICAL INFORMATION

(A) Whenever any contractor makes an invention or discovery to which the Department of Energy has elected or preserved the right to elect ownership at the time of contracting;

(i) for purposes of national security under section 202(a)(ii) of Title 35, United States Code, or (ii) because the invention will be made or conceived in the course of or under a funding agreement described in section 202(a)(iv) of Title 35, United States Code, or (iii) pursuant to sections 2182 and 2189 of Title 42, United States Code in a contract which includes the operation of a Department of Energy laboratory dedicated to the research and development activities of that Department's Naval Nuclear Propulsion Program, nuclear weapons programs, or other atomic energy defense activities,

such invention or discovery shall be or become the property of the Government unless a U.S. contractor requests ownership of such invention or discovery, and the Secretary of Energy does not notify the contractor within six months after the contractor request that exceptional circumstances as defined and implemented under 202(a)(ii) of Title 35, United States Code require Government ownership of the invention or the invention or discovery has been classified in accordance with Federal statutes and implementing regulations or has been designated sensitive technical information as authorized by Federal statutes and implementing regulations. If the Secretary does not so notify the requesting contractor, the contractor shall retain ownership

of the invention or discovery under the contractor ownership provisions of sections 200-206 of Title 35, United States Code. In making a decision under this section, the Secretary shall consider --

(1) whether national security will be compromised; and

(2) whether sensitive technical information (whether classified or unclassified) under the Naval Nuclear Propulsion Program or the nuclear weapons programs or other atomic energy defense activities of the Department of Energy for which dissemination is controlled under Federal statutes and regulations will be released to unauthorized persons.

Government Employee Inventions

By: JOHN H. RAUBITSCHEK*

A number of bills have been introduced during the 99th Congress to stimulate innovation and technology transfer at government laboratories.[1] Since these bills focus on licensing by the government of its patents covering inventions made at the laboratories, it seems appropriate to examine the mechanism by which the government acquires title to these inventions.

Rights in government employee inventions are determined in accordance with Executive Order 10096 and implementing regulations now issued by the Patent and Trademark Office. The Executive Order was signed by President Truman on January 23, 1950, after a three-year investigation by the Department of Justice into government patent practices and policies. Although this investigation concluded in 1947, it took almost three additional years and five draft versions of the Order before it was finally signed.[2] The Department of Defense, which was then responsible for 80 percent of the total number of patents covering employee inventions, did not support the Executive Order for a number of reasons including the negative impact it might have on employees.[3]

The Order established a Government Patents Board (GPB) chaired by a presidential appointee who was required to submit the implementing rules and regulations to the President for approval. The Board consisted of representatives from 10 agencies and acted in an advisory capacity to the chairman. The chairman had a small staff which ranged from 6-16 people, and the overhead of the entire operation was provided by the agencies on the Board. Considerable disagreement developed among the members of the Board over the handling of employee inventions, and legislation was recommended to resolve the problem. In fact, the Board, which had met regularly since its creation, ceased functioning after November 9, 1956.[4] The legislative recommendations were never acted on, and later President Kennedy in Executive Order 10930 abolished the Board on March 24, 1961. The functions of the chairman were transferred to the Secretary of Commerce, who delegated them in turn to the Commissioner of Patents.

The principle implementing procedures issued by the chairman were contained in Administrative Order No. 5, dated April 26, 1951. This was revised slightly in April 1962 and published as Part 300 of Title 37, Code of Federal Regulations. It now appears in Part 100 of Title 37. Additional procedural instructions were provided to the agencies by the chairman on January 10, 1955, which established a numbering system and format for the various reports required by Administrative Order No. 5.[5]

Since the issuance of Executive Order 10096, there has been concern about its constitutionality, because some have felt that the President does not have the power to deprive employees of common-law rights to their inventions.[6] Under common law as analyzed in 1933 by the Supreme Court in *United States v. Dubilier Condenser Corporation*[7], an employee, whether working for the government or in the private sector, retains ownership to his or her inventions absent a written agreement to the contrary, unless he or she was specifically employed or assigned to make the invention. The Court considered that the use of the employer's materials in making the invention results merely in a shop right or royalty-free use of the invention by the employer.

The criteria for determining relative invention rights are set forth in paragraph 1 of the Order, which reads in part (a) as follows:

> The Government *shall obtain* the entire right, title and interest in and to all inventions made by any Government employee
>
> (1) during working hours, *or*
>
> (2) with a contribution by the Government of facilities, equipment, materials funds, *or* information, *or* of time *or* services of other Government employees on official duty, or
>
> (3) which bear a direct relation to *or* are made in consequence of the official duties of the inventor.

(Emphasis supplied.) The use of a disjunctive makes the scope of the Order rather broad, and if the language of the Order is applied literally, it would require the government to take title to most inventions made by the government employees.[8] The Order, however, contains some flexibility and in paragraph 1(b) allows the government, subject to the approval of the chairman, to take only a license where the "contribution" is "insufficient equitably" to justify taking title or where the government has "insufficient interest" in the invention.

The first chairman chose not to apply the Executive Order literally, but rather followed the principles set forth in the *Dubilier* case.[9] This was accomplished by emphasizing the term "insufficient equitably"[10] and interpreting "shall" to be the permissive "may." The chairman reasoned that when Congress and the courts

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The views expressed in this article are those of the author and do not reflect the official policy or position of the Department of the Army, Department of Defense, or the United States Government.

intended something to be mandatory, the word "must" was used.[11] As an aside, the chairman noted that a strict construction of the Order would be contrary to existing cases and could not be done in the absence of statutory authority.[12] In addition, the chairman interpreted "or" as "and" and required all the criteria to be present in order to justify taking title.[13] Thus, the critical issue in the rights determination became whether or not the invention was directly related to the employee's duties.[14]

The Executive Order has been applied for almost 35 years without apparently any serious problem.[15] There have been few appeals by inventors from the agencies' decisions, which may be an indication of the fairness of the system.[16] However, inventors would not be expected to complain about a practice allowing them to keep rights.[17]

Nevertheless, this author seriously questions whether the present policy should be continued. It seems to be a doubtful practice to interpret a regulation contrary to the normal meaning of its terms, i.e., "shall" to mean "should" and "or" to mean "and." In fact, the Navy recommended in 1961 to change "shall" to "may" when Administrative Order No. 5 was under revision.[18] The proposal, however, was not adopted.

The justification for liberal interpretation because of a concern over the constitutionality of the Executive Order is no longer compelling. In 1976, the Seventh Circuit concluded in *Kaplan v. Corcoran* that the Executive Order was constitutional.[19] This decision was cited with approval in *Heinemann v. United States* by the Claims Court which held that the Executive Order was the "sole avenue" for determining employee invention rights and rejected the plaintiff's common-law argument.[20]

It is possible that some agency patent counsel have used the rights determination process as a mechanism to provide incentive to inventors. This might happen if an inventor is allowed to retain commercial rights and the government receives only a license, based either on "minimal" contribution by the agency to the making of the invention, or in exchange for the government filing a patent application. Thus, the employee/inventor could make money by licensing or selling a patent obtained by the government.[22]

Secondly, the liberal interpretation seems to be inconsistent with the development of the Executive Order, which adopted almost verbatim the Justice Department criteria for determining invention rights,[22] and therefore presumably accepted the recommended policy that government ownership of its employees' inventions will best serve the public interest.[23] In fact, it is generally recognized that the Executive Order was intended to change the status quo.[24] In spite of the liberal interpretation of the Executive Order, assignments increased after the Order was issued.[25] One explanation is that many patent counsel felt bound to make their determinations in accordance with the strict terms and intent of the Order.[26] Such a practice would not be questioned by the Patent and Trademark Office, because determinations to take title are not reviewed unless the inventor appeals. It is surprising that there were few appeals, but many inventors may not have been interested in rights and therefore were willing to execute an assignment without going through a rights determination.[27] This willingness may be influenced by advice given them by agency patent counsel.[28]

If agencies are permitted to interpret the Executive Order either strictly or liberally, it is likely that the application of the Order would vary from agency to agency, and maybe even within an agency. This, of course, would defeat the expressed purpose in the Executive Order to achieve uniformity. Although the high percentage of concurring opinions by the Commissioner evidences a growing uniformity as compared to the period prior to the Order,[29] complete uniformity has not been achieved nor could it be expected.

There is no formal appeal from the Commissioner's decision, which is final as provided by 37 C.F.R. 100.7(d). When an accused infringer questioned the plaintiff's title because it was acquired from a government employee, the court refused to examine the rights determination absent evidence of fraud.[31]

In *Kaplan*[32], jurisdiction in the district court was based on the Administrative Procedure Act and the review was to determine whether the agency decision on rights was supported by "substantial evidence." Although the Seventh Circuit reversed the lower court's holding that Executive Order 10096 was unconstitutional, it was silent on the question of jurisdiction. It is of interest that neither court mentioned the earlier Third Circuit decision of *Zimmerman v. United States*[33] which not only assumed that the Order was constitutional but also held that jurisdiction was in the Claims Court under 28 U.S.C. section 1498(a), which was amended in 1952 to allow a government employee in certain circumstances to bring suit against the U.S. for patent infringement. The Third Circuit noted that there was considerable disagreement on whether the Administrative Procedure Act was jurisdictional. In addition, it stated that the judicial review of a rights determination was *de novo* notwithstanding the finality of the Commissioner's decision.[34]

When the ownership of an employee invention issue was raised in the *Heinemann case, supra*, neither party initially questioned that jurisdiction was in the Claims Court. As far as the scope of review, that court recently determined that it would apply the "substantial evidence" test.[35] This represents an interesting situation because the Claims Court seems to be following *Zimmerman* on jurisdiction and *Kaplan* on scope of review.

At least one author has advanced reasons why the operations under the Executive Order should not be considered subject to the Administrative Procedure Act. For example, it was noted that the general public does not have an opportunity to participate in the determination.[36] Further, neither the decisions of the Commissioner nor a digest is published or widely circulated. An index of decisions was started in the early 1970s by the Patent and Trademark Office, which makes it possible for one to examine, in the Patent and Trademark Office, what prior practice has been. But the decisions themselves are not considered to form a precedent because they are not published and also are very dependent on the facts surrounding the particular invention. This changed to some extent on January 6, 1986, when the Patent and Trademark Office published in Volume 228 of the *U.S. Patent Quarterly* two decisions on appeals by the inventor of agency rights determinations. It is expected that the agencies will consider these decisions as *stare decisis*, especially since the Patent and Trademark Office is citing them in its own opinions.

Although the court in *Zimmerman* felt that 28 U.S.C. section 1498 was relevant in making rights determinations, the Comptroller General ruled that the existence of an implied license for the government under 28 U.S.C. section 1498 is not affected by a rights determination under the Executive Order.[37] The fact that the government may have rights in an employee's invention, apart from the Executive Order, is recognized by the determination that the inventor has all rights "subject to law." The phrase "subject to law" has been interpreted to be a reference to 28 U.S.C. section 1498.[38] The similarity in language between section 1498 and the Executive Order may confuse the issue of government rights. However, if the Executive Order is interpreted to limit the government to a shop right under the theory of *Dubilier*, the two essentially become equivalent.

Since there is no requirement when to make a rights determination, a problem could arise if an inventor, after executing an assignment, requests a rights determination. Under Title 37 of the Code of Fed-

eral Regulations, the inventor is given 30 days to appeal from an adverse decision by the agency. However, if an inventor executes an assignment gratuitously, the agency does not generally make a rights determination. Further, most agencies would be reluctant to determine rights after filing and obtaining a patent, especially if it were licensed. Although there is a problem in authority for a government agency to return rights to the inventor, especially after the assignment has been recorded in the Patent and Trademark Office, the Comptroller General has ruled that an assignment obtained through a mutual mistake is voidable.[39] In addition, a recorded assignment may not be enforced by a court because the inventor was misled by a government attorney into signing it.[40]

With the emphasis placed on the government to license its inventions, agencies may be under pressure to take title more often. However, there is no evidence that this in fact has occurred.[41] In addition, legislation has been passed creating a defensive patent called a Statutory Invention Registration (SIR) which the Department of Defense is expected to use for its military inventions.[42] In order to file for an SIR, the government should have an assignment or at least be entitled to one.

There are several other issues concerning the Executive Order that should be mentioned. One is the meaning of the term "making," which is not defined in either the Executive Order or Title 37 of the Code of Federal Regulations. The Chairman of the Government Patents Board, however, has given some guidance and considered an invention to be "made" when there has been conception as supported by written evidence.[43] The basis for this is not clear, and it represents a different standard from that used with contractor inventions in which the government also acquires rights if the invention was first reduced to practice under the contract. The chairman's definition of "making" may no longer be controlling.[44]

Another problem is determining what constitutes "directly related" which, as previously mentioned, is the critical issue in a rights determination. In testifying before Congress, Captain Robillard, Assistant Chief, Naval Research for Patents, stated that he could relate almost any invention to the employee's duties.[45] In the present practice, reliance is placed on what the inventor's supervisor thinks about the relationship because of first-hand knowledge and objectivity. But this is still a very difficult area because inventions can be looked at very broadly, as suggested by Captain Robillard.

If the claims are available, they are useful in determining the scope of the invention. In fact, it may be appropriate to wait until there are allowed claims before making a rights determination. However, since claims frequently are drafted by the agency patent counsel, the inventor's rights can be affected without his or her realizing it. For example, if the agency patent counsel includes claims only to the embodiment of the invention which relates directly to the job, a different rights determination might result than if a broader invention was claimed covering research performed before government employment, or which does not relate directly to the job. Of course, it becomes a rather confused situation if claims are included which cover some embodiments relating to the job and some which do not. This author does not recommend carving up the claims in a rights determination, but suggests that separate patent applications be prepared assuming that the government is interested in both types of embodiments. If it is subsequently determined that the embodiments are not patentably distinct, then a decision can be made later to combine the cases.

If a government employee makes an invention with a non-government employee, the rights may also become very confusing. For example, the government may be entitled to an assignment of an undivided interest from its employee which could be licensed or further assigned. Because it is unlikely that a company would be interested in being a licensee or assignee of such an interest, the government's rights would be equivalent to a royalty-free license. However, the owner of the other undivided interest might negotiate for the government's rights.

There are several ways the government might transfer its undivided interest. It could agree not to license any party or to exclusively license its undivided interest.[46] It is not clear that an exclusive license under these circumstances is subject to the government-wide licensing regulations.[47] If the other inventor is an employee of a nonprofit or small business contractor, Public Law 96-517 authorizes but does not require the agency to transfer its rights to the contractor.[48] In any situation, the government should make a rights determination in such a joint invention. Of course, if the government decides that the employee is entitled to commercial rights, the inventor may deal directly with the owner of the other undivided interest.

"Legislation has been passed creating a defensive patent called a Statutory Invention Registration (SIR) which the Department of Defense is expected to use for its military inventions."

Conclusion

Either the Executive Order should be revised to reflect more accurately the existing practice or the implementing regulations in Title 37 of the Code of Federal Regulations should be followed more closely by the agencies.[49] Of course, the policy on government employee invention rights could be addressed by statute, thereby putting to rest any lingering concerns over the constitutionality of the Executive Order.

FOOTNOTES

[1]S. 65, H.R. 695, H.R. 1572. H.R. 3773, a revision of H.R. 1572, passed the House unanimously on December 9, 1985. Its counterpart in the Senate is S. 1914.

[2] 3 C.F.R. 292 (1949-53 compilation). For a detailed history of the Executive Order, see Forman, *The Government Patents Board-Determination of Patent Rights in Inventions made by Government Employees*, 35 J. Pat. Off. Soc'y 95, 127 (1953).

[3]Final Report, Part II, Armed Services Patent Policy Review Board 18-26 (1952).

[4]*Patent Practices of the Government Patents Board*, a Preliminary Report of the Subcommittee on Patents, Trademarks, and Copyrights of the Senate Committee on the Judiciary on S. Res. 53, 86th Congress, 1st Sess. (1959), at III.

[5]No record could be found specifically revoking these procedures, so they may still be in effect. However, there is some confusion because a number of the reports such as "8d," "8e," and "8f," required of the agencies by Administrative Order No. 5, are not referred to in the present Title 37 of the C.F.R. and are not now provided by the agencies.

[6]Gerber, *Patents-Inventions by Federal Employees and Contractors-Disposition of Title and Rewards*, 35 J. Pat. Off. Soc'y 426 (1953); Tresansky, *Patent Rights in Federal Employee Inventions*, 67 J. Pat. Off. Soc'y 451 (1985).

[7]289 U.S. 178, 53 S. Ct. 554, 77 L.Ed. 513 (1933).

[8]Finnegan and Pogue, *Federal Employee Invention Rights Time to Legislate*, 55 MICH. L. REV. 918-66 (1957); *also published* in 40 J. PAT. OFF. SOC'Y 252-89, 322-54 (1958).

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

Does anyone really believe in free trade?

By Norman Gall

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

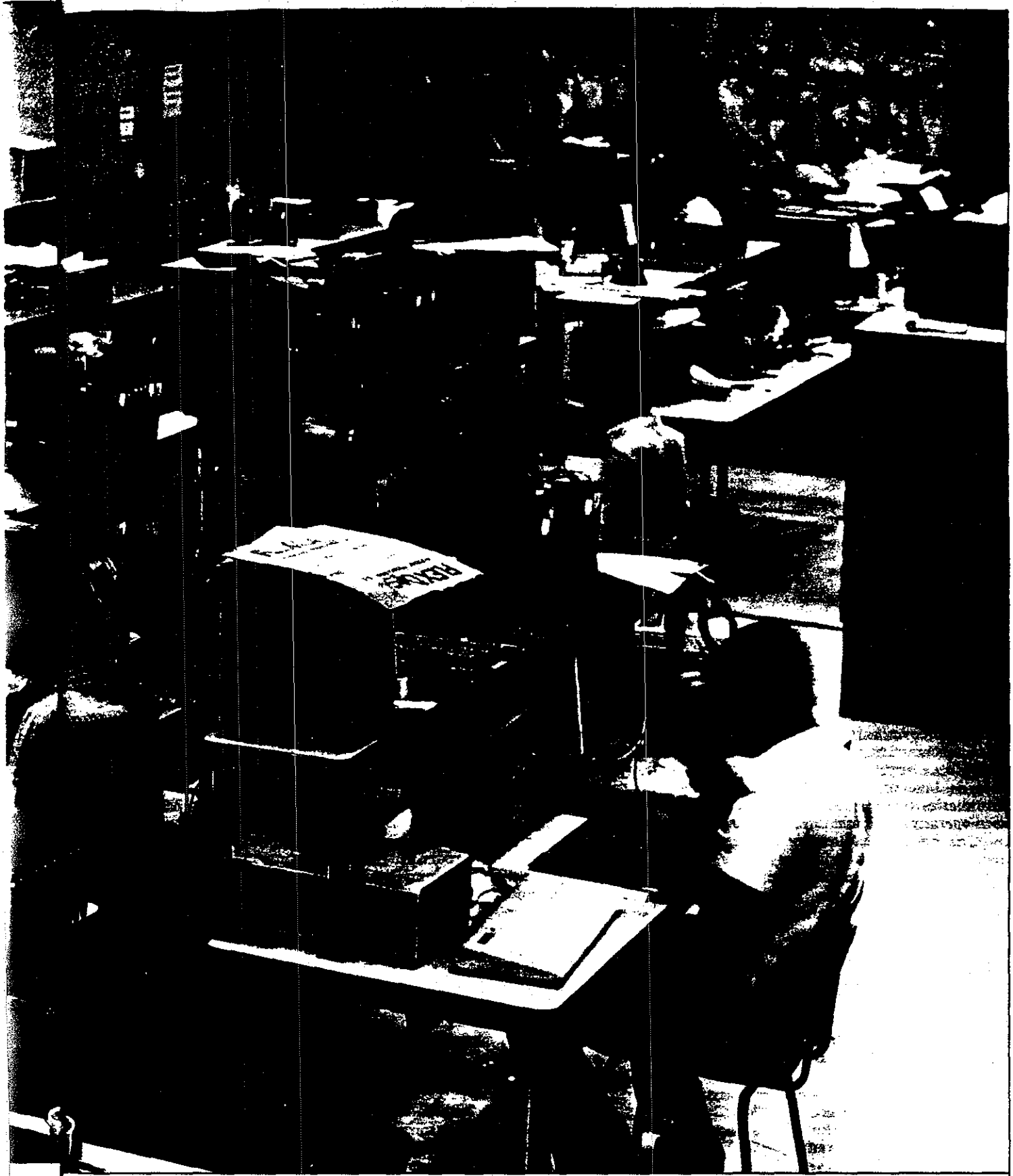
In Brazil over the past few years, the Syrian-born, U.S.-educated Elias played cat-and-mouse with lawyers representing IBM and Microsoft over complaints that Microtec and other Brazilian personal computer makers have been plagiarizing IBM's BIOS microcode and Microsoft's MS-DOS operational software used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

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

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

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

Photos by Paulo Fridman/Sygma



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

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

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

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

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

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

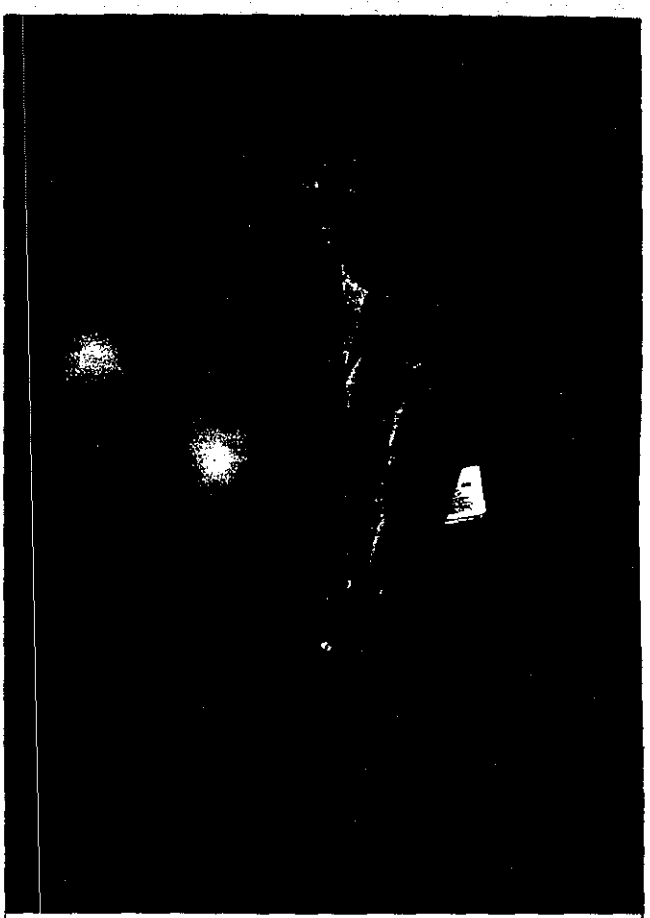
Because of these nationalistic policies, foreign-owned firms are banned from competing in Brazil's personal computer and minicomputer market. Brazil's computer industry is not high tech, if that means being near the cutting edge of worldwide technological advance. But it does show the ability of Brazilian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

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

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

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

Aren't the Brazilians and the others simply doing what



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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

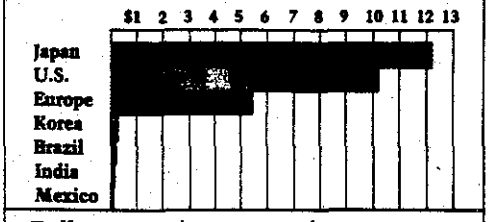
Vernon draws an ominous parallel: "A century ago the multinationals were in plantation agriculture and electric power. Now they're all gone because their technology and management skills were absorbed by local peoples. The same thing is happening in other fields today, including computers."

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

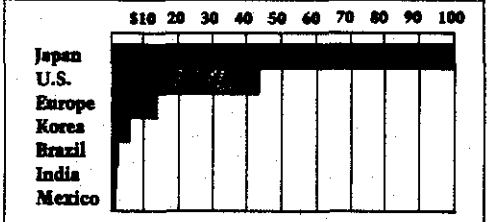
Where the chips fall

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

Semiconductor consumption ($billions)



Dollars per capita consumption



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NewsReview

SERVING AIR FORCE SYSTEMS COMMAND

Labs, inventors 'divvy up' royalties

By JUNE FORTE
AFSC Public Affairs
Andrews AFB, Md.

The Technology Transfer Act of 1986, signed into law by President Reagan Oct. 20, is expected to act as a catalyst in speeding federal laboratory technology into the commercial sector. Because federal inventors will be reaping a 15 percent share of the royalty pie, the new bill may very well spur an era of American inventiveness the likes of which has rarely been witnessed.

The new legislation authorizes the more than 700 federal laboratories to enter into cooperative research agreements with businesses, universities and other organizations.

Although the bill does not specifically prohibit foreign business participation in these joint-research ventures, it is geared toward stimulating the American economy. The Technology Transfer Act also provides for the sharing of licensing revenue between laboratory and inventor. Until Oct. 20, all royalties from patented Air Force inventions went into the Treasury Department coffers.

For Air Force Systems Command laboratories, the new legislation means funds — 85 percent of licensing revenues — earmarked to pursue new research, to support present studies and to pour lifeblood into

See **Legislation,** back page

. . . Legislation to spur inventiveness

From Page 1

projects shelved by budget constraints.

For Systems Command scientists and engineers, the law guarantees them a minimum 15 percent of the take. "Getting the royalties away from the Treasury Department was a four-year struggle," said Frank A. Lukasik, AFSC patent attorney, who has been personally and professionally involved in this legislation since its inception.

In the past, Lukasik said, there hasn't been much action in licensing government-owned inventions. "There's been no champion." With the new bill, the laboratory can license its own inventions. By giving our people a piece of the action, "they can be the champions now," he added.

For purposes of the act, every government location can be considered a laboratory and every federal employee — military and civilian — a potential inventor, he explained.

"Let's say a lab director has something new or novel — say it's an invention — and he or she can't get any further Air Force funds to develop it. The inventor can go out and find a corporation and say 'here's an item that's useful to the Air Force, but it also has a civilian application.' The laboratory now has the authority to accept cash contributions from the business to continue its work in-house or share the work or whatever," Lukasik said.

The word is out, he continued, that the Navy is currently negotiating a license for a laser patent developed by a naval research laboratory inventor. "The Navy will collect $2.5 million, and the inventor is eligible for a $375,000 cash award" — a far cry from the $300 incentive award of the past, which Lukasik said will still be given.

On the Air Force side, the "Two-Dimensional Drawing Board Manikin," an Aeronautical Medical Division (now the Human Systems Division) Human Resources Laboratory invention that was patented in 1977, is also being negotiated for licensing. Although the inventor no longer works for the government, he still will receive 15 percent and the Brooks AFB laboratory will get 85 percent of the royalties, Lukasik said.

AFSC scientists, engineers and other inventors should "dust off their files, dig through their notebooks and check their closets" for applicable inventions, Lukasik urged.

"They can begin by "spreading the word," he advised. But, he cautioned, "Be sure to tell the laboratory director first because there's always a potential for conflict of interest."

Anyone with a patented invention that has commercial application should contact the local Staff Judge Advocate for assistance. For unpatented inventions, work through the AFSC Patent Law Division, AUTOVON 858-5372.